



The Riksbank's operational framework for the implementation of monetary policy – a review

Riksbank Studies, March 2014

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of monetary policy – a review

Production: Sveriges Riksbank
Stockholm March 2014
ISBN 978-91-89612-79-2

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■ Preface

The operational framework for the implementation of monetary policy should be devised so that the Riksbank can steer interest rates and thereby influence economic growth and inflation. Hence, the operational framework has an important role in assuring that the Riksbank can reach its goal of maintaining price stability. The Riksbank should also promote a safe and efficient payments system. This places additional demands on the operational framework. It is crucial that the operational framework is devised so that it enables the Riksbank to handle a financial crisis in the optimal way.

During the autumn of 2008 the Riksbank initiated an inquiry into its operational framework for the implementation of monetary policy. The work of the commission of inquiry proceeded intermittently during the financial crisis of 2008-2009, which also provided valuable input regarding how well the system performs its tasks during turbulent times. During 2010 the commission visited several central banks to learn from their experience, both during normal times and during the financial crisis.¹

Looking forward, the Riksbank will need to continuously evaluate the performance of the operational framework in a changing environment. At the moment there is work in progress on regulating the financial sector, which might have a bearing on how the operational framework for the implementation of monetary policy is devised. The commission's review should therefore be viewed as a status report rather than a final evaluation of the operational framework. The commission of inquiry raises some issues that the Riksbank should consider working on in order to make the operational framework even more effective and better able to handle future crises.

The commission of inquiry has consisted of Peter Sellin and Per Åsberg Sommar, and with participation of Johanna Eklund in writing the study on the overnight market presented in chapter 4. The commission has been supported by a steering group consisting of representatives from the Monetary Policy Department, the Financial Stability Department and the Asset Management Department.²

Peter Sellin

Adviser, Monetary Policy Department

Per Åsberg Sommar

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- 1 The commission would like to express its gratitude for interesting discussions with representatives from the different central banks and the important feedback we received on chapter 5 in the inquiry.
 - 2 The commission would like to especially thank Björn Andersson, Meredith Beechey, Heidi Elmér, Henrik Gardholm, Ylva Hedén, Per Kvarnström, Kerstin Mitlid, Antti Koivisto, Kjell Nordin, Jan Schüllerqvist as well as participants in the steering group that have helped move to the inquiry forward in different ways.

■ Summary

Conclusions

The Riksbank's present operational framework for the implementation of monetary policy was launched in June 1994. This commission of inquiry is the first major review performed of the operational framework.¹ For the inquiry to be meaningful it is essential that we first make clear what tasks an operational framework should be able to fulfil. The commission has identified four such fundamental tasks:

- ensuring that the operational target of the central bank – usually the level of a short money market rate – is met
- mitigating volatility (fluctuations) in short money market rates
- underpinning an active money market to achieve an effective impact of monetary policy-related interest rate changes on longer rates
- enabling the central bank to provide liquidity support when needed.

If a central bank considers taking a measure in order for the operational framework to fulfil these tasks, it should always observe that the measure should be devised in such a way that it does not jeopardise the incentive of banks to find appropriate solutions on their own. For instance, banks should have sufficient incentive to manage their liquidity risks on their own.

Based on these tasks and the need for an incentivising structure, we have studied whether the Riksbank's operational framework for the implementation of monetary policy serves its purpose. We have found that:

- The operational framework has succeeded in stabilising the overnight rate close to the repo rate – even during the financial crisis.
- Volatility in the overnight rate remained subdued during the financial crisis. On the other hand, the volatility in the tomorrow/next-rate has been elevated during as well as immediately after the crisis.
- Traded volumes in the money market decreased during the financial crisis, although there were some trades and price formation seem to have worked reasonably well.
- Extraordinary lending in Swedish kronor as well as in US dollars for shorter and longer terms was conducted during the financial crisis in an effective

¹ At the end of Chapter 1 there is a text box that provides a brief description of the Riksbank's operational framework for the implementation of monetary policy.

way. In addition, the operational framework has been made more robust thanks to measures taken during the crisis:

- The introduction of a new counterparty category, “restricted monetary policy counterparty”, has improved the possibility to supply liquidity to banks in a financial crisis
- By setting up a portfolio in Swedish kronor denominated government bonds the Riksbank now has the system and competence in place to transact in Swedish bonds, which could prove useful in a crisis situation

Thus, the main message is that the Riksbank’s operational framework for implementing monetary policy has worked reasonably well both in normal times and during the financial crisis.

The inquiry’s different parts

The commission’s conclusions are presented in more detail in Chapter 1. The conclusions are based on the work contained in four substudies included in the commission of inquiry, which are presented in chapters 2-5. We will now give an overview of the commission of inquiry’s substudies.

THE CENTRAL BANK’S OPERATIONAL FRAMEWORK FOR THE IMPLEMENTATION OF MONETARY POLICY – A REVIEW OF LITERATURE

We go through studies of operational frameworks for the implementation of monetary policy published in academic periodicals and central bank publications. There is largely a consensus view that the central bank ought to attempt to steer a short market rate towards an operational target. Also, the central bank should attempt to minimise fluctuations in the short rate around the target in order to signal more clearly how tight (or stimulative) monetary policy is intended to be.

There is a great deal of literature that highlights different aspects of the use of interest rate corridors, i.e. a system in which the movements of the overnight rate are limited by the central bank standing prepared to lend and borrow money overnight at determined interest rates. We discuss what determines where in the corridor the overnight rate will end up. Here, the central bank’s liquidity supply to the banking system is shown to be of great significance. The literature also highlights problems with the corridor system. For example, it is not certain that a bank will want to utilise the central bank’s lending facility because this could signal to other banks that the bank in question has liquidity problems. Utilising the lending facility then carries a stigma.

We also go through literature addressing the use of minimum reserve requirements to steer a short-term money market rate. Because minimum reserve

requirements only have to be met on average over a certain period, the intention is to give the banks an incentive to even out fluctuations in the overnight rate that might arise during the period in question. However, several studies show problems that nevertheless give high volatility in a system with average minimum reserve requirements.

THE RIKSBANK'S OPERATIONAL FRAMEWORK FOR THE IMPLEMENTATION OF MONETARY POLICY

In this substudy we describe how the Riksbank steers the overnight rate for interbank loans in practice. We present the instruments in the Riksbank's toolkit and how these are used.

We find that the Riksbank's operational framework for the implementation of monetary policy serves its purpose in terms of stabilising the very shortest rate – the overnight (o/n) rate. However, we also show that this does not suffice for the repo rate to have a predictable influence on interest rates with longer maturities than overnight. In particular, we have noted that the rate with the tomorrow/next maturity is much more volatile than in other countries. We also find that experience from the latest financial crisis demonstrates that it is desirable for the Riksbank to stand well prepared to conduct monetary policy under extraordinary circumstances.

BALANCING LIQUIDITY BETWEEN SWEDISH BANKS OVERNIGHT 2007-2011

We use statistics of transactions from the Riksbank's payment system RIX to study how the overnight market works and how monetary policy is effectively conducted. The study shows that, both before and during the crisis, the overnight rate varied within the band deemed by the Riksbank to represent effectively implemented monetary policy. At the same time, the results show that the deviation of the overnight rate from the repo rate and the level of volatility in the overnight rate have both increased since the outbreak of the financial crisis.

In addition, the study shows that the level of activity on the overnight market was low during the financial crisis. The level of activity did not increase until October 2010, when the Riksbank's last fixed-interest rate loan with a one-year maturity fell due. However, the banks' liquidity planning seems to have changed slightly after the crisis. For example, banks that previously systematically financed large deficits on the overnight market have done so to a significantly lesser degree since October 2010.

OPERATIONAL FRAMEWORK FOR THE IMPLEMENTATION OF MONETARY POLICY

Different central banks use somewhat different operational frameworks for the implementation of monetary policy. In this study, we compare the operational

frameworks used in 12 different currency areas: Australia, Canada, Sweden, the Eurozone, the UK, the Czech Republic, Poland, Hungary, the US, Switzerland, Norway and New Zealand. The common factor of these areas is that their central banks have an inflation target, or a similar target for monetary policy.

We study how successful the various central banks have been in reaching their respective operational targets. These are often expressed as a target for a short money market rate. We also study how the central banks have managed to stabilise the short money market rates around the target. Most have been fairly successful in this by ensuring well-balanced liquidity in the banking system.

Underpinning an active money market, and in so doing establishing an efficient transmission of interest rate changes to longer maturities, is also an important task for the central bank. We provide examples of how some central banks have acted in this area. We note that there are central banks that have contributed to a liquid repo market being established, which the central bank could then use to conduct its market operations.

Finally, the central bank has a responsibility for providing liquidity-supporting measures when needed. Here, we attempt to systematically go through the approaches of the various central banks in our study. We have noted in particular that some central banks have opted to make permanent certain facilities introduced during the financial crisis to provide the banks with liquidity support. It might be an advantage to have such facilities in place to be able to act swiftly in a potential future crisis. However, if incorrectly devised, such permanent facilities can create moral hazard problems. The banks then expect support from the central bank instead of preventing the problems themselves.

Questions for further work

During the commission's work we have identified six questions regarding the operational framework that the Riksbank should consider. We will now briefly present these questions.

ACHIEVING THE CENTRAL BANK'S OPERATIONAL TARGET

Choice of operational target – an overnight rate target?

Unlike many other central banks, the Riksbank does not provide an express target for the overnight rate level, even though the operational objective of the Riksbank's monetary policy is to steer this very rate. Instead, in its monetary policy decisions, the Riksbank establishes that the repo rate, which is the rate used by the Riksbank in its monetary policy repos, is to be at a certain level.

The Riksbank could improve the clarity of the operational framework by starting to signal a desired level for the overnight rate without involving the repo rate. The following question thus merit further investigation:

Question 1. Should the interest rate level on which the Executive Board decides at its monetary policy meetings be formulated as an operational target for the overnight rate?

How wide should the interest rate corridor be?

A wide interest rate corridor provides strong incentives for the banks to exchange money with each other at the end of the day instead of using the Riksbank's standing facilities. But, the question is, does it need to be as wide as it is today? A narrower corridor would ensure a more effective implementation of monetary policy. This provides the basis for the next question on which to work further:

Question 2. How wide should the interest rate corridor be to ensure that banks have the right incentives to lend to each other rather than use the Riksbank's standing deposit facility and at the same time assuring an effective implementation of monetary policy?

MITIGATING VOLATILITY OF THE SHORTEST MONEY MARKET RATES

Given our method of calculating the overnight rate in Chapter 4, we can say that it fulfils the operational target of being close to the repo rate. The question is, however, whether our definition of the overnight rate is too narrow and whether a more comprehensive calculation of the overnight rate would paint a different picture of volatility.

The tomorrow-next (t/n) maturity, on loans from tomorrow until the following day, is particularly important because fixed income instruments in Sweden, unlike in many other countries, are based on the t/n rate and not on the overnight rate. This fact and the volatility we can observe, particularly at times when trading volumes in fixed-income instruments are highest (on IMM days), justify reviewing the need and ability to establish better functioning rate formation for the t/n maturity. A third question to work further on is thus:

Question 3. Does the pricing of loans with overnight and tomorrow/next maturities work sufficiently well?

UNDERPINNING AN ACTIVE MONEY MARKET

An active money market is fundamental to the overnight rate having an effective impact on longer rates.

Facilitating interbank secured loans?

If for some reason a bank finds it too risky to lend money to another bank on an unsecured basis at the end of the day, problems arise. This can lead to banks with a liquidity surplus refraining from lending to other banks with a deficit, and instead placing their surplus in the Riksbank's standing deposit facility. Then, another bank is forced to borrow from the Riksbank's lending facility. This prompts the following question:

Question 4. Should the Riksbank seek to achieve more efficient collateral management that facilitates overnight loans secured by collateral?

Transaction-based rates for the overnight and tomorrow/next maturities create conditions for a liquid derivatives market

The review of the operational framework has shown that it is possible to establish rates for individual loans overnight between the participants of the RIX payment system. Based on such interest rate data, it is then possible to calculate on a daily basis the average interest rate for interbank overnight loans. This is currently done as needed. However, we find that, as a matter of immediate urgency, the Riksbank should take the initiative for establishing and publishing transaction-based rates for the very shortest maturities (o/n and t/n) on an ongoing basis. This would not only make it possible to evaluate the implementation of monetary policy, but would also create the fundamentals for the emergence of fixed income instruments that can efficiently price risk on the money market. The next question to work further on is thus:

Question 5. Under which forms should the Riksbank contribute to transaction-based rates for the shortest maturities (overnight and tomorrow/next) being established and published on an ongoing basis?

THE RIKSBANK'S LIQUIDITY SUPPORT

Experience from the financial crisis shows the importance of the Riksbank standing prepared to quickly take appropriate extraordinary measures when the need arises. However, changes and new measures require preparation before they can be implemented. It is therefore important that procedures and systems for transactions that might come into play in a crisis situation are in place in advance. It motivates a sixth and final question to further work on:

Question 6. Which specific expertise and infrastructure does the Riksbank need to stand constantly prepared to quickly and efficiently supply liquidity to its counterparties in crises?

Many of the questions raised above affect to some extent the incentive of banks to manage liquidity and liquidity risks. When working with these matters, the gains from the Riksbank offering solutions to the problems must be weighed against the weakened incentive of banks to address the problems themselves.

■ A review of the operational framework for the implementation of monetary policy

The commission of inquiry's task and conclusions

The Riksbank's present operational framework for the implementation of monetary policy was launched in June 1994. This commission of inquiry is the first major review performed of the operational framework. The key question is whether the operational framework serves its purpose. What characterises an operational framework that serves its purpose? It depends on what the operational framework is to achieve. In a study of the literature on the area and discussions with a number of central banks, we have identified four fundamental tasks that the operational framework of a central bank is to fulfil:

- ensuring that the operational target of the central bank – usually the level of a short-term money market rate – is met
- mitigating volatility in short-term money market rates
- underpinning an active money market to achieve an efficient transmission mechanism
- enabling the central bank to provide liquidity support when needed.

If a central bank considers taking a measure in order for the operational framework to fulfil these tasks, it should always observe that the measure should be devised in such a way that it does not jeopardise the incentive of banks to find appropriate solutions on their own. For instance, banks should have sufficient incentive to manage their liquidity risks on their own.

Based on these tasks and the need for an incentivising structure, we have studied whether the Riksbank's operational framework for the implementation of monetary policy serves its purpose. We have found that:

- The operational framework has succeeded in stabilising the overnight rate close to the repo rate – even during the financial crisis.
- Volatility in the overnight rate remained subdued during the financial crisis. On the other hand, the volatility in the tomorrow/next-rate has been elevated during as well as immediately after the crisis.

- Traded volumes in the money market decreased during the financial crisis, although there were some trades and price formation seem to have worked reasonably well.
- Extraordinary lending in Swedish kronor as well as in US dollars for shorter and longer terms was conducted during the financial crisis in an effective way. In addition, the operational framework has been made more robust thanks to measures taken during the crisis:
 - The introduction of a new counterparty category, “restricted monetary policy counterparty”, has improved the possibility to supply liquidity to banks in a financial crisis.
 - By setting up a portfolio in Swedish kronor denominated government bonds the Riksbank now has the system and competence in place to transact in Swedish bonds, which could prove useful in a crisis situation.

Thus, the main message is that the Riksbank’s operational framework for implementing monetary policy has worked reasonably well both in normal times and during the financial crisis. However, this does not guarantee fulfilment of the tasks in the future, which motivates a review of what additional improvements could be considered. The commission has identified the following six questions on which the Riksbank should consider working further:

1. Should the interest rate level on which the Executive Board decides at its monetary policy meetings be formulated as an operational target for the overnight rate?
2. How wide should the interest rate corridor be to ensure that banks have the right incentives to lend to each other rather than use the Riksbank’s standing deposit facility and at the same time assuring an effective implementation of monetary policy?
3. Does the pricing of loans with overnight and tomorrow/next maturities work sufficiently well?
4. Should the Riksbank seek to achieve more efficient collateral management that facilitates overnight loans secured by collateral?
5. Under which forms should the Riksbank contribute to transaction-based interest rates for the shortest maturities (overnight and tomorrow/next) being established and published on an ongoing basis?
6. Which specific expertise and infrastructure does the Riksbank need to stand constantly prepared to quickly and efficiently supply liquidity to its counterparties in crises?

THE TASK OF THE COMMISSION OF INQUIRY

The task of the commission has been to evaluate whether the Riksbank's operational framework for the implementation of monetary policy serves its purpose. The evaluation of the operational framework for the implementation of monetary policy is presented in this chapter, and is based on four substudies that aim to:

- Explore the principles behind an operational framework for the implementation of monetary policy and highlight the characteristics of a good operational framework. We do this in the framework of a literature review (Chapter 2).
- Explain how the Riksbank's present operational framework functions. This involves taking stock of and documenting the materials and decisions that form the basis for how the present operational framework for the implementation of monetary policy is structured (Chapter 3).
- Explore whether the structure of the operational framework is such that the Swedish overnight rate constitutes a stable anchor for the formation of longer interest rates (Chapter 4).
- Compare the operational frameworks of certain other central banks to benefit from their experience from implementing monetary policy in the framework of a system with inflation targeting (Chapter 5).

These substudies form the basis of our evaluation in this chapter.

WORK OF THE COMMISSION

In the autumn of 2008 we commenced work on the review by taking stock of academic literature and central bank publications on the practical implementation of monetary policy. This work proceeded intermittently during the financial crisis of 2008-2009 and resulted in a review of literature that provides an overarching account and analysis of what an operational framework for the implementation of monetary policy is intended to achieve, and how it can be constructed. The literature study constitutes Chapter 2 of this study.

In 2010 we visited a great number of the central banks included in the comparative study we conducted of the different central banks' operational frameworks. This provided us with invaluable insight into how different fundamentals and considerations can lead to operational frameworks for the implementation of monetary policy being devised in different ways. A preliminary study was sent out to the various central banks at the end of 2012, which led to us receiving very valuable comments which we incorporated into the text. In Chapter 5, we describe the operational frameworks for the implementation of

monetary policy of the various central banks, and the lessons we learned from them.

Our interest then turned to how the overnight market in Sweden works, because that market constitutes the first stage of the monetary policy transmission mechanism. At the beginning of 2011 we published an article in the Riksbank publication *Economic Review*, on the Swedish market for balancing liquidity overnight during the period 2007-2010 (Eklund and Åsberg Sommar (2011)). This analysis is based on overnight loan data not previously available, but that has been prepared in the framework of this project. The article is included as Chapter 4 of the review.

In mid-2012 we published an article in *Economic Review* describing the Riksbank's operational framework for the implementation of monetary policy and providing a background for its present form (Sellin and Åsberg Sommar (2012)). This is provided as Chapter 3 of this study.

We are currently in a situation in which the crisis measures of central banks abroad have not yet been concluded. This commission of inquiry should thus be seen as a status report rather than a final evaluation of how the system works – especially in light of the work in progress on regulating the financial sector, which might have a bearing on how the operational framework for the implementation of monetary policy is devised.

Summary of the inquiry's different parts

Here, we provide an overview of the four subprojects included in the commission of inquiry. We start with a review of what academic and central bank literature have to say about the practical implementation of monetary policy. We then turn to a description of the present form of the Riksbank's operational framework. Focus then turns to the overnight rate, which the operational framework is intended to steer. We then compare the operational frameworks of 12 different central banks to find out what lessons can be drawn from them.

THE CENTRAL BANK'S OPERATIONAL FRAMEWORK FOR THE IMPLEMENTATION OF MONETARY POLICY – A REVIEW OF LITERATURE

We go through studies of operational frameworks for the implementation of monetary policy published in academic periodicals and central bank publications. There is largely a consensus view that the central bank ought to attempt to steer a short market rate towards an operational target. Also, the central bank should attempt to minimise fluctuations in the short rate around the target in order to signal more clearly how tight (or stimulative) monetary policy is intended to be.

There is a great deal of literature that highlights different aspects of the use of interest rate corridors, i.e. a system in which the movements of the overnight rate are limited by the central bank standing prepared to lend and borrow money overnight at determined interest rates. We discuss what determines where in the corridor the overnight rate will end up. Here, the central bank's liquidity supply to the banking system is shown to be of great significance. The literature also highlights problems with the corridor system. For example, it is not certain that a bank will want to utilise the central bank's lending facility because this could signal to other banks that the bank in question has liquidity problems. Utilising the lending facility then carries a stigma.

We also go through literature addressing the use of minimum reserve requirements to steer a short-term money market rate. Because minimum reserve requirements only have to be met on average over a certain period, the intention is to give the banks an incentive to even out fluctuations in the overnight rate that might arise during the period in question. However, several studies show problems that nevertheless give high volatility in a system with average minimum reserve requirements.

THE RIKSBANK'S OPERATIONAL FRAMEWORK FOR THE IMPLEMENTATION OF MONETARY POLICY¹

In this subproject we describe how the Riksbank steers the overnight rate for interbank loans in practice. We present the instruments in the Riksbank's toolkit and how these are used.

We find that the Riksbank's operational framework serves its purpose in terms of stabilising the very shortest rate – the overnight (o/n) rate. However, we also show that this does not suffice for the repo rate to have a predictable influence on interest rates with longer maturities than overnight. In particular, we have noted that the rate with the tomorrow/next maturity is much more volatile than in other countries. We also find that experience from the latest financial crisis demonstrates that it is desirable for the Riksbank to stand well prepared to conduct monetary policy under extraordinary circumstances.

BALANCING LIQUIDITY BETWEEN SWEDISH BANKS OVERNIGHT 2007-2011

We use statistics of transactions from the Riksbank's payment system RIX to study how the overnight market works and if monetary policy is effectively conducted. The study shows that, both before and during the crisis, the overnight rate varied within the band deemed by the Riksbank to represent efficiently implemented monetary policy. At the same time, the results show that the deviation of the

¹ A fact box briefly describing the Riksbank's operational framework can be found at the end of this chapter.

overnight rate from the repo rate and the level of volatility in the overnight rate have both increased since the outbreak of the financial crisis.

In addition, the study shows that the level of activity on the overnight market was low during the financial crisis. The level of activity did not increase until October 2010, when the Riksbank's last fixed-interest rate loan with a one-year maturity fell due. However, the banks' liquidity planning seems to have changed slightly after the crisis. For example, banks that previously systematically financed large deficits on the overnight market have done so to a significantly lesser degree since October 2010.

OPERATIONAL FRAMEWORK FOR THE IMPLEMENTATION OF MONETARY POLICY

Different central banks use somewhat different operational frameworks for the implementation of monetary policy. In this study, we compare the operational frameworks used in 12 different currency areas: Australia, Canada, Sweden, the Eurozone, the UK, the Czech Republic, Poland, Hungary, the US, Switzerland, Norway and New Zealand. The common factor of these areas is that their central banks have an inflation target, or a similar target for monetary policy.

We study how successful the various central banks have been in reaching their respective operational targets. These are often expressed as a target for a short money market rate. We also study how the central banks have managed to stabilise the short money market rates around the target. Most have been fairly successful in this by ensuring well-balanced liquidity in the banking system.

Underpinning an active money market, and in so doing establishing an efficient transmission of interest rate changes to longer maturities, is also an important task for the central bank. We provide examples of how some central banks have acted in this area. We note that there are central banks that have contributed to a liquid repo market being established, which the central bank could then use to conduct its market operations.

Finally, the central bank has a responsibility for providing liquidity-supporting measures when needed. Here, we attempt to systematically go through the approaches of the various central banks in our study. We have noted in particular that some central banks have opted to make permanent certain facilities introduced during the financial crisis to provide the banks with liquidity support. It might be an advantage to have such facilities in place to be able to act swiftly in a potential future crisis. However, if incorrectly devised, such permanent facilities can create moral hazard problems. The banks then expect support from the central bank instead of preventing the problems themselves.

Considerations and identified matters for further work

As noted in the introduction, we have arrived at the conclusion that the primary tasks of the operational framework are, with an incentivising structure that gives the banks the incentive to manage their own credit risks in the first instance,

- ensuring that the operational target of the central bank – usually the level of a short-term money market rate – is met
- mitigating volatility in short-term money market rates
- underpinning an active money market to achieve an efficient transmission mechanism
- enabling the central bank to provide liquidity support when needed.

We discuss below whether the Riksbank's operational framework is appropriately devised to fulfil these tasks. We identify and discuss questions on which to work further. In this work it will be important to strike a balance between the Riksbank offering measures that enhance the efficiency of liquidity management, and the cost of a reduced incentive of the market to find appropriate measures on its own.

ACHIEVING THE CENTRAL BANK'S OPERATIONAL TARGET

Choice of operational target – an overnight rate target?

There is largely a consensus view among central banks about what the operational target should be. Most central banks try to steer a short market rate, most commonly the overnight rate on loans from today until the following business day. It is the interest rate over which the central bank has most control, because it can force banks to borrow from or deposit with the central bank overnight at a rate the central bank determines itself. This interest rate level then guides the rates paid by banks when they borrow from each other overnight, and the rate they offer their customers. The central bank steers the overnight rate either directly by deciding on an overnight rate target, or indirectly by the standing facilities being linked to (or the market operations being conducted at) the policy rate which is to guide the overnight rate.

The Riksbank's operational target has been formulated such that the overnight rate is to be close to the repo rate. The repo rate level is determined by the Executive Board at its monetary policy meetings six times per year, and is the rate used by the Riksbank in its monetary policy repos. It works as a reference rate for the policy rates used by the Riksbank in its standing facilities and for the open market operations it performs. The market operations consist of the weekly issues of Riksbank certificates (at the repo rate) and the daily fine-tuning transactions (at

the repo rate +/- 10 basis points). The fine-tuning runs until the following business day, while the certificates usually have a one-week maturity.

Unlike many other central banks, the Riksbank does not state any express target for the overnight rate level, despite this being the operational target for the Riksbank's monetary policy. Instead, the Riksbank sets the level of the repo rate, which is the rate the Riksbank uses in its monetary policy repos and then expresses that the overnight rate is to be close to the repo rate. This relationship can cause uncertainty about which interest rate the Riksbank is actually trying to steer. Also, the Riksbank is not currently conducting any monetary policy repos, but offering Riksbank certificates with a one-week maturity at the repo rate.

The Riksbank could thus improve the clarity of the operational framework by starting to signal a desired level for the overnight rate without involving the repo rate. The following question thus merits further investigation:

Question 1. Should the interest rate level on which the Executive Board decides at its monetary policy meetings be formulated as an operational target for the overnight rate?²

How wide should the interest rate corridor be?

At its meeting on 6 December 2000, the Executive Board decided that the width of the interest rate corridor shall be 150 basis points until further notice. The decision documentation states that "A corridor width of 150 basis points has shown to bring about a functioning overnight market". But, how was a corridor width of 150 basis points originally derived? To answer this question we have to look back into history.

On 19 November 1992 the Riksbank was forced to abandon the stable exchange rate and let the krona float. This changed the conditions for the Riksbank's choice of rate steering system. The biggest deficiency in the old system was considered to be that it did not allow the bank to send subtle signals about where the interest rate was headed. A project was commenced in the autumn of 1993 to review the operational framework. On 26 May 1994, the General Council of the Riksbank decided on a new operational framework, to apply as of 1 June 1994. The Council decided to steer the overnight rate within an interest rate corridor, initially with a width of 150 basis points. Furthermore, it was decided that

"The Governor of the Riksbank has the right to decide on the repo rate within the framework of the guidelines agreed with the Council. He also has the right to

2 If an overnight rate target is introduced, it should also be ensured that objective fulfilment can be evaluated by publishing, on an ongoing basis, a calculated overnight rate, which does not currently exist. We come back to this in question 6 below.

decide on changes to the deposit and lending rate, if he deems the situation to be of such urgency that a decision by the Council cannot be awaited”.

The fact that the Governor can decide himself on the level of the repo rate within the corridor is of some importance in the choice of the corridor width, as described in the decision documentation (page 154f):³

“The corridor, i.e. the difference between the deposit and lending rate, within which the repo rate is set should be wide enough to provide sufficient scope for variations in the repo rate. Incentives for a smoothly functioning interbank market for overnight loans and other short-term deposits should also be upheld. In the current situation, a spread between the deposit and lending rate amounting to 1.5 percentage points is deemed appropriate.”

In an earlier passage it was judged that a corridor width of 100 basis points suffices for the banks to exchange money with each other on the overnight market instead of borrowing from or keeping surpluses deposited with the Riksbank (page 7):

“A system with clear incentives for balancing relative differences in liquidity between the banks is preferable. Earlier experience states that the alternative interest expense or interest income should correspond to a difference equalling around 100 basis points.”

In a number of examples of how the new interest rate steering system is intended to work, a corridor of 100 basis points is also used. The extra 50 basis points could thus be due to the wish to provide the Governor with sufficiently large scope, within the corridor decided by the Council, in which he can set the repo rate.

So, has the rate corridor system worked? Before Lehman Brothers collapsed, there was an informal agreement on the Swedish interbank market whereby the banks balanced liquidity overnight on an unsecured basis between themselves at the repo rate. The overnight rate thus ended up in the range of what is considered to be efficiently implemented monetary policy. However, this ultimately relied on the convention on which the banks had agreed, rather than a mechanism within the operational framework for the implementation of monetary policy. The Riksbank's extensive lending to the banks between October 2008 and October 2010 involved the banking system as a whole having a liquidity surplus towards the Riksbank. The banks thus did not need to balance liquidity surpluses and deficits between themselves overnight to any great extent over that period. It was only when the liquidity surplus in the banking system decreased, in connection with the Riksbank's final twelve-month fixed-rate loan maturing in October 2010, that the terms of the banks' overnight liquidity balancing were put to the test.

3 The Riksbank's new interest rate steering system – Source material in the interest rate steering project, 26/05/1994.

Some friction in liquidity balancing has emerged since then. Situations have arisen resembling a temporary monopoly, in which an individual bank could utilise its negotiation power to push up the price of overnight loans to other banks with a liquidity deficit.

If a central bank is to be able to conduct monetary policy by steering the short rate, the central bank must have an undisputed role of mediator of overnight liquidity when the banks cannot agree among themselves. Henckel et al (1999) warn that game play situations can arise in interbank overnight liquidity balancing, whereby a bank with a liquidity surplus chooses to be uncooperative for strategic reasons. The aim is to push other banks with a liquidity deficit into a corner and push up the price of overnight loans. It can go so far that the banks do not agree and ultimately have to use the central bank's standing deposit and lending facilities. Henckel et al (1999) find that the role of the central bank is to mediate liquidity from banks with a surplus to those with a deficit when the banks themselves cannot agree on the terms on which overnight liquidity balancing is to occur.

The UK has experienced serious problems on the overnight market resembling the points made by Henckel et al (1999). Because the problems in interbank liquidity balancing resulted in high volatility in the overnight (o/n) rate, the Bank of England (BoE) changed its operational framework in March 2005. According to Paul Tucker (2004): "Broadly, at present a single OMO counterparty can take our money – so that the system is square vis-à-vis the Bank – and seek to influence the market overnight rate by trading at a different rate from the Bank's rate" (page. 364). Tucker calls the fact of the Bank of England only intervening to correct the banking system's net position towards the BoE "the first fundamental flaw of the Bank's current system". This leads him to draw the conclusion: "So a first basic design principle is that a well-constructed system involves the possibility of gross intermediation across the central bank's balance sheet". The other fundamental flaw is, according to Tucker, that the Bank of England has too few counterparties with access to the deposit and lending facilities, and that it is too expensive to use them; in other words, the rate corridor is too wide.⁴ Tucker's conclusion is that: "A second basic design principle, therefore, is that access to intermediation via the Bank's balance sheet needs to be widespread and at an unprohibitive price" (page. 365).

4 The Bank of England did not have a corridor in the proper sense before the operational framework was changed in March 2005. Prior to that, the Bank of England had a deposit facility in which its counterparties could invest money overnight at a deposit rate of 100 basis points below the Bank rate, while the Bank of England conducted open market operations each day in the form of repos with a maturity of around two weeks in order to lend money to counterparties. In the event of counterparties needing further liquidity, it was possible to borrow money through a late lending facility at a rate that was 150 basis points above the Bank rate. The deposit facility and late lending facility thus created a corridor that was 250 basis points wide.

Like in the BoE's previous system, the Riksbank uses a wide interest rate corridor and only corrects the banking system's net position towards the bank (an amount equalling the banking system's liquidity surplus or deficit at the end of the day is lent/borrowed through the fine-tuning transactions). This, according to Paul Tucker, constitutes fundamental flaws in the operational system. In 2006 the BoE therefore switched to creating a narrower and symmetrical rate corridor of ± 25 basis points. Before that the BoE steered the overnight rate by enabling the banks to deposit liquidity surpluses overnight at a rate 100 basis points below the overnight rate, or borrow money from the BoE through the market operations four times a day at rates up to 150 basis points above the overnight rate, depending on when during the day they were conducted. A narrower rate corridor enables, when needed, performing a gross intermediation across the central bank's balance sheet (use of the lending and deposit facilities) without it creating high volatility of the overnight rate.

In our comparison of the operational frameworks in Chapter 5, we note that both the Reserve Bank of Australia (RBA) and the Bank of Canada, which use a narrow rate corridor of ± 25 basis points, have had extremely good objective fulfilment, both in normal circumstances and in the financial crisis. An important condition for success is that they make sure daily that liquidity in the system is balanced so that the banks trade in overnight loans at an interest rate close to the central bank's overnight rate target. In these countries, a corridor width of ± 25 basis points has proven sufficient for the banks to borrow money from each other instead of using the central bank's standing facilities in the first instance. When the RBA started to pay interest on deposits in August 1996, it set the deposit rate at 10 basis points below the target rate. This led to the banks preferring to invest money in the RBA rather than lend money on the overnight market. The RBA then changed the deposit rate to 25 basis points below the target rate (in October 1997) and the banks then started in the first instance to borrow money from each other at a rate within 10 basis points of the target rate.

The fact that the Riksbank offers fine-tuning transactions at the end of each business day to balance the banking system's position towards the Riksbank does not guarantee that the overnight rate will be close to the target, because it is the interest rates on the deposit and lending facilities that set the actual limits of the overnight rate. In a wide corridor, the banks' negotiation power towards each other might potentially become important for the deviation of the overnight rate from the target. If the rate corridor were narrower, however, the deviation of the overnight rate from the target could not be so large. Also, a narrower corridor should help de-stigmatise use of the Riksbank's standing facilities. A condition for this is, however, that the Riksbank is clear in its communication that only solvent banks may use the standing facilities. But, the narrower the corridor, the more the

incentive to use the facilities increases, which could lead to higher average volatility than we have observed to date.

On the whole, we note that the Riksbank, for the standing facilities, uses a wide rate corridor of ± 75 basis points around the repo rate (or actually the overnight rate target). This provides strong incentives for the banks to exchange money with each other at the end of the day instead of using the Riksbank's standing facilities. However, because the rate corridor is so wide, it cannot guarantee that the interest rate decisions of the Executive Board, which are usually a matter of a 25-basis-point change, will be reflected in the overnight rate. That would motivate a corridor width of a maximum of ± 25 basis points. The wide corridor also provides potential scope for major deviations in the overnight rate from the target, depending on the negotiation power of the banks in relation to each other on the overnight market. Finally, a wide corridor carries a stigma – the lending rate is considered to be a penalty rate rather than an incentivising, well-balanced cost for utilising the Riksbank's standing facilities. A narrower corridor would help de-stigmatise using the Riksbank's standing facilities and reduce the negotiation power of individual banks. A condition for this is, however, that the Riksbank is clear in its communication that only solvent banks may use the standing facilities, and the intention of having a rate corridor is so banks will resolve liquidity distribution among themselves in the first instance. This provides the basis for the next question to work further on:

Question 2. How wide should the interest rate corridor be to ensure that banks have the right incentives to lend to each other rather than use the Riksbank's standing deposit facility and at the same time assuring an effective implementation of monetary policy?

MITIGATING VOLATILITY OF THE SHORTEST MONEY MARKET RATES

Why is low volatility important?

If monetary policy is to be plain and clear, it helps if volatility of the shortest money market rates is low. Because, a stable overnight rate constitutes a necessary, if not sufficient, anchor for stabilising the formation of longer interest rates. In the framework of the review of the operational framework, we have calculated the overnight rate based on overnight transactions in the Riksbank's payment system RIX (see Chapter 4). Calculated on this method, we can say that volatility of the overnight rate meets the operational target of being close to the repo rate. The question is, however, whether the definition of the overnight rate is too narrow bearing in mind that it does not cover transactions conducted between financial institutions (and other firms) that are not RIX participants. A more

comprehensive calculation of the overnight rate could paint a different picture of volatility.

The rate on the tomorrow-next (t/n) maturity, i.e. on loans from tomorrow until the following day, is particularly important because fixed income instruments in Sweden, unlike in many other countries, are based on the t/n rate and not on the overnight rate. This means that the development of the t/n rate is directly linked to other fixed income instruments and the formation of interest rates in these submarkets. We can also note that the Riksbank lacks a framework for steering the rate for the t/n maturity. Prior to the financial crisis, the rate on the Swedish market for the maturity was firmly anchored at 0.10 percentage points above the overnight rate. In connection with the phase-out of the Riksbank's extraordinary measures in the form of long-term lending in October 2010, volatility on the t/n market became high at the same time as the three-month rate rose in relation to the overnight rate. It would be natural for the higher t/n volatility to have been reflected in a higher risk premium on longer maturities. It indicates that the monetary policy transmission mechanism started to function less well during this period, even though there are other factors explaining the higher three-month rate.

The Riksbank thus has no mechanism apart from the standing deposit and lending facilities and fine-tuning transactions to deal with any frictions in the interbank market that arise as a consequence of uneven liquidity distribution among the banks. Such frictions are amplified by the fact that the banks introduced an agreement of principle at the time of the financial crisis whereby an individual bank may not have a deficit of more than SEK 10 billion at the end of the day. This limitation has led to the banks attempting to avoid deficits on the overnight market by meeting their liquidity requirements a day earlier, on the t/n maturity. This has created a great deal of volatility in the t/n rate.

Even in normal times, the t/n rate can show extreme fluctuations on certain days, mainly in connection with IMM days when many financial contracts are to be turned over. This seems to create stress on the market and has an undesirable effect on rate formation. Some of the foreign participants on the market do not have access to the Riksbank's standing facilities. They must thus cover their t/n positions at all costs, which could be a contributory factor for the volatility of the t/n rate.

The most important reference rate for pricing fixed-income instruments in Swedish kronor is thus the rate on loans with the tomorrow/next (t/n) maturity. This fact and the volatility we can observe, particularly at times when trading volumes in fixed-income instruments are highest (on IMM days), justify reviewing the need and ability to establish better functioning rate formation for the t/n maturity. The next question to work further on is thus:

Question 3. Does the pricing of loans with overnight and tomorrow/next maturities work sufficiently well?

Steering interest rates by means of average minimum reserve requirements or daily settlement?

The purpose of having a minimum reserve requirement that is to be met on average over a reserve maintenance period is that the banks themselves can even out fluctuations in the overnight rate by means of intertemporal arbitrage on the interbank market. Then, the central bank will not need to supply daily liquidity, which is the case if there is daily settlement like in Sweden, Australia and Canada.

During the reserve maintenance period, the central bank supplies the exact amount of liquidity needed for the banks to meet their minimum reserve requirements. The idea is that, if the banks know that the central bank will supply the exact amount of liquidity needed for the overnight rate to equal the policy rate on the final day of the reserve maintenance period, there is no need for a bank receiving a negative liquidity shock to borrow money at a rate in excess of the policy rate before the final day. Neither is there any reason for a bank receiving a positive liquidity shock to lend at a rate below the policy rate before the final day. The banks know that, on the final day, they will be able to borrow or lend the exact amounts needed at the policy rate.

Given that there are no restrictions on intertemporal arbitrage trade, the overnight rate will, during a given day of the reserve maintenance period, equal the expected overnight rate on the final day of the reserve maintenance period. Several empirical studies show, however, that the overnight rate does not behave as it theoretically should in most countries that apply average minimum reserve requirements. Volatility is particularly high during the final days of the reserve maintenance period. A system with average minimum reserve requirements involves the introduction of a highly complex intertemporal optimisation problem for both the banks and the central bank. It is therefore not surprising that it does not work as well as it theoretically should.

In the framework of this review, we have not investigated minimum reserve requirements for purposes other than improving the implementation of monetary policy.

UNDERPINNING AN ACTIVE MONEY MARKET

An active money market is fundamental to the efficient functioning of the transmission from the overnight rate to longer rates. The review of the operational frameworks of other central banks shows that the central banks have had an important role in promoting the development of the money markets in their respective currency areas.

Facilitating interbank secured loans?

In times of great uncertainty, banks might prefer to borrow money secured by collateral from each other to a greater extent. In this way, they can reduce the counterparty risks to which they are exposed. The ability of banks to dimension their risks by borrowing money from each other on a secured basis when needed requires, however, flexible and efficient collateral management.

An example of how efficient collateral management can be devised is found in Switzerland. On the interbank market in Switzerland, monetary policy repos and interbank repos are conducted on an electronic repo platform that is fully integrated with securities settlement systems and the payment system. This enables the efficient management of collateral for different purposes; either for transactions with the central bank or those with other commercial banks. Such a flexible collateral management system would have been highly useful in other currency areas in the latest financial crisis too, when the banks had a greater preference for secured loans than unsecured loans. The Swiss central bank was a driving force for the development of this infrastructure as part of its task to promote an active money market.

In Sweden, collateral management is not as efficient as in Switzerland, one reason being that the settlement times of the RIX payment system and Euroclear Sweden AB's securities settlement system are not synchronised. The problem is mainly in that the final time for normal settlement by payment for repo transactions in the securities settlement system is 2 p.m. RIX, however, is open until 5 p.m. Until that time, RIX participants might need collateral to take out intraday loans to carry out payments in RIX. In addition, the banks cannot, when the need arises, use the collateral they have deposited with the Riksbank for intraday credits as collateral for interbank loans overnight.⁵ If the settlement times in the securities settlement system were synchronised with the RIX payment system, the banks could carry out loans against collateral until 5 p.m. and in

5 The banks that participate in the RIX payment system have a large volume of collateral deposited at the Riksbank so that they may, when needed, borrow from the Riksbank intraday interest-free, but on a secured basis. During the period January 2007 to September 2008, the five largest banks deposited between SEK 16 and 35 billion per bank on average in the form of unutilised collateral at the Riksbank overnight. As at 31 October 2013, the values for the five largest were between SEK 11 and 26 billion – SEK 17 billion on average.

addition to that release collateral deposited at the Riksbank to take out intraday credits and use them as needed for taking out secured loans overnight from other banks.⁶ Instead of the banks using the Riksbank's standing facilities at the slightest concern about the creditworthiness of counterparties, the chance of a market solution would probably increase if it were possible to lend to another bank on a secured basis. Another condition for enabling this is also that collateral for the loan be transferred to the bank issuing the loan at the same time as the money is transferred to the bank receiving the loan.

A factor to observe in this context is the banks' agreement of principle whereby a bank's liquidity deficit at the end of the day in RIX must not exceed SEK 10 billion. If there were alternatives to unsecured lending, such as to release collateral deposited at the Riksbank in order to use them for secured loans between banks, this would reasonably involve less stress on the overnight market. If the circumstances are such that the banks would prefer to lend on a secured basis overnight, this would involve an efficiency gain if the collateral were available to this end. This gives rise to the following question:

Question 4. Should the Riksbank seek to achieve more efficient collateral management that facilitates overnight loans secured by collateral?

Transaction-based rates for the overnight and tomorrow/next maturities create conditions for a liquid derivatives market

Another example of central banks promoting the development of money markets is that most central banks establish and publish transaction-based rates for the overnight maturity. For example, the ECB and the central banks of Poland, Hungary and Switzerland have helped pave the way for developing overnight index swaps (OIS) markets by launching transaction-based reference rates for the overnight maturity. This makes it easier for private participants to manage risk. For central banks, OIS rates are useful as a measure of the market's monetary policy expectations. They are also important to the ability of central banks to evaluate the implementation of monetary policy and how the interbank market and operational framework for the implementation of monetary policy function.

The operational framework project has shown that it is possible to establish rates for individual loans overnight between the participants of the RIX payment system. Based on such interest rate data, it is then possible to calculate on a daily basis the average interest rate for interbank overnight loans. This is currently done as needed. However, we find that, as a matter of immediate urgency, the Riksbank should take the initiative for establishing and publishing transaction-based interest

6 On the other hand, it would not be desirable nor appropriate for the Riksbank to act as a central counterparty, rather the parties in the deal should be the banks themselves.

rates for the overnight and tomorrow/next maturities on an ongoing basis. The main reasons for this are that transaction-based rates for these maturities between banks create conditions for the emergence of fixed-income instruments that can efficiently price risk on the money market, and that they better equip the Riksbank to analyse the functionality of the interbank market and the operational framework for monetary policy. The next question to work further on is thus:

Question 5. Under which forms should the Riksbank contribute to transaction-based rates for the shortest maturities (overnight and tomorrow/next) being established and published on an ongoing basis?

THE RIKSBANK'S LIQUIDITY SUPPORT

A solvent bank can also experience liquidity problems. In such cases, the Riksbank offers liquidity support either to an individual bank or the banking system at large. In our review of the Riksbank's operational framework, we noted at an early stage that preparedness for providing liquidity support needs improving. In May 2012, the Riksbank therefore decided to procure a bond portfolio in Swedish kronor. Its purpose is to make sure that the Riksbank has the systems, procedures and knowledge needed to stand prepared in the future to carry out repos, purchases and sales of bonds at short notice.

Experience from the financial crisis shows that this is very important for the Riksbank's ability to quickly take appropriate extraordinary measures when the need arises. However, changes and new measures require quite some preparation before they can be implemented. It is thus important for procedures and systems to be in place in advance.

Central banks around the world chose to apply slightly different strategies during the financial crisis. Some central banks took measures that then became permanent features of their operational frameworks. The Bank of England is perhaps the most obvious example. Other central banks, such as the Bank of Canada, chose to introduce measures that were easy to phase out when they were no longer needed, but which could easily be implemented again when the need arises. The Riksbank belongs to the latter category of central banks. The Riksbank primarily focused on providing liquidity support in the form of different loans, such as lending at longer maturities in Swedish kronor, and lending in foreign currency. These measures were easy to phase out in that they phased themselves out when the banks' demand for this type of loan dried up. However, the question is whether it will really be so easy to implement the measures again when needed. For instance, employee turnover means that direct experience from the crisis is easily lost.

It is important that procedures and systems for transactions that might come into play in a crisis situation are in place in advance. Otherwise, it might take an unnecessarily long time to start putting the extraordinary measures into place, and getting them to function. Such measures could be, for instance, the direct purchase and sale of securities, repo transactions and trade in foreign exchange swaps. It is also important that the organisation performs regular exercises in making decisions on and putting into operation liquidity supply in crisis situations. This is an important question to investigate in order for the Riksbank to constantly stand prepared. It motivates a sixth and final question to further work on:

Question 6. Which specific expertise and infrastructure does the Riksbank need to stand constantly prepared to quickly and efficiently supply liquidity to its counterparties in crisis?

Many of the questions raised above affect to some extent the incentive of banks to manage liquidity and liquidity risks. When working with these matters, the gains from the Riksbank offering solutions to the problems must be weighed against the weakened incentive of banks to address the problems themselves.

How the operational framework for the implementation of monetary policy works

According to the Sveriges Riksbank Act, the Riksbank shall maintain price stability. The Riksbank has interpreted that task such that the objective of monetary policy is for inflation to be low and stable. This objective has been formulated more precisely such that the Riksbank shall keep inflation – measured as CPI (consumer price index) – around 2 per cent annually. In practice, monetary policy is conducted through what is known as the operational framework for the implementation of monetary policy. This is therefore at the core of the Riksbank's operations.

The operational framework for the implementation of monetary policy is designed to steer the market's overnight (o/n) rate, that is, the interest rate on overnight loans between the banks. The intention is for this o/n rate to influence other market rates, and hence so too the interest rates paid by households and companies. It thus influences activity in the economy and ultimately inflation too. The instruments that the Riksbank has at its disposal for steering the overnight rate consist

of standing facilities and open market operations (currently in the form of fine-tuning transactions and Riksbank certificates).

With the standing facilities, the Riksbank provides an opportunity for the banks to deposit money overnight at a deposit rate corresponding to the Riksbank's most important policy rate, the repo rate, minus 0.75 percentage points and the opportunity to borrow money at a lending rate corresponding to the repo rate plus 0.75 percentage points. Because no bank would exchange money with another bank at a rate that is poorer than that obtainable in transactions with the Riksbank, the interest rates of the standing facilities will set the limits, or a "corridor", for the overnight rate.⁷

The more exact position of the overnight rate within the corridor is however a matter for negotiation between the banks on the overnight market. In order to increase the banks' willingness to agree on overnight rates in the vicinity of the repo rate, the Riksbank is prepared each afternoon to perform fine-tuning transactions. In these operations, the Riksbank offers

⁷ It is however perceivable that a bank might envisage borrowing from another bank at a slightly higher rate than the Riksbank's lending rate in order to avoid the stigma that would be involved if it became known that the bank had borrowed from the central bank's lending facility.

credit against collateral or overnight deposits at the repo rate plus/minus 0.10 percentage points. The purpose of the fine-tuning is to balance the banking system's liquidity position towards the Riksbank at the end of the day. If at the end of the day the banking system has a deficit towards the Riksbank, the Riksbank offers loans equalling the scope of the deficit at the

repo rate plus 0.10 percentage points. If the banking system instead has a surplus, the Riksbank offers to borrow an amount corresponding to the surplus at the repo rate minus 0.10 percentage points. Each week, the Riksbank also offers banks the possibility of investing money in *Riksbank certificates* with a one-week maturity at the repo rate.

References

Eklund, Johanna and Per Åsberg Sommar (2011). The Swedish market for balancing liquidity between the banks overnight, 2007-2010, *Economic Review* 2011:1, 63-84.

Henckel, Timo, Alain Ize and Arto Kovanen (1999). Central banking without central bank money, Working Paper No. 92, International Monetary Fund.

Sellin, Peter and Per Åsberg Sommar (2012). Review of the Riksbank's operational framework for the implementation of monetary policy, *Economic Review* 2012:2, 43-65.

Tucker, Paul (2004). Managing the central bank's balance sheet: where monetary policy meets financial stability, *Bank of England Quarterly Bulletin*, Autumn 2004, 359-382.

■ Central banks' operational framework for the implementation of monetary policy – literature review

The operational framework for the implementation of monetary policy enables a central bank to steer the level of a short-term money market rate. The intention is that changes in this rate lead to changes in the rates encountered by companies and households. Growth and inflation in the entire economy are thus influenced, and the central bank has the possibility of fulfilling the primary objective of price stability. There is vast and growing literature about how a central bank goes about implementing monetary policy in practice, and we attempt to provide an overview of this in this chapter.

The central bank's operational framework for the implementation of monetary policy

When monetary policy is conducted in practice, an operational target needs to be formulated first of all, the fulfilment of which also entails fulfilment of the central bank's primary target of price stability. The operational framework for the implementation of monetary policy must be devised in such a way that it enables the central bank to reach the operational target.

According to Bindseil and Nyborg (2008) the operational framework consists of three elements:

- the operational target
- the operational framework for reaching the target
- the central bank's liquidity management.

We will address each of these elements in this literature review.

THE OPERATIONAL TARGET

First of all, we will discuss the objective of the operational framework. This is commonly formulated as a desirable level for a short-term money market rate. The intention is that changes in this rate lead to changes in the rates encountered by companies and households. Growth and inflation in the entire economy are thus influenced, and the central bank has the possibility of fulfilling the primary objective of price stability.

There is largely a consensus view that the *central bank's operational target* should be to steer the overnight rate – that is, the interest rate on loans from today until tomorrow, also known as the “o/n rate”. It is the interest rate over which the central bank has most control, because it can force banks to borrow from or deposit with the central bank overnight at a rate it determines itself. This interest rate level then guides the rates paid by banks when they borrow from each other overnight, and the rate they offer their customers.

The central bank also attempts to minimise fluctuations in the overnight rate. The literature presents many reasons for this:

- the price paid by the banks for a liquidity shock at the end of the day is stabilised
- fluctuations in time-varying term premiums are reduced
- a clearer monetary policy signal is sent.

THE OPERATIONAL FRAMEWORK

We then address the question of how to reach the operational target. This involves taking stock of the *instruments* the central bank may use within the bounds of its operational framework. In brief, such instruments consist of standing facilities, open market operations, minimum reserve requirements, counterparty selection and a list of securities eligible for use as collateral for obtaining loans from the central bank.

As instruments for steering the overnight rate, most central banks use a combination of *standing facilities* and *open market operations*. The standing facilities are made up of a lending facility, from which the banks can borrow money, and a deposit facility, in which they can invest money. The maturity is usually from today until tomorrow (or rather the following business day). The standing facilities will constitute what is known as an *interest rate corridor*, which will set the limits for the fluctuations of the overnight rate.

A further instrument for steering the overnight rate addressed in literature is *minimum reserve requirements*. Minimum reserve requirements that are to be met on average over a reserve maintenance period are a way to get the banks to even out fluctuations in the overnight rate themselves through intertemporal arbitrage, without the central bank having to supply or withdraw liquidity daily. The central bank supplies the exact amount of liquidity needed by the banks to meet the minimum reserve requirements over the period.

When the central bank devises the operational framework for the implementation of monetary policy, it must also take a stance on which assets are to constitute *eligible collateral* in lending to counterparties, and on which parties are to be included in the *circle of counterparties*.

THE CENTRAL BANK'S LIQUIDITY MANAGEMENT

Finally, we address the *central bank's liquidity management*. Banks have balances on accounts at the central bank, known as reserves. Banks need reserves in order to meet the central bank's minimum reserve requirements, if the central bank has such requirements, and potentially to act as a buffer against unforeseen end-of-day payments. A key question is how the central bank ensures meeting the banking system's demand for reserves. In a financial crisis, the central bank might need to supply the banking system with extra liquidity. In such a situation, the central bank's balance sheet can expand substantially.

The central bank's operational target – steering a short-term market rate?

MOST CENTRAL BANKS TRY TO STEER THE OVERNIGHT RATE

There is largely a consensus view of the central bank's operational target.¹ Most central banks try to steer a short market rate, most commonly the overnight rate on loans from today until the following business day. This is either done directly by deciding on a target for the overnight rate, or indirectly by the standing facilities being linked to (or the market operations being conducted at) the *policy rate*, which is to guide the overnight rate. The policy rate, or the overnight rate target, is commonly determined by the governors of the central bank at its regular monetary policy meetings (usually held between six and twelve times a year).

Why is the shortest rate chosen? The simple reason is that the overnight rate is the one which the central bank can steer. The central bank can force the commercial banks to borrow from or deposit with the central bank overnight at a rate it determines itself (Henckel et al. (1999)). However, the central bank usually provides a certain limited amount of scope for negotiation for the banks to decide the overnight market rate, and we will discuss the benefits and drawbacks of this. Changes in the overnight rate in turn affect longer risk-free rates, because the latter are chiefly determined by expectations about the future overnight rate. The overnight rate thus serves as an anchor for the yield curve, which describes rates with different maturities. The yield curve of rates on risky assets is determined by an increase to the risk-free rates with the same maturity. Through this so-called monetary transmission mechanism, the central bank can influence the rates encountered by households and companies.

¹ See e.g. Borio (1997), Bindseil (2004) and Ho (2008).

WHY CAN'T A LONGER RATE BE STEERED?

If the central bank decides on the level for a longer rate, it lets the market determine a suitable overnight rate level instead. Decisions on discreet changes in the longer rate would often be predictable (just as changes in the policy rate are today) and hence lead to substantial changes in the overnight rate on the day prior to a rate change coming into effect.

Example. Bindseil and Nyborg (2008) provide a numerical example of how steering a longer rate can affect the overnight rate. They assume that the central bank steers the 90-day rate. According to the expectations hypothesis, the 90-day rate is related to overnight rates according to

$$(1) \quad i_{90,t} = \frac{1}{90} \sum_{j=0}^{89} i_{1,t+j}$$

where $i_{90,t}$ and $i_{1,t+j}$ are the 90-day rate and overnight rate on day t and day $t+j$, respectively. Note that the 90-day rates overlap by 89 days. This means that the difference between the 90-day rate on day t and the 90-day rate on day $t-1$ is

$$(2) \quad i_{90,t} - i_{90,t-1} = \frac{1}{90} (i_{1,t+89} - i_{1,t-1})$$

Assume that $i_{1,t+89} = 4\%$ and that the central bank is expected to cut the 90-day rate from 5 per cent on day $t-1$ to 4 per cent on day t . The overnight rate will then be $i_{1,t-1} = 94\%$!

McGough et al. (2005) suggest that the central bank can steer a longer rate in a situation when the policy rate is close to zero. In a commentary on this article, Woodford (2005) argues that, in such a circumstance, it would be better for the central bank to commit to keeping the policy rate close to zero over a long period of time, as in Eggertsson and Woodford (2003). According to Manna, Pill and Quirós (2001), steering a longer rate would also lead to a series of operational problems.

ARE FLUCTUATIONS IN THE OVERNIGHT RATE A PROBLEM?

Besides setting a policy rate that is to guide the overnight rate, central banks also attempt to minimise fluctuations in the overnight rate around the policy rate (or the target for the overnight rate). Why is this done? Different reasons have been highlighted in theoretical literature. In Allen et al. (2009), the answer is that, in so doing, the central bank solves a problem that exists on the interbank market. In their model, it is assumed that the banks are exposed to an end-of-day liquidity shock, which leads to them being uncertain about how much of a reserve they need to hold to avoid borrowing from the central bank's lending facility at a relatively high interest rate. In the model, they cannot protect themselves from

such shocks. By means of the central bank fixing the overnight rate, it resolves the problem of the lack of shock protection possibilities.

Other reasons put forward have more to do with the impact of monetary policy. The overnight rate is key to signalling the direction of monetary policy, because the overnight rate is the first step in the transmission of monetary policy. The central bank must thus ensure that the overnight rate is close to its policy rate (Linzert and Schmidt (2007)). Välimäki (2008) puts forth similar arguments, but finds that, as long as the difference between the overnight rate and policy rate is stable, the central bank can simply adjust the policy rate to achieve the desired effect on market rates. A more pragmatic reason for the central bank to minimise fluctuations in the overnight rate is set forth by Cassola and Morana (2006). They claim that volatility in money market rates is the main reason for time-varying term premiums. The latter make it harder to read expectations off the forward rate curve, and hence make it more difficult to evaluate how predictable the central bank has been.

The operational framework

In order to reach the operational target, an operational framework of instruments designed to steer the overnight rate, or other short market rate, is needed. Such instruments consist of open market operations, standing facilities, minimum reserve requirements, counterparty selection and a list of securities eligible for use as collateral for obtaining loans from the central bank.

In this section, we note first of all that the boundary between open market operations and standing facilities is not entirely clear. We then discuss which of the two instruments is preferable. The majority of this section addresses different types of system in which the central bank's standing lending and deposit facilities form an interest rate corridor which limits overnight rate fluctuations. Interesting questions are how wide the corridor should be and where in the corridor the overnight rate should be positioned. We then discuss the significance minimum reserve requirements can have as an instrument for steering the overnight rate. Finally, we address the question of which collateral and counterparties the central bank uses.

OPEN MARKET OPERATIONS AND STANDING FACILITIES

There is no clear distinction between open market operations and standing facilities. There is rather a spectrum of instruments containing elements of both. Bindseil and Würtz (2007) divide the monetary policy instruments up, from the purest form of open market operations to the purest form of standing facilities, see box on page 41.

Direct purchase and sale of securities is the purest form of open market operations. Regularity is a concept associated with standing facilities. Regular purchase and sale is thus not as pure a form of open market operations. In reverse transactions (transactions based on repo agreements or secured loans), the interest rate is an important factor. The interest rate plays a key role in standing facilities, so reverse transactions take us farther away from open market operations. If we introduce regularity on top of that, we obtain something that can be considered to be standing facilities. The purest form of standing facilities is that which is available at any time during the day. A simple distinction sometimes used is that open market operations are initiated by the central bank, while the use of standing facilities is initiated by the central bank's counterparties.

From open market operations to standing facilities

1. Outright operations

- i. Discretionary, non-published outright operations.
- ii. Regular outright operations.

2. Non-regular reverse operations. The central bank buys or sells eligible assets through repo agreements, or provides credit in exchange for eligible assets as collateral.

- i. Without pre-announced volume, variable-rate tender.
- ii. With pre-announced volume, variable-rate tender.

3. Regular reverse operations

- i. Variable-rate tenders.
- ii. Fixed-rate tenders, discretionary allotment ratio.
- iii. Fixed-rate tenders, 100 per cent allotment.
- iv. Daily fixed-rate tenders, 100 per cent allotment.
- v. Fixed-rate tenders, 100 per cent allotment, accessible at any time until the closure of the payment system.

Should the central bank use open market operations...

Theoretical literature is often devoted to analyses in which the central bank only uses open market operations.² There are not many formal models that include a role for both open market operations and standing facilities. Exceptions are found in models based on Freeman (1996).³ He constructs a model in which loans are repaid with money. In certain situations, there may be a money shortage, and then there is a role for the central bank to temporarily increase money supply. This can be done either through open market operations or a lending facility. Freeman (1999) introduces a risk of bankruptcy into the model, such that part of the loans are not repaid. The bankruptcy risk is exogenous and cannot be influenced by the central bank. Freeman shows that, in such circumstances, open market operations lead to better risk distribution, and hence higher welfare, than does a lending facility. Because, when the central bank buys the loans, it absorbs more risk than when it offers loans secured by collateral. This is optimal when the central bank's actions do not affect the bankruptcy risk. Chapman and Martin (2007) introduce the possibility of monitoring potentially leading to lower bankruptcy risks. However, that does not alter the conclusion that open market operations lead to higher welfare than lending through standing facilities.

...or are standing facilities better?

Cúrdia and Woodford (2010b) arrive at a diametrically opposite conclusion regarding the value of open market operations compared with standing facilities. They show that, under the assumption that assets are only valued based on their expected return and that all investors can buy whichever volumes they wish at the same prices, the central bank's open market operations have no effect on the economy, because the private sector will act in a way that neutralises the very effects of the central bank's actions.⁴ Cúrdia and Woodford point out that this does not mean that monetary policy is irrelevant, which is sometimes claimed, but only that the central bank cannot use *open market operations* to implement monetary policy. The central bank can still steer the overnight rate by deciding the terms of the banks' overnight loans and deposits with the central bank.

Within the framework of a general equilibrium model, Martin and Monnet (2009) show that the instrument that provides the highest welfare – open market operations or standing facilities – depends on how high inflation is. When inflation is low, a regime of open market operations results in higher welfare. However, for inflation levels that can be achieved in both regimes, standing facilities give higher

2 See e.g. Leao and Leao (2006) and Allen et al (2009).

3 See e.g. Freeman (1999), Mills (2004) and Chapman and Martin (2007).

4 This result was already presented by Wallace (1981).

welfare. The model shows the advantages of combining open market operations and standing facilities.

AN INTEREST RATE CORRIDOR SETS LIMITS FOR THE OVERNIGHT RATE

A model for the equilibrium rate in a corridor system

Several studies have been conducted on how a central bank can steer a short market rate using an interest rate corridor.⁵ These models are based on the Poole model (1968) in which the banks are uncertain about how much reserves they should have. The most important decision a bank in the model must make each day is how much it should borrow or lend overnight on the interbank market (and how much it should hold as reserves). After having borrowed or lent on the interbank market, the bank is exposed to a liquidity shock at the end of the day. The source of such shocks is payments made by the bank's customers, which the bank cannot predict. The bank may not overdraw its account at the central bank overnight, but would then be forced to borrow from the lending facility at a disadvantageous rate. In order to reduce the risk of this happening, the bank holds reserves in its account at the central bank. However, if the bank holds reserves that are too high, it will probably instead have a surplus at the end of the day, which is placed in the deposit facility at a relatively low interest rate. The bank is assumed to choose the size of its reserves in a way that minimises the expected cost of ending up in the facilities.⁶

Woodford (2001) derives a bank's demand for reserves in a model of the type described above. He assumes that the liquidity shocks are independently distributed across the banks, with mean 0 and standard deviation σ_j . He then puts the banks' aggregate demand as equal to the supply of reserves and derives the equilibrium rate (overnight), which will by necessity be within the rate corridor:⁷

$$(3) \quad i = i_D + F\left(\frac{-R}{\sum_j \sigma_j}\right)(i_B - i_D),$$

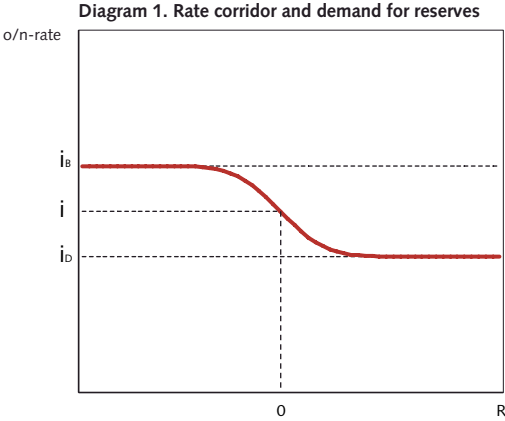
where F is a distribution function with mean zero and variance 1 and $F(0)=1/2$. By selecting the level of available reserves, R , the central bank can determine the overnight rate level within the corridor, which is expressed as the difference between the lending and deposit rate ($i_B - i_D$). Available reserves are equal to

5 Some of the better known studies are Furfine (2000), Woodford (2000, 2001, 2003), Bartolini et al. (2002), Clouse and Dow (2002), Whitesell (2006a), Ennis and Weinberg (2007), Gaspar et al. (2008), Berentsen and Monnet (2008) and Martin and Monnet (2009).

6 Baltensperger (1974) finds that, to a certain extent, a bank is able to influence the size of the liquidity shock. The bank weighs how much resources it should invest in liquidity management in order to reduce the size of the shocks on the one hand, against the extent of costs it is willing to bear to hold reserves on the other. See also Furfine and Stehm (1998) and Heller and Lengwiler (2003).

7 See the Appendix for a full derivation of the equilibrium rate.

the difference between liquidity supply through open market operations, M , and liquidity absorption through autonomous factors, A (such as the general public's demand for banknotes and coins, or changes in the government's account at the central bank). If the central bank chooses to conduct open market operations such that $R=M-A=0$, the overnight rate will end up in the middle of the corridor because $F(0)=1/2$, see diagram 1. Bindseil and Würtz (2008) call equation (3) *the fundamental equation for control of the short rate through open market operations*.



If the central bank ensures that the probability of the banking system's need to borrow is as high as its need to deposit money at the end of the day, the overnight rate will thus end up in the middle of the rate corridor. This operational framework is usually called a symmetrical corridor. How it works is described in e.g. Woodford (2000, 2001), Whitesell (2006a), Berentsen and Monnet (2008) and Martin and Monnet (2009). If instead the central bank supplies more liquidity than what is required for the banking system's net position towards the central bank to be in balance, the value of the distribution function in (3) will move towards zero. The resulting overnight rate will then be close to the deposit rate. Steering the overnight rate in this way by pushing it down towards the rate corridor floor has been analysed by Woodford (2000), Goodfriend (2002) and Keister et al. (2008). These two forms of practical implementation of monetary policy – the symmetrical corridor and floor system – are among the most common today.

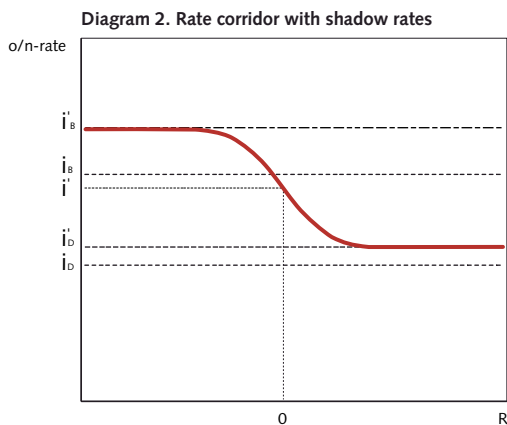
As long as the central bank's liquidity forecasts are relatively accurate, it can counteract changes in the autonomous factors and the fluctuations of the overnight rate around the policy rate ought therefore to be relatively small. Woodford (2001) notes that, according to equation (3), the central bank can change the overnight rate merely by changing the deposit and lending rates of the standing facilities. The central bank thus does not need to use open market

operations to change the overnight rate. This is an important insight that has been evident to central bank economists for a long time, but which has only been adopted by academic researchers recently.

The central bank can use an interest rate corridor to steer the overnight rate even if technological developments were to lead to banknotes and coins no longer being used for payment. Even in a purely account-based system, the central bank would be the party providing risk-free reserves and deciding the terms on which these are lent or deposited, see Woodford (2000) and Freedman (2000).

Weaknesses of the corridor system

Borrowing from the central bank might carry a stigma, in that a shadow rate equalling the real cost would be a fair bit above the central bank's lending rate. This is illustrated in diagram 2 with the lending rate shown as i_B' . At the same time the alternative to depositing in the central bank's deposit facility will be lending on the market, with accompanying credit risk for which a risk premium should be required. The higher actual deposit rate is illustrated as i_D' , which equals the deposit rate plus the value of avoiding taking on the credit risk. Whitesell (2006a) draws the conclusion that the overnight rate will not be in the middle of the interest rate corridor, but rather in the upper area of the corridor, just as in diagram 2.



The symmetry can be re-established by aiming to balance the system at a positive quantity of reserves, $R > 0$, instead of at zero. If the central bank supplies more reserves than needed to counteract changes in autonomous demand, this should put downward pressure on the overnight rate. We will move downwards along

the demand curve in the diagram. The Bank of Canada started to push down the overnight rate in this way after noting that it was systematically trading above the target.⁸

A further weakness with a corridor system is that, in such a system, the demand curve for reserves tends to be steepest at the central bank's desired rate level, see Whitesell (2006a). So, even relatively small inaccuracies in the central bank's liquidity projection can have major effects on the overnight rate. A clear way of making the demand curve less steep is to reduce the width of the corridor. We see that the demand curve D' in diagram 3b is much flatter than demand curve D in diagram 3a. In other words, the narrower the corridor, the lower the overnight rate's sensitivity to changes in reserves.

Diagram 3a. Demand for reserves in a wide rate corridor

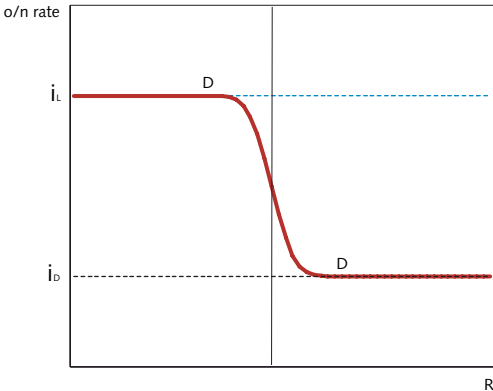
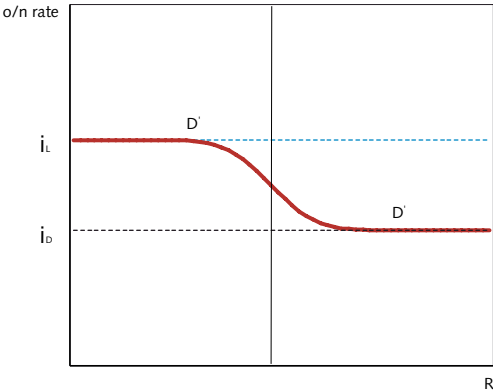


Diagram 3b. Demand for reserves in a narrow rate corridor



8 See Engert, Gravelle and Howard (2008).

Can a zero corridor be used?

Wouldn't it possible to use a zero corridor? That is, the central bank both receives deposits and lends at the policy rate (secured by collateral). A zero corridor would lead to the major banks with access to the standing facilities ceasing to trade with each other overnight, because it would then be more advantageous to trade with the central bank, according to Tucker (2004). With a lack of an overnight market, other participants in need of managing their liquidity – small banks, investment banks, brokerages and companies – would be reliant on the major banks. The question is whether this would matter so much. In terms of the small banks, they do not seem to be particularly active on the overnight market anyway, especially not at the end of the day, see e.g. Ashcraft, McAndrews and Skeie (2009) and chapter 4.

It has been questioned whether the overnight market is needed at all, see Martin and McAndrews (2010). If the marginal cost of holding reserves is practically equal to zero, as claimed by Friedman (1969), the distinction between holding reserves intraday and overnight disappears. The banks might then prefer to hold reserves overnight, also to cover the larger need for intraday reserves, because it costs no extra. The banks will choose to hold the reserves they need rather than obtaining them on a market when the need arises. Furfine (2001) and King (2008) however claim that banks have a better understanding of the business operations of banks than other creditors, so they should be better at monitoring other banks. So, in their view, the interbank market can play an important role here. Both studies find that the credit risk of banks is priced on the US interbank market for overnight loans. High-risk banks have consistently had to pay more than other banks for overnight loans. They have, according to King (2008) also been subject to greater rationing than other banks.

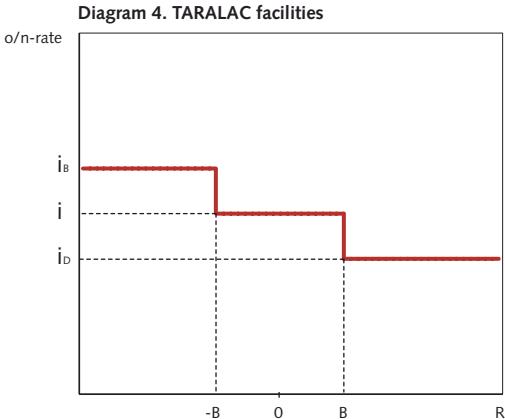
Another disadvantage of the zero corridor highlighted by Tucker (2004) is that the central bank loses control of its balance sheet in that utilisation of the standing facilities takes place on the initiative of counterparties. Mehrling (2006) also finds that the most important reason for central banks preferring the standing facilities not to be used is that a central bank wants to be in control of its own balance sheet. In addition, he sees a value in the central bank forcing upon the market liquidity management discipline, which is desirable in itself. Hoskin, Nield and Richardson (2009) maintain that it is not desirable for credit risk to be moved from the banks' shareholders to taxpayers, which in their view is the case in high usage of the central bank's standing facilities.

Berentsen and Monnet (2008) (BM) present a model in which the central bank setting the lending rate higher than the deposit rate is shown to be optimal. If it were to set rates equally, nobody would want to hold money overnight. Everybody would then instead hold a large quantity of commodities, which in the model

can be used as collateral for loans from the central bank’s lending facility. This is inefficient because collateral has a positive alternative cost, while the central bank does not have any cost for creating money. Martin and Monnet (2009) (MM) use a version of the model in BM to compare an operational framework which only uses standing facilities with a system which only uses open market operations. While BM uses a commodity as collateral for loans, MM uses a government bond instead, which also enables them to analyse market operations in the form of the purchase and sale of government securities. Unlike BM, MM finds that the central bank should set the lending rate equal to the deposit rate, i.e. the width of the rate corridor should be zero, in order to maximise welfare. Bindseil and Jablecki (2011) analyse the balance the central bank must strike between rate volatility, scope of the central bank’s balance sheet and activity on the interbank market when it determines the width of the interest rate corridor.

Does a limited zero corridor give a better market function?

One way of combining a zero corridor with a functioning overnight market has been proposed by Bindseil and Würtz (2008). Their suggestion is based on limiting the amounts that can be deposited or borrowed at the policy rate in the limited standing facilities – Target Rate Limited Access Facilities (TARALAC). For amounts greater than what TARALAC permits, shown as B , a traditional symmetrical corridor applies, see diagram 4.



Let $u = M - A$ be the banking system’s net position towards the central bank at the end of the day. Then, the overnight rate in a TARALAC system is given by

$$(4) \quad i = i_B P(u < -B) + i^* P(-B \leq u \leq B) + i_D P(u > B),$$

a weighted average of the lending rate, i_B , the policy rate, i^* and the deposit rate, i_D , in which the weights are determined by the probability, P , of the net position falling within the different intervals defined by B . In order for the overnight rate to be equal to the policy rate, the central bank must perform open market operations such that the probability of the banking system needing to borrow more than B is equal to the probability of it needing to deposit more than B , $P(u < -B) = P(u > B)$. Thus, the conditions are basically the same as for a normal corridor system. Here, however, the central bank also decides the size of B . The greater B is, the lower the probability of the banking system falling outside of the interval $[-B, B]$, and the greater the stability of the overnight rate. However, the greater B is, the weaker too the incentives for the banks to trade with each other on the overnight market.

When the central bank determines the size of B , it must thus weigh the advantage of a stable overnight rate against the desirability of an active overnight market. These considerations determine how large the limitation on the amounts in TARALAC should be. Holthausen et al. (2008) analyse a similar but asymmetrical system of lending in a primary loan facility at the policy rate, and in a residual loan facility at a higher rate. There is only one rate for depositing, which is lower than the policy rate. They make a comparison with a system of average minimum reserve requirements, and conclude that volatility in the overnight rate is lower in their system.

Asymmetrical corridor system for greater flexibility

So far, the rate corridor discussion has been based on the overnight rate falling in the middle of the rate corridor. However, this is not the only possibility. Perez-Quirós and Rodríguez-Mendizábal (2010) suggest that a central bank could use an asymmetrical corridor to steer liquidity in the banking system at full allotment at the policy rate in the open market operations. They show that, in their model, the banks' demand for reserves is determined by the asymmetry coefficient

$$(5) \quad \alpha = \frac{i^* - i_D}{i_B - i_D}.$$

where i^* is the policy rate. The banks require reserves to protect themselves against future liquidity shocks, which could lead to them being forced to borrow from the central bank's lending facility. They obtain reserves through the open market operations at the policy rate. These reserves are then placed in the central bank's deposit facility as a buffer. The volume of reserves required by banks will therefore be determined by the difference between the policy rate and deposit rate in relation to the width of the rate corridor. The central bank can then influence

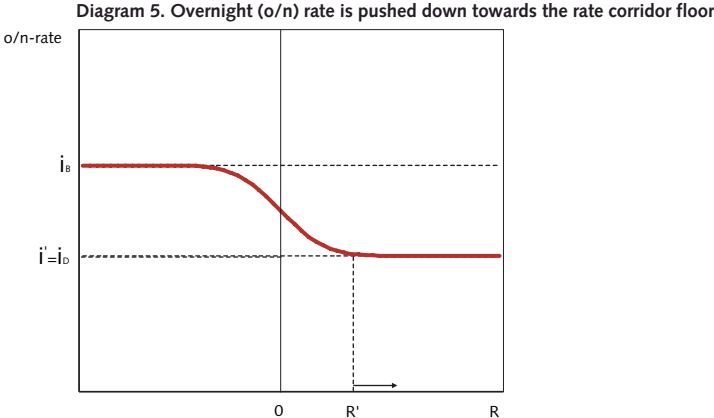
the banks' demand for reserves by selecting α , i.e. the corridor's degree of asymmetry. Goodhart (2010) recommends that central banks use an asymmetrical corridor, and provides some examples of how this could be useful. In a situation of a weak economy and vulnerable financial sector, the asymmetry should, for example, encourage loans from the central bank. In a situation of the economy approaching recovery and programmes of extraordinary lending to the banking system being wound up, borrowing from the central bank's lending facility should also be made relatively expensive.

A floor system provides a further steering instrument

A system could be envisaged in which the central bank supplies sufficient liquidity to push the rate down to the rate corridor floor. In diagram 5, this is illustrated by having to supply a minimum of R' in the open market operations. In this system, the overnight rate is given by equation (3), but if the central bank supplies much more liquidity than needed according to the liquidity forecast of the autonomous factors, equation (3) is reduced to

$$(6) \quad i = i_D$$

Hence, the policy rate is set equal to the deposit rate



According to Goodfriend (2002) the great advantage of a floor system is that the central bank gains another steering instrument. When the central bank has supplied sufficient liquidity for the overnight rate to be close to the rate corridor floor, it can supply further liquidity without it affecting the overnight rate. Under which circumstances might the central bank perceivably want to supply further liquidity? The answer is in the event of liquidity problems arising on financial

markets for some reason, as was the case during the financial crisis of 2008-2009. If liquidity shocks and other shocks to which monetary policy ought to react are fairly independent of each other, it is an advantage for a central bank to have two different instruments. See Bernhardsen et al. (2009) for a description of how a floor system worked in Norway during the financial crisis. See also Keister and McAndrews (2009) for a highly pedagogical description of the role that the reserves supply can play for the banking system in financial turmoil.

As an argument against a floor system, Whitesell (2006b) states that it can lead to interbank trade in overnight loans ceasing to function. Bordes and Clerc (2010) describe how the ECB de facto introduced a floor system as of October 2008, and how this led to the banks basically delegating their liquidity management to the central bank. In particular, the weaker banks which could not borrow on the interbank market were entirely referred to the ECB's fixed-interest rate loan for their funding. Bordes and Clerc (2010) find that this weakened the incentive of banks to invest resources in attending to their liquidity management.

During the financial crisis, and especially after Lehman Brothers filed for bankruptcy in the autumn of 2008, many central banks supplied the banking system with more liquidity than was necessary to balance the system's net position towards the central bank. This resulted in a floor system in practice. The Bank of Canada announced that the policy rate now equalled the deposit rate, while other central banks were not as transparent. If the overnight rate consistently diverges from the announced target, market participants might start to question whether this really is a technical problem in monetary policy implementation, and whether it might rather be a question of a stealth rate cut, according to Ennis and Keister (2008). They find that fulfilling the operational target is important for clear, credible communication from the central bank.

What is the real importance of the interest rate corridor in steering interest rates?

Borio and Disyatat (2009) find that the literature about the corridor system attaches too much importance to the significance of the corridor in the ability to steer the overnight rate. Instead, they emphasise the importance of the central bank signalling the level at which it wants the overnight rate to be. According to Borio and Disyatat (2009) the operational framework consists of two elements:

1. *Signalling* the desired level for the o/n rate.
2. *Liquidity operations* are used to underpin such signalling.

The central bank can signal the desired level of the overnight rate, either by announcing a policy rate for market operations or standing facilities, or by announcing an overnight rate target. In both cases, the operational target is a certain level for the overnight rate. What makes the central bank's signalling

credible is that, if it so wished, it could buy or sell as much reserves as it wants to at the price it has chosen itself. It can be said that the supply curve for reserves is horizontal at the chosen rate level. How, then, does demand for reserves appear? Empirical studies show that the demand curve is (largely) vertical, see e.g. Friedman and Kuttner (2010), who document this for the US, euro area and Japan. Hence, the overnight rate and quantity of reserves are (largely) independent of each other. The same level of reserves can coexist with different rate levels and, conversely, the same rate level can co-exist with different levels of reserves. Hence, the rate can be determined independently of the extent of reserves in the banking system. Borio and Disyatat (2009) call this *the decoupling principle*. See Freixas, Martin and Skeie (2009) for a formal model in which the interest rate is determined in this manner.

In another much discussed article, which points out the importance of the central bank's signalling, Guthrie and Wright (2000) describe how the central bank in New Zealand steered the interest rate using "open mouth operations" prior to 1999. It sufficed for the central bank to announce where it wanted the rate. The implicit threat of it potentially conducting open market operations to implement its intentions sufficed for the interest rate to end up where the central bank wanted it. According to Disyatat (2008), the policy rate can be seen as a commitment from the central bank, and if this commitment is credible, monetary policy instruments need not be used.

Has the Federal Reserve steered the overnight rate using open market or open mouth operations? Thornton (2000) does not find empirical support for either. However, Demiralp and Jordá (2002) find that the Federal Reserve (Fed) has had better control of the overnight rate, and with fewer operations than before, since it started to announce an overnight rate target. According to Carpenter and Demiralp (2006) the overnight rate starts to change even before the Fed announces a change in the overnight rate target, which reflects the expectations of market participants about future changes in the Fed's overnight rate target. Nautz and Schmidt (2009) find evidence of the Fed's increased transparency having led to greater stability in the overnight rate. This applies to both the immediate publishing of the overnight rate target in February 1994 and the publishing of the risk assessment that the FOMC started with in January 2000.

The fact that "open mouth operations" can also affect longer rates is documented in Andersson, Dillén and Sellin (2006). They show how the speeches of the governors of the Riksbank affect the yield curve on maturities from three months to five years.

MINIMUM RESERVE REQUIREMENTS FOR AVOIDING DAILY MARKET OPERATIONS

Minimum reserve requirements have been traditionally used for holding a determined amount on a non-interest-bearing account at the central bank. The minimum reserve requirement was to be met at any given time. In a liquidity crisis, the central bank could then allow the bank to use its minimum reserve funds. Nowadays, minimum reserve requirements are chiefly used with the aim of steering the overnight rate, and the minimum reserve requirement must only be met on average over a certain period of time – the reserve maintenance period.

What interest rate should the central bank pay on the reserves? Cúrdia and Woodford (2010a, 2010b) show that the central bank should pay the policy rate on the reserves if it is striving to maximise the welfare of households in its model. Ennis and Keister (2008) are representative of the discussion recently held in the US, which instead discusses the possibility of paying an interest rate on the reserves that is below the policy rate and which would set a floor for the overnight rate. This results in something resembling a rate corridor.

Meeting minimum reserve requirements on average over a reserve maintenance period

The point of having a minimum reserve requirement that is to be met on average over a reserve maintenance period is that the banks themselves can even out fluctuations in the overnight rate by means of intertemporal arbitrage on the interbank market. Then, the central bank should not need to supply liquidity daily.

During the reserve maintenance period, the central bank supplies the exact amount of liquidity needed for the banks to meet their minimum reserve requirements. The idea is that, if the banks know that the central bank will supply the exact amount of liquidity needed for the overnight rate to equal the policy rate on the final day of the reserve maintenance period, there is no need for a bank receiving a negative liquidity shock to borrow money at a rate in excess of the policy rate before the final day. Neither is there any reason for a bank receiving a positive liquidity shock to lend at a rate below the policy rate before the final day. The banks know that, on the final day, they will be able to borrow or lend the exact amounts needed at the policy rate.

Given that there are no restrictions on intertemporal arbitrage trade, the overnight rate will equal the expected overnight rate on the final day of the reserve maintenance period. This property of the overnight rate is usually called the *martingale property*.

Average minimum reserve requirement and the rate corridor

The following description, of how the overnight rate is determined in a system of average minimum reserve requirements over a reserve maintenance period when

there is also a rate corridor, is based on Välimäki (2008). On the final day T of the reserve maintenance period, the overnight rate is determined by

$$(7) \quad i_t = P_T i_B + (1 - P_T) i_D$$

where P_T is the probability of the outstanding minimum reserve requirement being positive at the end of the final day of the reserve maintenance period. If the outstanding minimum reserve requirement is positive, this would involve borrowing at the lending rate of the lending facility on that day in order to avoid paying a penalty rate. Let p_t be the probability of the banks needing to utilise the lending facility and q_t be the probability of them utilising the deposit facility on day $t < T$. The overnight rate is then determined on a day before the final day of the reserve maintenance period as

$$(8) \quad i_t = p_t i_B + q_t i_D + (1 - p_t - q_t) E_t i_T$$

The central bank should supply the banking system with liquidity in such a way that it minimises the expected need to utilise the standing facilities on the final day. Assuming a symmetrical distribution of the bank's liquidity shocks, we then obtain $P_T = 1/2$. The expected overnight rate on the final day of the reserve maintenance period will equal the middle of the corridor, or the policy rate. If the minimum reserve requirement is large in relation to the size of the liquidity shocks, the probabilities of ending up in the standing facilities should be low. Then, the overnight rate should be close to the policy rate throughout the entire reserve maintenance period.

A condition for the system to work as envisaged is that the banks truly expect the overnight rate to equal the policy rate on the final day of the reserve maintenance period. This is why the Bank of England opted for a narrower corridor on the final day of the reserve maintenance period. On the final day of the reserve maintenance period, the rate corridor is used to steer the overnight rate, see Clews (2005) and MacGorain (2006). A narrower corridor on the final day of the reserve maintenance period can also help reduce the expected gain from attempting to manipulate rates on the money market, see Ewerhart et al. (2007).

Problems with average minimum reserve requirements

Holthausen et al. (2008) point to four disadvantages in the use of average minimum reserve requirements:

- it is very difficult for the banks to form an opinion of how their reserves should develop over time to reach an optimal solution

- on the final day of the reserve maintenance period, the method is ineffective
- there are empirical studies that show that the overnight rate does not have the martingale property under average minimum reserve requirements
- reserve requirements increase the central bank's balance sheet total.

The literature has dwelled mainly on the third point. There are many empirical studies that have tested whether or not the overnight rate has the martingale property.

It is a well-documented fact in empirical literature that the martingale property is not valid for the overnight rate in a minimum reserve requirement system. One of the first and best known studies to show this is Hamilton (1996). The fact that volatility in the overnight rate increases during the final days of the reserve maintenance period seems to be a phenomenon common to all countries that use this type of system, see Bartolini and Prati (2006). For the euro area, several studies have documented this phenomenon, including Würtz (2003), Pérez-Quirós and Rodríguez-Mendizábal (2006), Cassola and Morana (2006), Nautz and Offermanns (2007) and Beaupain and Durré (2008).

Several potential reasons for the overnight rate not having the martingale property have been expressed in literature. Different types of transaction costs have been studied by Kopecky and Tucker (1993), Hamilton (1996), Clouse and Dow (1999) and Bartolini, Bertola and Prati (2002). The banks' desire to show a tidy balance sheet – window dressing – can also destroy the martingale property, as shown by Allen and Saunders (1992) and Bindseil, Weller and Würtz (2003). Bartolini et al. (2002) show how the banks' expectations about how the central bank will react to liquidity shocks play a key role in how the volatility of the Fed funds rate develops during the reserve maintenance period. Clouse and Dow (2002) is one of the most detailed models of the US system. They have a reserve maintenance period of 14 days in their model, and have also modelled in the ability to transfer part of the requirement to the following period, which the US system allows. They show that systematic changes in the overnight rate over different days of the reserve maintenance period can be explained by the institutional structure.

Furfine (2000) shows that it suffices for banks to be penalised if they overdraw their account on any day of the reserve maintenance period for the martingale property to be absent from the overnight rate. This is because the penalty puts a limitation on the banks in terms of utilisation of arbitrage possibilities and rectification of deviations in the overnight rate. Pérez-Quirós and Rodríguez-Mendizábal (2006) also describe how the increasing volatility of the overnight rate during the reserve maintenance period might depend on how the operational framework and supply of liquidity are devised. The ECB supplies an equal amount of liquidity in each week of the reserve maintenance period. The probability of a bank having met the minimum reserve requirement for the entire period on a

certain day increases the farther into the reserve maintenance period it gets. Once the minimum reserve requirement is met, the bank has no other choice than to lend the money, potentially to the central bank in the deposit facility, at a low interest rate. The banks thus wait to accumulate reserves, resulting in downward pressure on interest rates at the beginning of the period, and upward pressure at the end. Also, the bank's ability to counter liquidity shocks declines as the reserve maintenance period draws to an end. This makes the banks more sensitive to shocks at the end of the period. The supply of reserves becomes less sensitive to rate changes, which leads to liquidity shocks having a greater effect on the overnight rate.

One of few studies to support the martingale property is Cassola (2008). He assumes that the probabilities of a bank overdrawing its account or meeting the minimum reserve requirement early in the reserve maintenance period are close to zero. Then, the martingale property in the overnight rate is valid in his model. He then tests the model on the European overnight rate EONIA and cannot refute the martingale property.

Whitesell (2006a) warns that a central bank risks losing control of a minimum reserve requirement system in line with banks devising different ways to circumvent the requirements.

WHICH SECURITIES SHOULD CONSTITUTE ELIGIBLE COLLATERAL?

An overarching discussion about the fundamental principles for the central bank's use of collateral is provided in Chailloux et al. (2008). The main reason for the central bank calling for collateral for loans to counterparties is to protect itself from credit risk. However, another important reason is that it makes it easier for the central bank to treat counterparties equally and avoid the problems that would arise if it had to implement price differentiation between counterparties in the implementation of monetary policy operations. Secured loans enable using the same interest rate for a heterogeneous group of counterparties, which facilitates clearer signalling of monetary policy. However, if the central bank uses bids for a variable rate in its operations, the alternative cost of the collateral might have a bearing on the bidding, resulting in less clear signalling.

According to Chailloux et al. (2008) a broad cover pool that is not used to such a great extent in normal circumstances is preferable to a narrowly defined cover pool that is used to a great extent, because it allows (i) a limitation of the market impact in normal circumstances, (ii) rapid expansion of reserves in a crisis, and (iii) the central bank to swap illiquid securities for liquid securities in a liquidity crisis (provided that the central bank has such liquid securities in its portfolio in domestic currency). According to Cheun et al. (2009) it was thanks to the broad cover pool approved by the ECB that euro-denominated mortgage bonds could continue

being issued during the financial crisis, whereas there was an evident drop in issue volumes in the US.

HOW MANY COUNTERPARTIES SHOULD A CENTRAL BANK HAVE?

The fact that the central bank should use a limited number of counterparties in its open market operations is an important insight from the theoretical model in Chapman and Martin (2007). They use Freedman's (1996,1999) model, but with the addition that a bank can reduce the risk associated with a borrower entering bankruptcy by dedicating costs to monitoring the borrower. The scope of the monitoring is assumed to be observable by other banks, but not by the central bank. The risks of bankruptcy are then limited if most banks procure liquidity from another bank instead of from the central bank, because the central bank has poorer information than the banks. It is then optimal for the central bank to distribute reserves to a small number of counterparties, which in turn distribute the reserves onwards to other banks.

Chailloux et al. (2008) note that the arrangement of the central bank only having a handful of monetary policy counterparties in open market operations was called into question during the financial crisis. During a crisis, bottlenecks can emerge which prevent liquidity from being spread to all parts of the banking system (also beyond the banking system). They also question whether an arrangement in which a small group of banks have implicit insurance against liquidity problems is neutral in terms of competition. Cheun et al. (2009) too note that the Fed, which prior to the crisis had few counterparties in open market operations and a narrowly defined cover pool, was forced to introduce an array of programmes during the crisis which in practical terms meant that it extended the number of counterparties and accepted a broader cover pool.

The central bank's liquidity management

Normally, the banking system usually has a liquidity deficit towards the central bank, so the central bank must regularly supply the banking system with liquidity. The question is how this is best done. In a financial crisis, the central bank will have to supply more liquidity than normal, and this will lead to the central bank's balance sheet expanding.

HOW DOES THE CENTRAL BANK SUPPLY THE BANKING SYSTEM WITH LIQUIDITY?

Liquidity supply through auctions

There is literature that studies how, in purely practical terms, to go about supplying the banking system with liquidity. This is preferably done through auctions of loans or repos. Bindseil and Würtz (2008) recommend that the auctions be as

simple and transparent as possible. This means that one of the following bidding procedures should be used:

- bid at fixed rate with 100 per cent allocation
- bid at variable rate with a pre-announced volume.

A pre-announced volume involves the banks not needing to speculate about how the central bank will determine the volume after the auction, which could have undesirable effects on the bidding. Alternatives to the bidding procedures above are

- bid at fixed rate with a pre-announced maximum volume
- bid at variable rate with a pre-announced minimum bid rate.

The maximum volume may not be set too low. This could give rise to problems with overbidding, i.e. the banks bid for more than they really want in order to receive as large an allocation as possible. The point of setting a minimum bid rate is to avoid granting overly advantageous loans.

Problems with over- and underbidding at auctions

The ECB's earlier experience highlights several interesting problems that can arise, depending on how the auction is devised. These experiences are documented and analysed in a large number of studies, mainly by the ECB's own economists. The Eurosystem's open market operations are conducted in the form of bidding procedures at a fixed or variable rate. From the beginning on 1 January 1999, the ECB used fixed-rate bidding without a pre-announced volume. However, in June 2000 the ECB abandoned fixed-rate bidding and switched to using variable-rate bidding with a pre-announced minimum bid rate.⁹ The reason was an escalating overbidding problem. The ECB's own explanation is that the overbidding was due to expectations about the policy rate being hiked during the term of the repo (ECB (2000)). However, Nautz and Oechssler (2006) note that such expectations did not prevail during the entire period in which the ECB used fixed-rate bidding. When there were instead expectations about a rate cut, it received underbids at the auctions.¹⁰

An alternative reason for the overbidding phenomenon is that the ECB did not supply sufficient liquidity during the reserve maintenance period, because it is

9 In fixed-rate bids, the ECB states the rate beforehand, and counterparties state the amounts they want to trade at this rate. In variable-rate bids, the counterparties put in bids for both amounts and rates (each counterparty can put in several bids). In variable-rate bids, the ECB states a minimum bid rate, which acts as a policy rate.

10 See also Ewerhart (2002) and Bindseil et al. (2009).

more concerned about the overnight rate being below the policy rate than about it being above the policy rate (Ayuso and Repullo (2001, 2003)). This put upward pressure on the overnight rate, making the difference between the overnight and policy rates so large that repos were highly advantageous. Ehrhart (2001) shows that it suffices for there to be a probability of a bank being subject to rationing in allocation for it to overbid. If this “rationing hypothesis” is combined with an adaptive learning process as in Nautz and Oechssler (2003), it can lead to escalating overbidding. Nyborg and Strebulaev (2001) show that the overbidding phenomenon can also emerge if there is a risk of counterparties being squeezed after the auction – that is, those that did not receive an allocation at the auction having to pay a premium on the interbank market to those who did. Nautz and Oechssler (2006) conclude that none of the hypotheses alone can explain the overbidding phenomenon.

Allocation at multiple or uniform rates?

Even after the ECB switched to variable-rate tenders, with the allocation method being a multiple-rate auction (American auction), the difference between the overnight rate and policy rate remained positive, according to Ewerhart, Cassola and Valla (2010). They find it surprising that the cost of liquidity is cheaper on the primary market (in ECB auctions) than on the secondary market. Bearing in mind that lots of banks bid at the auctions, the price should be in line with the market. Ewerhart, Cassola and Valla (2010) find that the reason for the price difference is that, at the time of the auction, there is uncertainty about what the liquidity is worth, and the banks then bid a lower rate than what they believe it to be worth (known as “bid shading”) in order to counteract the problem of the “winner’s curse”, i.e. of the party that made the greatest misjudgement on the upside receiving an allocation first. Cassola, Ewerhart and Morana (2007) use an econometric model to estimate the importance of bid shading. They find it is significant and varies positively with allotment uncertainty at auction.

Abbassi and Nautz (2010) study how the outcome of the ECB’s weekly repos affect money market rates. They arrive at the conclusion that a large difference between the average rate and the marginal rate of the auction can have a destabilising effect on money market rates, particularly in periods of market stress. They therefore suggest that the ECB switches from multiple-rate to uniform-rate auctions for its weekly repos (see also Bindseil, Nyborg and Strebulaev (2009) and Nyborg and Strebulaev (2004)). Ewerhart, Cassola and Valla (2010) find however that the rates bid at multiple-rate auctions are on average closer to the policy rate than those bid at uniform-rate auctions, which would speak in favour of using allocation at multiple rate.

EXTRAORDINARY LIQUIDITY SUPPLY AND THE CENTRAL BANK'S BALANCE SHEET.

When does the central bank's balance sheet matter to monetary policy? According to Cúrdia and Woodford (2010b, p. 3) the balance sheet matters only when there are imperfections in the functioning of the credit market: "Neither the size nor the composition of the central bank's balance sheet matter for equilibrium prices or quantities *except* because of financial imperfections." They build the central bank's balance sheet into a traditional new Keynesian model of the transmission mechanism. Then, monetary policy can be conducted along three different dimensions:

- setting an overnight rate target
- determining reserve supply
- determining how much to lend to the private sector.

Besides normal rate-setting, there are thus two further dimensions in which the central bank's balance sheet is used. In terms of the supply of reserves, this must be determined such that it is consistent with the overnight rate target. This in turn involves a uniquely determined rate that is to be paid on the reserves held by banks with the central bank. It must be set equal to the overnight rate target.

An important result from Cúrdia and Woodford's model is that lending to the private sector ("credit policy") can increase welfare when financial markets work imperfectly. However, they show that there is no reason to continue to create new reserves ("quantitative easing") when the policy rate is close to zero. If the central bank only purchases government securities for the newly created reserves, and the policy does not entail any change in expectations about the future interest rate policy that the bank will conduct (which is the case in Auerbach and Obstfeld (2005)), it ensues that quantitative easing does not lead to higher welfare. They also find that the Bank of Japan's experiences from the period 2001-2006 seem to support their theoretical insights. Shiratsuka (2010), however, finds that all unconventional monetary policy in practice has involved a mixture of credit policy and quantitative easing – including the Bank of Japan's policy during the period 2001-2006. However, he acknowledges that the policy during this period does not seem to have noticeably affected inflation and growth.

After the Federal Reserve had cut its overnight rate target to between 0 and 0.25 per cent in December 2008, it started to purchase bonds to further stimulate the economy. These large-scale asset purchases led to a substantial expansion of the Federal Reserve's balance sheet. But, did these purchases have the intended effect on longer rates? An empirical study by Cagnon et al. (2010) says yes, they did. They find that the bond purchases led to economically meaningful and long-lasting reductions in longer rates for a series of securities (0.3 to 1.0

rather than expectations about lower future rates on shorter maturities. The Bank of England started purchasing bonds funded by reserves (“quantitative easing”) in March 2009. Joyce et al. (2010) find that the purchases resulted in reduced rates on government bonds by around 1 percentage point. Both studies also find a significant “portfolio effect”, i.e. that demand for other bonds has increased when return on government bonds has fallen, in which process the rates on these other bonds have also been pushed down. The results are confirmed in a later study by Meaning and Zhu (2011) who arrive at the conclusion that the bond purchases of both central banks have had a more or less equal effect on rates for a certain purchase amount. Rates on government and corporate bonds alike were significantly affected by the asset purchases.

Conclusions

There is largely a consensus view that the *central bank's operational target* should be to steer the overnight rate. This is the rate over which the central bank has most control. The reason is that the central bank is able to force the other banks to borrow/deposit overnight at a rate it determines itself. Central banks also attempt to minimise fluctuations in the overnight rate around the policy rate. The literature presents many reasons for this:

- the price paid by the banks for a liquidity shock at the end of the day is stabilised
- fluctuations in time-varying term premiums are reduced
- a clearer monetary policy signal is sent.

As instruments for steering the overnight rate, most central banks use a combination of *standing facilities* and *open market operations*. If the central bank conducts open market operations in such a way that the probability of the banking system needing to utilise the lending facility at the end of the day is as high as the probability of it needing to utilise the deposit facility, the overnight rate will be in the middle of the interest rate corridor. Alternatively, the central bank can supply the banking system with so much liquidity that the overnight rate is pushed down towards the floor of the corridor. A potential disadvantage of a floor system is that the overnight market is less active. This must also be taken into account in a symmetrical corridor. The width of the corridor may be determined by weighing the significance of steering the overnight rate (which would indicate a narrower corridor), against the significance of having an active overnight market (which would indicate a wider corridor).

A further instrument for steering the overnight rate addressed in literature is *minimum reserve requirements*. Minimum reserve requirements that are to be met

on average over a reserve maintenance period are a way to get the banks to even out fluctuations in the overnight rate themselves through intertemporal arbitrage, without the central bank having to supply or withdraw liquidity daily. The central bank supplies the exact amount of liquidity needed by the banks to meet the minimum reserve requirements over the period. In practice, however, it has turned out that this arrangement does not seem to have such a stabilising effect on the overnight rate as it theoretically should.

The selection of *eligible collateral* used by the central bank in lending to counterparties, and the choice of *circle of counterparties* appointed are two further factors in the operational framework for the implementation of monetary policy. Lending against collateral is a way of protecting oneself from credit risk. However, the equal treatment of counterparties also makes it easier for the central bank, because it does not need to implement price differentiation between the counterparties in the implementation of monetary policy operations. While there are arguments in favour of the central bank using a broad cover pool, it is less clear as to whether it should have a broader or narrower circle of counterparties.

Appendix: Deriving the equilibrium interest rate

In this appendix we derive the equilibrium rate (overnight) in a model made known by Woodford (2001). The model is based on Henckel et al. (1999) which in turn base it on Poole (1968). Here, we follow the presentation in Gaspar et al. (2008) and Bindseil and Würtz (2008).

In the morning, before trade on the interbank market has commenced for day t , the bank has a holding of

$$(A1) \quad a_t$$

on its account at the central bank. During the day, payments are made on behalf of customers which usually exceed the original holding in the account by a wide margin. This is possible because the central bank provides intraday credit, usually at no cost (zero interest rate).¹¹ If the bank assesses that it will have a large surplus (deficit) at the end of the day, due to the trade of customers, it can go to the interbank market and lend (borrow) b_t , such that the position on the bank's account at the central bank will be

$$(A2) \quad s_t = a_t - b_t.$$

Alternatively, it can be viewed as the bank choosing how high a level of reserves, s_t , it is to hold with the central bank. After the interbank market has closed, the bank is exposed to a liquidity shock, λ_t , which can be positive or negative. According to Furfine (2000) the shock can be caused by operational errors, book-keeping errors or an expected payment that is not received in time before the payment system closes. The position in the bank's account at the end of the day is then changed to

$$(A3) \quad a_t - b_t + \lambda_t.$$

The following morning, the loan is repaid with interest i_t (the overnight rate) and the bank is paid (or has to pay) for any utilisation of the central bank's deposit (lending) facility. However, for the sake of simplicity, no interest income (or interest expense) is capitalised in this presentation. The position in the morning will then be

11 The reason for the difference in the pricing of intraday and overnight credit has been the subject of several studies ever since Freeman (1996). For a current study, see Bhattacharya, Haslag and Martin (2009). Kahn and Roberds (2009) provide an introduction to payments economics.

$$(A4) \quad a_{t+1} = a_t + \lambda_t.$$

If the bank has to meet a minimum reserve requirement over a certain period, it must also keep track of how much it must hold in the account throughout the remainder of the reserve maintenance period in order to meet the requirement. The outstanding minimum reserve requirement (“reserve deficiency”) is given by

$$(A5) \quad d_{t+1} = \max\{0, d_t - \max[0, a_t - b_t + \lambda_t]\}, \quad d_1 = RR,$$

where RR is the minimum reserve requirement for the period. The outstanding minimum reserve requirement is thus reduced by the balance of the account following the liquidity shock, provided that this balance is positive.

Woodford (2001) uses a model without minimum reserve requirements, which is a version of Henckel et al. (1999). He assumes that the liquidity shocks are independently distributed across the banks, with mean $E[\lambda_j | s_j] = 0$ and variance $V[\lambda_j | s_j] = \sigma_j^2$. For each j , λ_j / σ_j has a distribution function F with mean zero and variance 1 and $F(0) = 0.5$. Bank j is assumed to maximise its expected return by selecting b_j ,

$$(A6) \quad E_j \Pi(s_j, \lambda_j) = i b_j + i_D E_j [\max(a_j - b_j + \lambda_j, 0)] + i_B E_j [\min(a_j - b_j + \lambda_j, 0)].$$

Woodford (2001) prefers to use a bank’s reserves at the central bank, s_j , as a control variable. He then writes of (A6) as

$$(A7) \quad E_j \Pi(s_j, \lambda_j) = i a_j + i s_j + i_D E_j [\max(s_j + \lambda_j, 0)] + i_B E_j [\min(s_j + \lambda_j, 0)],$$

where E_j is bank j ’s expectation at the beginning of the day, i is the overnight rate i_B and i_D is the lending and deposit rate, respectively, on the central bank’s standing facilities. From the first-order condition, bank j ’s desired reserves can be derived as,

$$(A8) \quad s_j = -\sigma_j F^{-1} \left(\frac{i - i_D}{i_B - i_D} \right).$$

In equilibrium, the aggregate demand for reserves must equal the supply from the central bank.

$$(A9) \quad \sum_j s_j = R,$$

where R is the banks' aggregate reserves at the central bank at the beginning of the day. By substituting the banks' desired reserves in this condition, the level of the overnight rate in equilibrium can be calculated, which will be

$$(A10) \quad i = i_D + F \left(\frac{-R}{\sum_j \sigma_j} \right) (i_B - i_D).$$

References

- Abbassi, Puriya and Dieter Nautz (2010). Monetary transmission right from the start: the (dis) connection between the money market and the ECB's main refinancing rates, Discussion Paper No. 7, School of Business and Economics, Freie Universität Berlin.
- Acharya, Viral, Denis Gromb, Tanju Yorulmazer (2008). Imperfect competition in the inter-bank market for liquidity as a rationale for central banking, CEPR Discussion Paper No. 6984.
- Acharya, Viral and Tanju Yorulmazer (2008). Cash-in-the-market pricing and optimal resolution of bank failures, *Review of Financial Studies* 21, 2705-2742.
- Allen, Franklin and Douglas Gale (2000). Financial contagion, *Journal of Political Economy* 108, 1-33.
- Allen, Franklin, Elena Carletti and Douglas Gale (2009). Interbank market liquidity and central bank intervention, *Journal of Monetary Economics* 56, 639-652.
- Andersson, Malin, Hans Dillén and Peter Sellin (2006). Monetary policy signaling and movements in the term structure of interest rates, *Journal of Monetary Economics* 53, 1815-1855.
- Ashcraft, Adam, James McAndrews and David Skeie (2008). Precautionary reserves and the interbank market, Federal Reserve Bank of New York Staff Reports No. 370.
- Auerbach, Alan and Maurice Obstfeld (2005). The case for open-market purchases in a liquidity trap, *American Economic Review* 95, 110-137.
- Ayuso, Juan and Rafael Repullo (2001). Why did the banks overbid? An empirical model of the fixed rate tenders of the European Central Bank, *Journal of International Money and Finance* 20, 857-870.
- Ayuso, Juan and Rafael Repullo (2003). A model of the open market operations of the European Central Bank, *The Economic Journal* 113, 883-902.
- Baltensperger, Ernst (1974). The precautionary demand for reserves, *American Economic Review* 64(1), 205-210.
- Bartolini, Leonardo, Giuseppe Bertola and Alessandro Prati (2002). Day-to-day monetary policy and the volatility of the federal funds interest rate, *Journal of Money, Credit and Banking* 34(1), 137-159.
- Bartolini, Leonardo and Alessandro Prati (2006). Cross-country differences in monetary policy execution and money market rates' volatility, *European Economic Review* 50, 349-376.
- Beaupain, Renaud and Alain Durré (2008). The interday and intraday patterns of the overnight market – evidence from an electronic platform, Working Paper No. 988, European Central Bank.
- Berentsen, Aleksander and Cyril Monnet (2008). Monetary policy in a channel system, *Journal of Monetary Economics* 55, 1067-1080.
- Bernhardsen, Tom, Arne Kloster, Elisabeth Smith and Olav Syrstad (2009). The financial crisis in Norway: effects on financial markets and measures taken, *Financial Markets and Portfolio Management* 23, 361-381.
- Bhattacharya, Joydeep, Joseph Haslag and Antoine Martin (2008). Understanding the cost difference between intraday and overnight liquidity, *Journal of Financial Transformation*, Capco Institute, vol. 24, 105-107.
- Bindseil, Ulrich (2004a). *Monetary policy implementation*, Oxford University Press, New York.
- Bindseil, Ulrich (2004b). The operational target of monetary policy and the rise and fall of reserve position doctrine, Working Paper No. 372, European Central Bank.

- Bindseil, Ulrich and Juliusz Jablecki (2011). The optimal width of the central bank standing facilities corridor and banks' day-to-day liquidity management, Working Paper No. 1350, European Central Bank.
- Bindseil, Ulrich, Kjell G. Nyborg (2008). Monetary policy implementation, in *Handbook of European Financial Markets and Institutions* edited by Xavier Freixas, Philipp Hartmann and Colin Mayer, Oxford University Press.
- Bindseil, Ulrich, Kjell G. Nyborg and Ilya Strebulaev (2009). Repo auctions and the market for liquidity, *Journal of Money, Credit and Banking* 41(7), 1391-1421.
- Bindseil, Ulrich, Benedict Weller and Flemming Würtz (2003). Central bank and commercial banks' liquidity management – what is the relationship? *Economic Notes* 32, 37-66.
- Bindseil, Ulrich and Flemming Würtz (2007). Open market operations – their role and specification today, in *Open Market Operations and Financial Markets* edited by David G. Mayes and Jan Toporowski, Routledge.
- Bindseil, Ulrich and Flemming R. Würtz (2008). Efficient and universal frameworks (EUF) for monetary policy implementation, mimeo, European Central Bank.
- Borio, Claudio (1997). The implementation of monetary policy in industrial countries: a survey, *BIS Economic Paper*, No. 47.
- Borio, Claudio and Piti Disyatat (2009). Unconventional monetary policies: an appraisal, *BIS Working Paper*, No 292.
- Carpenter, Seth and Selva Demiralp (2006). Anticipation of monetary policy and open market operations, *International Journal of Central Banking* 2(2), 25-63.
- Cassola, Nuno, Christian Ewerhart and Claudio Morana (2007). Structural econometric approach to bidding in the main refinancing operations of the Eurosystem, Working Paper No. 793, European Central Bank.
- Cassola, Nuno and Claudio Morana (2006). Volatility of interest rates in the euro area: evidence from high frequency data, *The European Journal of Finance* 12(6), 513-528.
- Chailloux, Alexandre, Simon Gray, Ulrich Klüh, Seiichi Shimizu and Peter Stella (2008). Central bank response to the 2007-08 financial market turbulence: experiences and lessons drawn, Working Paper No. 08/210, International Monetary Fund.
- Chailloux, Alexandre, Simon Gray and Rebecca McCaughrin (2008). Central bank collateral frameworks: principles and policies, International Monetary Fund Working Paper No. 222.
- Chapman, James and Antoine Martin (2007). Rediscounting under aggregate risk with moral hazard, Federal Reserve Bank of New York Staff Report 296.
- Cheun, von Köppen-Mertes and Weller (2009). The collateral frameworks of the Eurosystem, the Federal Reserve System and the Bank of England and the financial market turmoil, Occasional Paper Series No. 107, European Central Bank.
- Clews, Roger (2005). Implementing monetary policy: reforms to the Bank of England's operations in the money market, *Bank of England Quarterly Bulletin*, summer 2005, 211-220.
- Clouse, James and James Dow (1999). Fixed costs and the behavior of the federal funds rate, *Journal of Banking and Finance* 23, 1015-1029.
- Clouse, James and James Dow (2002). A computational model of bank's optimal reserve management policy, *Journal of Economic Dynamics and Control* 26, 1787-1974.
- Cúrdia, Vasco and Michael Woodford (2010a). Conventional and unconventional monetary policy, Department of Economics Discussion Paper No. 0910-17, Columbia University.
- Cúrdia, Vasco and Michael Woodford (2010b). The central bank balance sheet as an instrument of monetary policy, mimeo, Columbia University.

Demiralp, Sela and Oscar Jordá (2002). The announcement effect: evidence from open market desk data, *Economic Policy Review* 8(1), Federal Reserve Bank of New York.

Disyatat, Piti (2008). Monetary policy implementation: misconceptions and their consequences, Working Paper No. 269, Bank for International Settlements.

ECB (2000). The switch to variable rate tenders in the main refinancing operations, in *Monthly Bulletin* (July), 37-42.

Eggertsson, Gauti and Michael Woodford (2003). The zero bound on interest rates and optimal monetary policy, *Brookings Papers on Economic Activity* 1, 139-233.

Ehrhart, Karl-Martin (2001). European Central Bank operations: an experimental investigation of the fixed rate tender, *Journal of International Money and Finance* 20, 871-893.

Engert, Walter, Toni Gravelle and Donna Howard (2008). The implementation of monetary policy in Canada, Bank of Canada Discussion Paper 2008-9.

Ennis, Huberto M. and Todd Keister (2008). Understanding monetary policy implementation, *Economic Quarterly* 94(3), Federal Reserve Bank of Richmond, 235-263.

Ennis, Huberto M. and John A. Weinberg (2007). Interest on reserves and daylight credit, *Economic Quarterly* 93(2), Federal Reserve Bank of Richmond, 111-142.

Ewerhart, Christian (2002). A model of the eurosystem's operational framework for monetary policy implementation, Working Paper No. 197, European Central Bank.

Ewerhart, Christian, Nuno Cassola, Steen Ejerskov and Natacha Valla (2007). Manipulation in money markets, *International Journal of Central Banking*, 113-148.

Ewerhart, Christian, Nuno Cassola, and Natacha Valla (2010). Declining valuations and equilibrium bidding in central bank refinancing operations, *International Journal of Industrial Organization* 28, 30-43.

Fecht, Falko, Kjell G. Nyborg and Jörg Rocholl (2008). The price of liquidity: bank characteristics and market conditions, Discussion Paper No. 30, Deutsche Bundesbank.

Flannery, Mark (1996). Financial crises, payment system problems and discount window lending, *Journal of Money, Credit and Banking* 28, 804-824.

Freedman, Charles (2000). Monetary policy implementation: past, present and future – will electronic money lead to the eventual demise of central banking? *International Finance* 3(2), 211-227.

Freeman, Scott (1996). The payments system, liquidity and rediscounting, *American Economic Review* 86, 1126-1138.

Freeman, Scott (1999). Rediscounting under aggregate risk, *Journal of Monetary Economics* 43, 197-216.

Freixas, Xavier, Antoine Martin and David Skeie (2009). Bank liquidity, interbank markets and monetary policy, Staff Report No. 371, Federal Reserve Bank of New York.

Friedman, Benjamin and Kenneth N. Kuttner (2010). Implementation of monetary policy: how do central banks set interest rates? Manuscript prepared for the *Handbook of Monetary Economics*, vol. 3.

Friedman, Milton (1969). The optimum quantity of money, in *The optimum quantity of money and other essays*, Chicago: Aldine.

Furfine, Craig (2000). Interbank payments and the daily federal funds rate, *Journal of Monetary Economics* 46, 535-553.

Furfine, Craig (2001). Banks as monitors of other banks: evidence from the overnight market for federal funds, *Journal of Business* 74, 33-57.

- Furfine, Craig and Jeff Stehm (1998). Analysing alternative intraday credit policies in real-time gross settlement systems, *Journal of Money, Credit and Banking* 30(4), 832-848.
- Gagnon, Joseph, Matthew Raskin, Julie Remache and Brian Sack (2010). Large-scale asset purchases by the Federal Reserve: did they work? Federal Reserve Bank of New York *Staff Report* no. 441.
- Gaspar, Vitor, Gabriel Pérez Quirós and Hugo Rodríguez Mendizábal (2008). Interest rate dispersion and volatility in the market for daily funds, *European Economic Review* 52, 413-440.
- Goodfriend, Marvin (2002). Interest on reserves and monetary policy, *Economic Policy Review* 8 (May), 77-84.
- Goodhart, Charles (2010). Liquidity management, in *Financial Stability and Macroeconomic Policy*, a symposium sponsored by the Federal Reserve Bank of Kansas City, 157-168.
- Guthrie, Graeme and Julian Wright (2000). Open mouth operations, *Journal of Monetary Economics* 46, 489-516.
- Hamilton, James D. (1996). The daily market for federal funds, *Journal of Political Economy* 104, 26-56.
- Heller, Daniel and Yvan Lengwiler (2003). Payment obligations, reserve requirements and the demand for central bank balances, *Journal of Monetary Economics* 50, 419-432.
- Henckel, Timo, Alain Ize and Arto Kovanen (1999). Central banking without central bank money, Working Paper No. 92, International Monetary Fund.
- Ho, Corrinne (2008). Implementing monetary policy in the 2000s: operating procedures in Asia and beyond, Working Paper No. 253, Bank for International Settlements.
- Holthausen, Cornelia, Cyril Monnet and Flemming Würtz (2008). Implementing monetary policy without reserve requirements, mimeo, European Central Bank.
- Joyce, Michael, Ana Lasasosa, Ibrahim Stevens and Matthew Tong (2010). The financial market impact of quantitative easing, Bank of England Working Paper No. 393.
- Kahn, Charles M. and William Roberds (2009). Why pay? An introduction to payments economics, *Journal of Financial Intermediation* 18, 1-23.
- Keister, Todd and James McAndrews (2009). Why are banks holding so many excess reserves? Staff Report No. 380, Federal Reserve Bank of New York.
- Keister, Todd, Antoine Martin and James McAndrews (2008). Divorcing money from monetary policy, *Economic Policy Review*, Federal Reserve Bank of New York.
- King, Thomas (2008). Discipline and liquidity in the interbank market, *Journal of Money, Credit and Banking* 40, 295-317.
- Kopecky, Kenneth J. and Alan L. Tucker (1993). Interest rate smoothness and the non-settling-day behaviour of banks, *Journal of Economics and Business* 45, 297-314.
- Leao, Emanuel R. and Pedro R. Leao (2006). Modelling the central bank repo rate in a dynamic general equilibrium framework, *Economic Modelling* 24, 571-610.
- Linzert, Tobias and Sandra Schmidt (2008). What explains the spread between the euro overnight rate and the ECB's policy rate? Working Paper No. 983, European Central Bank.
- MacGorain, Seamus (2006). Achieving overnight rate stability in a reserve averaging framework, mimeo, Bank of England.
- Manna, Michele, Huw Pill and Gabriel Quirós (2001). The Eurosystem's operational framework in the context of the ECB's monetary policy strategy, *International Finance* 4(1), 65-99.

- Martin, Antoine and James McAndrews (2010). Should there be intraday money markets? *Contemporary Economic Policy* 28(1), 110-122.
- Martin, Antoine and Cyril Monnet (2009). Monetary policy implementation frameworks: a comparative analysis, Working Paper No. 27, Federal Reserve Bank of Philadelphia.
- Meaning, Jack and Feng Zhu (2011). The impact of recent central bank asset purchase programmes, BIS Quarterly Review, December 2011.
- McGough, Bruce, Glenn Rudebusch and John Williams (2005). Using a long-term interest rate as the monetary policy instrument, *Journal of Monetary Economics* 52, 855-879.
- Mehrling, Perry (2008). Monetary policy implementation: a microstructure approach, in *David Laidler's Contributions to Macroeconomics*, edited by Robert Leeson. Palgrave MacMillan.
- Mills, David (2004). Mechanism design and the role of enforcement in Freeman's model of payments, *Review of Economic Dynamics* 7, 219-236.
- Nautz, Dieter and Jörg Oechssler (2003). The repo auctions of the European Central Bank and the vanishing quota puzzle, *Scandinavian Journal of Economics* 105(2), 207-220.
- Nautz, Dieter and Jörg Oechssler (2006). Overbidding in fixed rate tenders – an empirical assessment of alternative explanations, *European Economic Review* 50, 631-646.
- Nautz, Dieter and Christian Offermanns (2007). The dynamic relationship between the euro overnight rate, the ECB's policy rate and the term spread, *International Journal of Finance and Economics* 12, 287-300.
- Nautz, Dieter and Sandra Schmidt (2009). Monetary policy implementation and the federal funds rate, *Journal of Banking and Finance* 33, 1274-1284.
- Nyborg, Kjell G. and Ilya Strebulaev (2001). Collateral and short squeezing of liquidity in fixed rate tenders, *Journal of International Money and Finance* 20, 769-792.
- Nyborg, Kjell G. and Ilya Strebulaev (2004). Multiple unit auctions and short squeezes, *Review of Financial Studies* 17, 545-580.
- Pérez Quirós, Gabriel and Hugo R. Mendizábal (2006). The daily market for funds in Europe: what has changed with the EMU? *Journal of Money, Credit and Banking* 38(1), 91-118.
- Pérez Quirós, Gabriel and Hugo R. Mendizábal (2010). Asymmetric standing facilities: an unexploited monetary policy tool, Documentos de Trabajo No. 1004, Banco de España.
- Poole, William (1968). Commercial bank reserve management in a stochastic model: implications for monetary policy, *Journal of Finance* 23, 769-791.
- Poole, William (1970). Optimal choice of monetary policy instruments in a small stochastic macro model, *Quarterly Journal of Economics* 84, 197-216.
- Shiratsuka, Shigenori (2010). Size and composition of the central bank balance sheet: revisiting Japan's experience of the quantitative easing policy, Working Paper No. 42, Federal Reserve Bank of Dallas.
- Thornton, Daniel L. (2000). The relationship between the federal funds rate and the Fed's federal funds rate target: is it open market or open mouth operations? Discussion paper 9/00, Economic Research Centre of the Deutsche Bundesbank.
- Tucker, Paul (2004). Managing the central bank's balance sheet: where monetary policy meets financial stability, *Bank of England Quarterly Bulletin*, Autumn 2004, 359-382.
- Välimäki, Tuomas (2008). Why the effective price for money exceeds the policy rate in the ECB tenders, Working Paper No. 981, European Central Bank.
- Wallace, Neil (1981). A Modigliani-Miller theorem for open-market operations, *American Economic Review* 71, 267-274.

Whitesell, William (2006a). Interest rate corridors and reserves, *Journal of Monetary Economics* 53, 1177-1195.

Whitesell, William (2006b). Monetary policy implementation without averaging or rate corridors, Finance and Economics Discussion Paper No. 22, Federal Reserve Board.

Woodford, Michael (2000). Monetary policy in a world without money, *International Finance* 3(2), 229-260.

Woodford, Michael (2001). Monetary policy in the information economy, in *Economic policy for the information economy*, Federal Reserve Bank of Kansas City.

Woodford, Michael (2003). *Interest and prices: Foundations of a theory of monetary policy*. Princeton University Press, Princeton, N.J.

Woodford, Michael (2005). Comment on "Using a long-term interest rate as the monetary policy instrument", *Journal of Monetary Economics* 52, 881-887.

Würtz, Flemming (2003). A comprehensive model on the euro overnight rate, Working Paper No. 207, European Central Bank.

■ The Riksbank's operational framework for the implementation of monetary policy

The Riksbank attempts to influence interest rates in the economy so that the inflation target is met. In this article we describe how the Riksbank steers the risk-free overnight rate for interbank loans in practice. We present the instruments in the Riksbank's toolkit and how these are used to steer the overnight rate. We find that the Riksbank's operational framework for the implementation of monetary policy performs its task of stabilising the overnight rate well. However, we also show that the framework is not adequate to satisfactorily influence interest rates at longer maturities than overnight. Experience from the latest financial crisis has also demonstrated that the Riksbank should be well prepared to conduct monetary policy under extraordinary circumstances. In this context, there may be a need to add to the Riksbank's toolkit. There is also a need to continuously evaluate the operational framework.

The Riksbank began to evaluate its operational framework for the implementation of monetary policy in the spring of 2008. The financial crisis began shortly afterwards, which taught the Riksbank new lessons about how the framework functions. This article should thus be seen as a status report rather than as a final evaluation – especially considering that we are now in a situation in which the crisis measures taken by central banks abroad are still ongoing. Work is also underway on the regulation of the financial sector which may have consequences for the design of the operational framework.

The operational framework plays a central role for the Riksbank's ability to implement monetary policy. The Riksbank changed its approach to conducting monetary policy in the 1990s. In connection with the crisis in 1992, the Riksbank abandoned the fixed exchange-rate regime and decided instead to conduct inflation targeting.¹ In order to provide a more transparent system for the implementation of monetary policy, a new operational framework was introduced in June 1994. The Riksdag (the Swedish parliament) subsequently increased the Riksbank's ability to attain the inflation target by adopting a new Sveriges

¹ Under the Sveriges Riksbank Act, the Riksbank shall maintain price stability, which means that inflation should be low and stable. The Riksbank has specified the target for monetary policy such that inflation should be 2 per cent a year, measured as the annual percentage change in the Consumer Price Index (CPI). Any deviation from the target does not have to be immediately corrected as this could have negative consequences for economic growth.

Riksbank Act that since 1 January 1999 ensures the Riksbank's independence. An Executive Board consisting of six members was entrusted to independently decide on a policy rate at monetary policy meetings held at intervals of six to eight weeks.

Since 1999, the Riksbank has conducted monetary policy by the Executive Board deciding on and signalling the level of the most important policy rate – the repo rate – that is compatible with the inflation target. The Riksbank's operational framework for the implementation of monetary policy is designed to steer the market's overnight rate, that is the interest rate on overnight loans between the banks. The idea is that the framework should stabilise the overnight rate at a level close to the repo rate. In this way the overnight rate should act as an anchor for the yield curve (interest-rate formation at longer maturities). However, in an attempt to steer interest-rate formation at longer maturities more directly, the Riksbank also publishes a forecast of future repo rates, a so-called repo-rate path, that are compatible with the inflation target. The Riksbank's ambition is to stabilise the shortest, risk-free interest rate while the market is allowed to determine interest rates at longer maturities that include various risk premiums.

In the spring of 2008, the Riksbank began to evaluate how well the operational framework for the implementation of monetary policy works. This evaluation mainly entails reviewing how the framework performs its tasks of effectively implementing the Riksbank's monetary policy decisions and steering liquidity in the payment system. This review was started in 2008, but the financial crisis began shortly afterwards and this taught the Riksbank new lessons about how the framework functions under different circumstances. The evaluation thus needs to continue so that we can take these lessons into account. In the meantime, however, we can present a status report that describes how the framework works today and identifies some areas that merit further inquiries.

This article consists of three sections. The first section describes how the operational framework works and explains how it came to take its present form by looking back at some high points in its historical development. The second section describes the Riksbank's counterparties and the securities these use as collateral for loans from the Riksbank and in the monetary policy repos. In the third and final section, we discuss some areas in which there are questions that merit further inquiries.

Steering the overnight rate and liquidity in the banking system

We begin by briefly describing payments during the day in the payment system (intraday payments) and on the overnight market, that is the market for loans overnight between the banks. It is the interest rate on this market – *the overnight*

rate – that the Riksbank tries to steer.² The Riksbank offers the banks that participate in the RIX payment system the opportunity, when necessary, to borrow from the Riksbank during the day without paying interest but against collateral via so called intraday loans. The conditions for these loans are generous. In this way, the Riksbank encourages the banks to use intraday loans in order to make payments more easily and more efficiently. However, in order to avoid individual banks systematically funding their operations via the Riksbank the conditions for overnight loans are not as generous. The banks therefore balance out their liquidity positions in relation to each other at the end of the day. In this balancing process, banks with a surplus lend to banks with a deficit so that that the banking system as a whole is balanced before the payment system closes for the day.

The liquidity surpluses or deficits that remain after the banks have balanced their liquidity positions with each other constitute the banking system's net position in relation to the Riksbank. If the banking system has a liquidity surplus in relation to the Riksbank this can be deposited overnight with the Riksbank. If, on the other hand, the banking system has a liquidity deficit then the system as a whole can borrow the corresponding sum from the Riksbank overnight.

The conditions governing how the banks can deposit and borrow liquidity overnight form the core of the operational framework. By setting the conditions for the banks' deposits and borrowing at the Riksbank, the Riksbank can steer the interest rate for loans at the shortest maturity – overnight loans. As the Riksbank focuses on balancing the banks' liquidity at the end of the day in this way, the interest rate for overnight loans – the overnight rate – becomes the operational target for monetary policy. The Riksbank stabilises the overnight rate and thus creates an anchor for interest rate formation at longer maturities, which is necessary but far from sufficient to stabilise interest rate formation at longer maturities.

If the banking system has a large liquidity surplus to deposit at the end of the day this may push down the overnight rate. This gives the Riksbank a reason to use some form of instrument to try to draw in this liquidity at longer maturities. In the next section we therefore discuss which instruments the Riksbank uses for this purpose. We also discuss the Riksbank's liquidity management during the financial crisis when it took a number of extraordinary measures, the main measure being to lend to the banks at longer maturities. As we shall see, this had consequences for the Riksbank's steering of both liquidity and interest rates.

2 A more detailed description of the overnight market is given in Kronstedt Metz (2005) and Eklund and Åsberg Sommar (2011).

THE CONDITIONS GOVERNING INTRADAY CREDIT AND CREDIT OVERNIGHT FORM THE CORE OF THE OPERATIONAL FRAMEWORK.

If two people have accounts in the same bank, a payment between them may be carried out simply by the bank debiting the account of one of them and crediting the account of the other. We then say that the payment is settled (or carried out) in *commercial bank money*. However, if the two people concerned have accounts with different banks, a payment must also be made between these banks. Such interbank transactions are usually settled in central bank money, that is by debiting and crediting the banks' accounts in the Riksbank's payment system RIX.³

RIX participants can increase their credit limit in the payment system by using securities or foreign currency as collateral for intraday loans or by transferring banknotes and coins to the Riksbank. Intraday loans, which are interest free, are registered in the RIX participants' loan accounts in the system. Although the loans are interest free this does not mean that they are cost free, as the loans are provided against collateral and there are certain costs associated with the management of the securities used as collateral.

Central bank money can also be created on the initiative of the Riksbank. The Riksbank can lend Swedish kronor at longer maturities than intraday and can also buy assets. For example, the Riksbank can buy foreign currency from a RIX participant and pay by crediting the participant's RIX account with Swedish kronor. RIX is open every Swedish banking day between 7 a.m. and 5 p.m. RIX participants who are not entitled to overnight loans have to settle their intraday loans by close of business. Otherwise, they have to pay a fee. In the case of the other participants the procedure is that if the balance of their RIX account is negative then it is considered that they have requested a loan from the Riksbank's lending facility. If, on the other hand, the balance of their RIX account is positive when the payment system closes, then it is considered that they have requested to use the Riksbank's deposit facility. The maturity of the loans and deposits under these so-called standing facilities is overnight from the time RIX closes until it opens the following banking day.

As a rule, the banks can get better conditions for loans and deposits from each other than the conditions that apply in the standing facilities. This is because in a normal situation the banks believe that lending to each other overnight entails no risk. In the first instance, they therefore use the so-called overnight market to lend or deposit money overnight at the *overnight rate*. If, on the other hand, the banks believe that there is a risk of not getting their money back they will not lend to each other. Banks with a liquidity surplus will instead deposit money in the

³ The RIX participants are the Riksbank, the Swedish National Debt Office and a number of credit institutions and clearing organisations. Settlement in RIX takes place under the principle of real-time gross settlement. This means that payments are settled one at a time and that the funds transferred to a RIX account become immediately accessible in the account and can be used for other payments.

Riksbank's deposit facility and thus in practice refer banks with a liquidity deficit to the Riksbank to borrow from the Riksbank's lending facility.

HOW DOES THE RIKSBANK STEER THE OVERNIGHT RATE?

The operational framework for the implementation of monetary policy is designed so as to make it possible to steer the overnight rate towards the level of the repo rate adopted by the Executive Board of the Riksbank. The primary instruments for steering the overnight rate are the Riksbank's standing facilities, the so-called deposit and lending facilities, and the fine-tuning transactions.

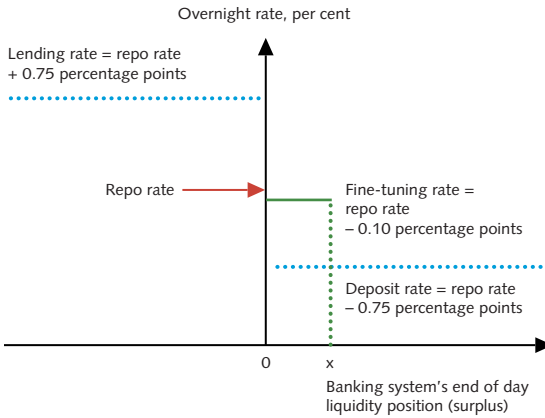
Standing facilities

The Riksbank provides a deposit facility with a deposit rate equal to the repo rate minus 0.75 percentage points and a lending facility with a lending rate equal to the repo rate plus 0.75 percentage points (see Chart 1). At close of business, that part of a bank's loan account that is equal to the bank's holdings in its main RIX account is automatically repaid. If the balance of a bank's loan account with RIX shows a deficit when the payment system closes for the day, the bank has to pay the lending rate on the balance overnight (that is until the next bank day). If the balance of a bank's main account shows a surplus when the payment system closes, the bank earns the deposit rate on the sum overnight. The sum that can be borrowed from the lending facility is limited by the adjusted value of the collateral provided by the bank. There is no limit on how much a bank may deposit in the deposit facility.

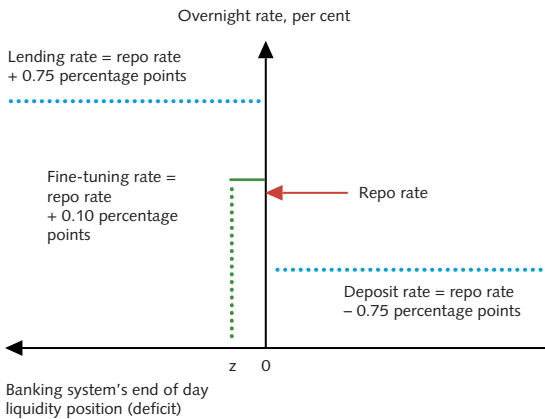
Due to the standing facilities, a bank will never deposit a surplus on the overnight market at a rate lower than the deposit rate or borrow at a rate higher than the lending rate. It will be more advantageous to leave the balances in RIX until it closes. The deposit and lending rates thus form a corridor for the overnight rate. The position of the overnight rate within the corridor is a matter for negotiation between the banks on the overnight market.

Chart 1. The Riksbank's operational framework for the implementation of monetary policy

Panel A. The banking system has a liquidity surplus in relation to the Riksbank



Panel B. The banking system has a liquidity deficit in relation to the Riksbank

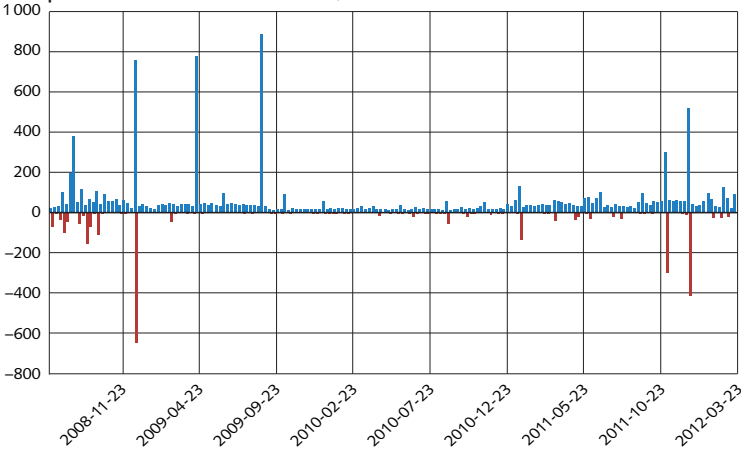


Note. Panel A shows a situation in which at the end of the day the banking system has a liquidity surplus of SEK x million in relation to the Riksbank, while panel B shows a situation in which at the end of the day the banking system has a liquidity deficit of SEK z million in relation to the Riksbank. The figure also shows that the repo rate is the reference rate for the Riksbank's other policy rates.

Several million kronor remain in the standing facilities at the end of almost every banking day (see Figure 1). Why isn't RIX fully balanced before it closes? This is because the surpluses often consist of smaller sums divided between several banks. None of these banks is particularly interested in completing a transaction as the transaction costs will be higher than the interest income. Usually, therefore, it is only small sums that end up in the standing facilities. There are, however, some exceptions, as we can see in Figure 1. The extreme values that can be noted at a few points in time in Figure 1 are probably due to liquidity-management mistakes on the part of one of the banks.

During the financial crisis it was unusual for a bank to have a deficit at the end of the day as the Riksbank offered extra liquidity to the banks, which also meant that the lending facility was seldom used in this period.

Figure 1. Deposits (+) and lending (-) in the standing facilities, weekly data for the period 7 June 2008-23 March 2012, SEK million



Source: The Riksbank's weekly reports

Fine-tuning transactions

Daily fine-tuning transactions were introduced in 1995 as a way for the Riksbank to stabilise the overnight rate around the repo rate and thus avoid fluctuations in the overnight rate being interpreted as policy signals by the market participants.⁴

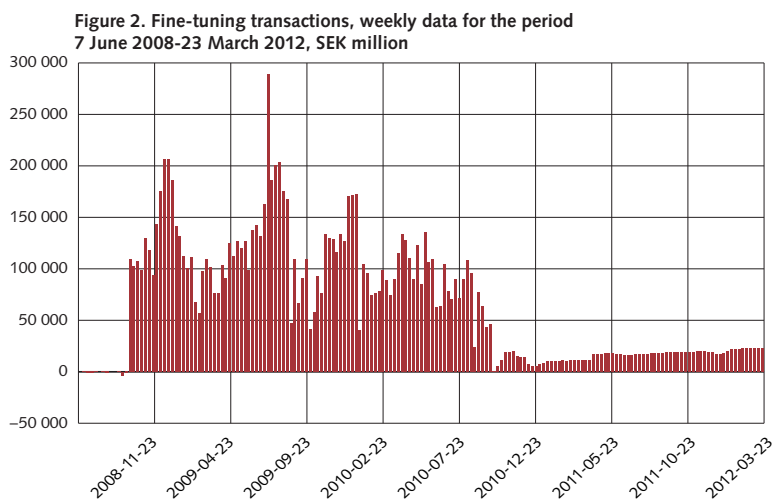
The fine-tuning transactions are normally carried out every banking day between 4 p.m. and 4.40 p.m..⁵ In the fine-tuning transactions, the Riksbank offers credit against collateral or overnight deposits at an interest rate equal to the repo rate +/- 0.10 percentage points (see Chart 1). If the banking system as a whole has a liquidity deficit, the Riksbank lends funds, although not to an amount that exceeds the banking system's total deficit. A similar procedure applies if the banking system as a whole has a liquidity surplus. In this case, the Riksbank receives funds, but not to an amount that exceeds the banking system's total surplus.

The banks know that the banking system's liquidity position in relation to the Riksbank will largely be in balance after the Riksbank has carried out the fine-tuning transactions. This means that the total lending requirement of the banks with deficits will be as large as the surplus of the other banks in the system. If a

4 See Holmberg (1996).
 5 As all the monetary policy counterparties have been able to participate in fine-tuning transactions since 8 October 2008, the Riksbank has expanded the period allowed for fine-tuning, which previously began at 4.20 p.m.

bank with a deficit finds a bank with surplus, they usually perform a transaction with an interest rate equivalent or almost equivalent to the repo rate. According to the banks themselves, the knowledge that the system will largely be in balance at the end of each day contributes to this pricing practice.

Before the Riksbank began to provide extra liquidity during the financial crisis the fine-tuning transactions amounted to very small sums (see Figure 2). However, from mid-October 2008 it was not unusual for the banks to deposit over SEK 100 billion overnight in fine-tuning operations as they did not want to tie up liquidity by bidding to the full in emissions of Riksbank certificates with a maturity of one week. Even after the Riksbank stopped providing extra liquidity the banks have preferred to be liquid. Since the end of October 2010 interest in Riksbank certificates has been non-existent and the entire liquidity surplus has been placed in the fine-tuning transactions.⁶



Source: The Riksbank's weekly reports

The width of the interest rate corridor has varied

Prior to 1 January 1999, the deposit and lending rates were decided on by the General Council of the Riksbank. The Governor of the Riksbank was then able to decide on the level of the repo rate within the interest rate corridor that followed from the General Councils decision. The deposit and lending rates could thus be used to signal monetary policy in the slightly longer term. At its meeting on 6 December 2000, the Executive Board decided that the monetary policy signalling function of the deposit and lending rates would be abolished. The deposit and

6 There has only been one exception. In mid-December 2010 a bank purchased Riksbank certificates for SEK 500 million.

lending rates would instead be changed when the repo rate was changed, so that the repo rate would always be in the middle of the interest rate corridor. The main reason for this change was that the market attached greater importance to other methods that the Riksbank used to signal the long-term direction of monetary policy, for example the speeches of the members of the Executive Board.⁷

Since the new framework came into operation on 1 June 1994, the width of the corridor has been 1.50 percentage points, with only two exceptions.

- Between 11 August 1994 and 12 April 1995 the width of the corridor was 2.00 percentage points. On 11 August, the Riksbank announced that it had increased the lending rate to 8 per cent while the deposit rate was left unchanged at 6 per cent. At the same time, the repo rate was raised from 6.92 per cent to 7.20 per cent.
- When the Executive Board decided to cut the repo rate 0.50 per cent on 20 April 2009, they also decided to narrow the interest rate corridor from 1.50 to 1.00 percentage points to avoid a negative rate for the deposit facility.⁸ The width of the corridor was restored from and including 7 July 2010.

HOW DOES THE RIKSBANK STEER LIQUIDITY IN THE BANKING SYSTEM?

Given that the Riksbank carries out the fine-tuning transactions at the repo rate ± 0.10 percentage points, liquidity in the banking system may be of some significance for the level of the overnight rate. For example, the overnight rate was pushed down by almost 0.10 percentage points when the Riksbank lent large sums to the banks during the financial crisis. There are two reasons for this: first, what the Riksbank lends automatically comes back at the end of the day as deposits and, second, the banks to a large extent make deposits using the Riksbank's fine-tuning transactions at the repo rate minus 0.10 percentage points. It is therefore important for the Riksbank to steer liquidity in the banking system. The Riksbank does this primarily by using monetary policy repos or by issuing Riksbank certificates. These transactions are carried out at the repo rate. According to the Riksbank's regulations for RIX and monetary policy instruments, the Riksbank can also use FX swaps or direct purchases and sales of securities.⁹ The different types of transaction that the Riksbank uses to steer liquidity in the banking system are called *open market operations*.

7 The speeches of the members of the Executive Board are no longer used as a signalling tool. The Riksbank publishes a forecast for the repo rate instead.

8 However, when the repo rate was cut to 0.25 per cent on 8 June 2009, the width of the corridor was left unchanged and the deposit rate thus became -0.25 per cent. In Figure 1 we can see that the sums in the deposit facility were unusually low during the following year when the deposit rate was negative.

9 Sveriges Riksbank, Terms and conditions for RIX and monetary policy instruments.

Monetary policy repos and issues of Riksbank certificates

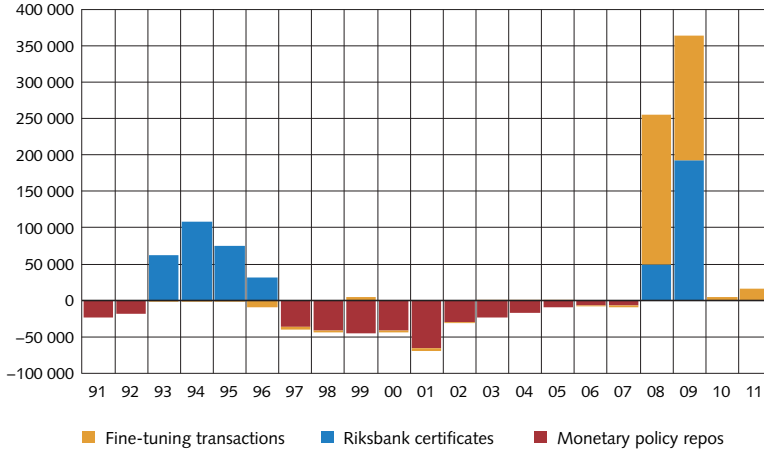
Each week, the Riksbank offers to borrow money from the banks by issuing Riksbank certificates with a maturity of one week. If the banking system has a liquidity deficit instead, which was the case before October 2008, the Riksbank can lend money by conducting a monetary policy repo. The repo procedure entails the Riksbank purchasing acceptable securities from a monetary policy counterpart at the same time as this counterpart undertakes to repurchase corresponding securities for a predetermined price a week later. The difference between the prices of the repos and certificates in connection with sale and repurchase is determined by the Riksbank's repo rate.

One week was chosen as the period for the maturity of certificates and the frequency of repos because the Riksbank wanted to be able to change the repo rate every week.¹⁰ This was changed on 1 October 1999 when it was decided that the Executive Board would in the future only decide on policy rates at the special monetary policy meetings held at intervals of six to eight weeks. This dissolved the close relationship between the repo-rate decisions and the weekly market operations.

The banking system had a liquidity deficit throughout the period 1997-2007. The Riksbank therefore used weekly repos with a maturity of one week to supply liquidity to the banking system (see Figure 3). During the summer of 2008, the repos were so small that there was a risk of having to alternate from one week to another between supplying liquidity to or draining liquidity from the banking system. This would have made liquidity management more complicated for the monetary policy counterparties. In order to be able to continue with the monetary policy repos, the Riksbank carried out a structural foreign currency transaction. Beginning on 8 September 2008, the Riksbank sold foreign currency and bought kronor to a value of SEK 5 billion so that the banking system would continue to be in deficit. The intention was to subsequently begin issuing Riksbank certificates once the banking system was in a situation with an ongoing liquidity surplus in relation to the Riksbank. This happened sooner than expected.

¹⁰ See Mitlid and Vesterlund (2001).

Figure 3. The banking system's liquidity surplus 31 December 1991-2011, SEK billion



Source: The Riksbank

Steering liquidity during the financial crisis

In October 2008 it was clear that the international financial unease was also affecting the financial markets in Sweden. The market for long-term loans was working less and less effectively. In this situation, the Riksbank launched a loan facility in Swedish krona to increase access to loans at longer maturities. In the first auction of three-month loans on 6 October, the banks borrowed SEK 100 billion. At a stroke, the banking systems' liquidity deficit with the Riksbank became a liquidity surplus.

Initially, the Riksbank drained the liquidity surplus using the daily fine-tuning transactions. To reduce the size of these transactions, the Riksbank began, on 14 October, to issue Riksbank certificates with a maturity of one week. Later, in the period 1 June to 13 October 2010, the banks were also offered, once a week, Riksbank certificates with longer maturities than one week. These certificates fell due at the time of the next monetary policy meeting. In addition, the Riksbank offered loans in US dollars to the Swedish banks during the crisis. The reason for this was the strained situation on the markets for short-term borrowing in US dollars that arose after Lehman Brothers filed for bankruptcy in September 2008. This lending was made possible by an agreement between the Federal Reserve and a number of other central banks, including the Riksbank, under which the Federal Reserve agreed to lend US dollars to these central banks. On 1 October 2008, the Riksbank lent USD 7 billion for a month in a first auction.¹¹ This was followed by an additional 14 loans at maturities of one and three months. The final loan

¹¹ This first loan in US dollars was, however, funded through the Riksbank's foreign exchange reserve.

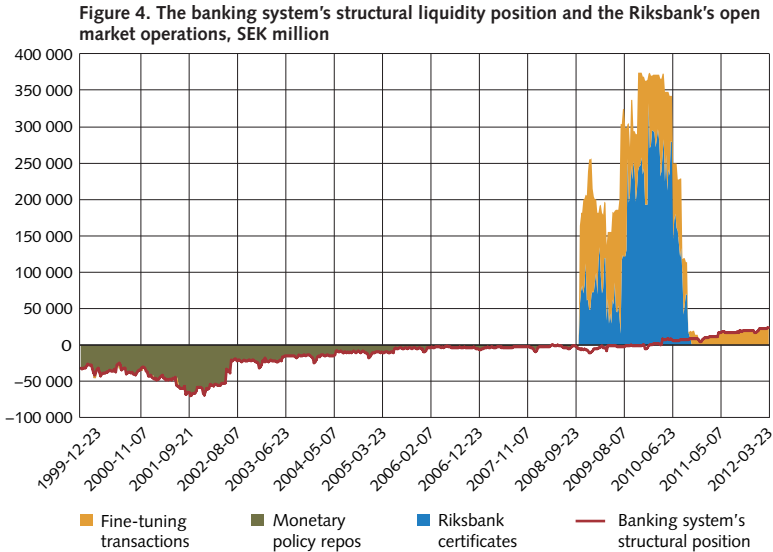
was offered in August 2009. In the auctions the Riksbank typically offered USD 10 billion (apart from two smaller loans of USD 7 and 5 billion dollars respectively). The last loans were far from fully subscribed as the situation on the market had normalised. The US dollar lending facility was thus phased out.

The structural liquidity position of the banking system

Figure 4 shows that the banking system continues to have a liquidity surplus even after the extraordinary measures in the form of loans to the banks have expired. In other words the banking system has moved from a structural liquidity deficit to having a structural liquidity surplus in relation to the Riksbank. How did this happen? To answer this question we have to go back a decade.

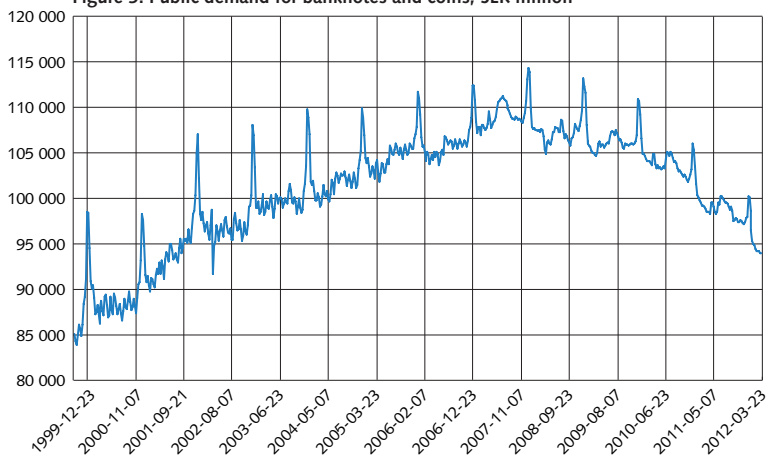
We can see in Figure 4 that the monetary policy repos have decreased in size over time since 2001 and that this trend means that the banking system's structural liquidity position moves from deficit to surplus during the financial crisis. What is this trend due to?

If items on the asset side other than the monetary policy transactions increase (for example through purchases of foreign or domestic assets with payment in kronor), the banking system will have a greater surplus (or a smaller deficit) in relation to the Riksbank. If items on the liability side other than the monetary policy transactions increase, the banking system will have a greater deficit (or a smaller surplus). So what are the items that have driven the banking system towards a surplus?



Source: The Riksbank's weekly reports

Figure 5. Public demand for banknotes and coins, SEK million



Note. The public's demand for banknotes and coins is illustrated in the figure on the basis of movements in the item "Banknotes and coins in circulation" in the Riksbank's balance sheet. Source: The Riksbank's weekly reports

The Riksbank's annual payments of profits to the Treasury have had the greatest impact on the development of the banking system's structural position.¹² Part of the Riksbank's profits are paid to the Treasury each year.¹³ This is done by crediting the National Debt Office's account in RIX with a sum equivalent to the amount of profits to be transferred. The National Debt Office then deposits the money with a commercial bank as the Riksbank does not pay any interest on the Office's account. This increases the structural liquidity surplus of the banking system. The money in the transfer thus affects the size of the open market operations. This is the main explanation of the fall in the volume of monetary policy repos since 2001 and the fact that there is now a liquidity surplus in the banking system.

Another factor that has contributed to the banking system having a structural surplus in relation to the Riksbank is that the public demand for banknotes and coins has declined (see Figure 5). We can see that the demand for banknotes and coins increased until 2007 but began to fall thereafter. When the public demand for banknotes and coins decreases the banks return more banknotes and coins to the Riksbank and the banks' RIX accounts are credited by the corresponding amounts. This increases the banks' liquidity surplus in relation to the Riksbank and, consequently, their deposits with the Riksbank, for example through the fine-turning transactions, also increase.

¹² See Nessén, Sellin and Åsberg Sommar (2011) for a more detailed discussion.

¹³ A detailed description of the method for calculating the transfer of profits to the Treasury is given in Gardholm and Gerwin (2011).

How is the size of the weekly operations determined?

The emission volumes for Riksbank certificates (or previously the size of the repos) are calculated with the help of a forecast of the banking system's liquidity surplus (or previously deficit) for the coming week. Table 1 shows how to calculate the surplus on the basis of the items in the Riksbank's balance sheet. The example is based on the Bank's balance sheet as of 31 August 2011. The banking system's surplus on this day was calculated to amount to SEK 17 571 million. The Riksbank then offered an emission volume of SEK 17 600 million, but no bids were received in the auction. This is because the banks preferred to use the fine-tuning transactions when they wanted to have liquidity available on a daily basis. The Riksbank instead drew in SEK 17 539 million of the surplus in fine-tuning transactions. The remaining SEK 32 million were deposited in the deposit facility.

Table 1. The banking system's liquidity surplus 31 August 2011

	SEK MILLION
Gold and foreign currency reserve	324 172
Other assets	4 084
Banknotes and coins in circulation	-99 082
Other liabilities	-144 826
Equity	-66 777
The banking system's surplus	17 571

That which above all needs to be forecast in order to determine emission volumes is the public demand for banknotes and coins. This item usually increases in connection with salary payments, before the Christmas shopping period and in connection with holidays. As these increases come at regular intervals from year to year, the forecasts are based on information from the corresponding week in the previous year. The difference between the liquidity forecast and the actual daily surplus (or deficit) is covered by the daily fine-tuning transactions.

If the banks had bid for the entire issue volume of SEK 17 600 billion on 31 August 2011, then the banking system's liquidity position in relation to the Riksbank would have been more or less in balance during the week concerned. Daily changes in the public demand for banknotes and coins would probably then have led to a situation in which, at the end of the day, the banking system would have had a surplus on some days and a deficit on others. In the case of a deficit the Riksbank would have lent money in the fine-tuning transactions, while on the days when the banking system had a surplus the Riksbank would have borrowed money.

Issues of Riksbank certificates are announced by the Riksbank asking for bids at a fixed rate (volume bids). The conditions for each issue (or repo) are announced every Tuesday at 9.30 a.m. and cover

- the type of operation (drawing in liquidity by issuing certificates or supplying liquidity through repos)
- maturity (usually one week)
- the applicable interest rate (the current repo rate)
- the lowest and highest bid volume (in the example SEK 1 million and the total issue volume on 31 August 2011).

The period for submitting bids expires at 10 a.m.. The allocation is then calculated and announced at 10.15 a.m.. If the sum of the bids exceeds the size of the issue (or the repo) the bids are met proportionately in accordance with the ratio between the sum to be allocated and the total sum of the bids. The settlement date is the day after the announcement, which means that certificates (repos) will normally run from Wednesday to Wednesday.

Currency swaps

Instead of withdrawing liquidity from the banking system by issuing Riksbank certificates the Riksbank could use currency swaps. This involves selling foreign currency spot for Swedish kronor at the same time as performing the reverse transaction forward (normally from one week up to three months). The Riksbank and the counterparty then agree on a spot price and a forward price for the transaction. By means of this transaction the Riksbank withdraws Swedish kronor from the banking system during the period of the swap agreement. The foreign currency is taken from the foreign exchange reserve. If the Riksbank wishes instead to add liquidity it sells Swedish kronor spot for foreign currency at the same time as performing the reverse transaction forward.

In contrast to when the Riksbank uses monetary policy repos or issues Riksbank certificates, open market operations with currency swaps are normally carried out using a bilateral procedure. This means that the Riksbank performs a transaction with one or more foreign exchange policy counterparties without a bidding procedure.

Purchases or sales of securities

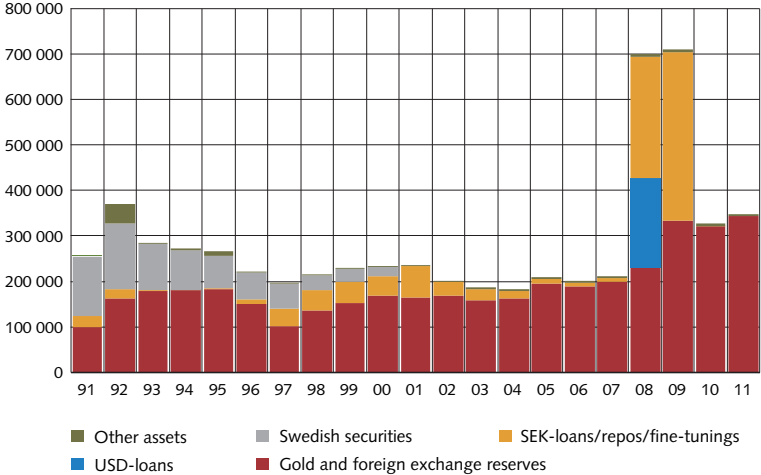
The Riksbank can also buy or sell securities on the market in order to affect the financial system's structural deficits or surpluses. However the Riksbank has not used this type of market operation in recent years.

The Riksbank's portfolio of Swedish securities was disposed of in 2001, which is shown in Figure 6. As early as in 1998, the Riksbank reported that it intended to reduce its holdings of government securities by SEK 20 billion. This was because it was considered that the Riksbank's domestic securities portfolio no longer fulfilled

any monetary policy function.¹⁴ At the end of the 1990s, the portfolio was mainly used for market maintenance purposes, which meant that the Riksbank provided a repo facility in Swedish securities to the market participants. In this way the Riksbank lent Swedish securities that were attractive on the market.

In November 1999, it was decided to transfer the market-maintaining repo facility to the Swedish National Debt Office. It was then that the question was raised as to whether there was any remaining reason for the Riksbank to hold a portfolio of domestic securities, which at this point in time mainly consisted of government bonds (the Riksbank also had a small holding of treasury bills and mortgage bonds, but these matured in 2000). The conclusion was that this was not the case. The assessment of the General Council was that the Riksbank's equity could be reduced by SEK 20 billion. On 17 May 2001, the Riksdag consequently decided that the Riksbank should make an extraordinary transfer of profits to the treasury. On 13 June, the Riksbank transferred its remaining portfolio of Swedish government bonds, to value of SEK 20 billion, to the Swedish National Debt Office.

Figure 6. The Riksbank's assets on 31 December 1991-2011, SEK billions



Note. Gold is reported at market value from 1995.

Source: The Riksbank

The Riksbank's counterparties and collateral

So far we have described how the Riksbank can steer the overnight rate and liquidity in the banking system by carrying out different types of transaction with

¹⁴ The nominal value of the portfolio at that time was SEK 47 billion. For more information see the Riksbank's press release no. 11, dated 9 March 1998.

its counterparties in the money and foreign-exchange markets. But how does the Riksbank select the circle of counterparties? In this section we try to provide an overall description of the different categories of counterparty and the securities they use as collateral for loans from the Riksbank and in the monetary policy repos.

COUNTERPARTIES

Which counterparties does the Riksbank need? Since the operational target of the monetary policy operational framework is to stabilise the overnight rate it is natural that the participants who need to be active in the overnight market should be included among the Riksbank's counterparties. This is also the case. When there is friction on the market for short liquidity it is good for the Riksbank to have a large number of counterparties so that the Riksbank can carry out effective liquidity support measures in the form of loans to the market participants that need them. But normally there are only a few large agents on the Swedish market who want to bear the costs of being a counterparty.¹⁵ Different counterparties also have different capacities and needs and there are thus different categories of counterparty.

In Chart 2 we outline the different categories of counterparty. A *primary monetary policy counterparty* is a counterparty in fine-tuning transactions and in monetary policy repos/certificates, has access to the standing facilities and is a RIX participant.¹⁶ A *counterparty in monetary policy repos/certificates* is a RIX participant that, unlike a primary monetary policy counterparty, is not a counterparty in fine-tuning transactions. During the financial crisis, however, these institutions also gained access to the fine-tuning transactions and still have that access today. There is also a category of counterparties that are RIX participants with *access to the standing facilities*. In addition, there are *RIX participants* that do not have access to either the Riksbank's facilities or market operations. A *counterparty in foreign exchange transactions* may also belong to one of the categories above, but could equally be an institution that does not even participate in RIX.

In spring 2009, the category *restricted monetary policy counterparty* was introduced to facilitate funding for the credit institutions that were not monetary policy counterparties to the Riksbank. They could in fact have applied to be monetary policy counterparties. But the Riksbank did not want to extend the circle of participants in RIX with institutions that do not have a natural need to

¹⁵ Counterparties incur costs for having necessary systems in place and the staff to manage them, and also pay a fee for participating in RIX.

¹⁶ The primary monetary policy counterparties are a restricted circle of the major banks: Nordea, SEB, Svenska Handelsbanken and Swedbank AB. A current list of RIX participants and counterparties can be found on the Riksbank website www.riksbank.se.

participate in the payment system, since this could entail increased operational risks in the system. A credit institution with its registered office in Sweden can instead apply to be a restricted monetary policy counterparty. The Riksbank then decides which operations a restricted monetary policy counterparty is entitled to participate in. Since the Riksbank does not currently have any extraordinary lending there is no reason for any institution to apply to be a restricted monetary policy counterparty.

Chart 2. Different categories of counterparty

RIX (payment system) participants	(25 participants)
<ul style="list-style-type: none"> • Credit Institutions, Investment Firms, Clearing Organisations and the Swedish National Debt Office • Intraday Credit 	
Monetary-policy counterparty	(17 counterparties)
<ul style="list-style-type: none"> • RIX Participant and Credit Institution domiciled or has a branch in Sweden • Standing facilities and main operations 	
Primary monetary-policy counterparty	(6 counterparties)
<ul style="list-style-type: none"> • Credit Institution with a large share of the money and bond market • Fine-tuning Operations (from autumn 2008 all Monetary Policy Counterparties) 	
Foreign-exchange counterparty	(9 counterparties)
<ul style="list-style-type: none"> • Credit Institution with a large share of the foreign-exchange market 	

Monetary policy counterparties must be RIX participants. The reason is that the Riksbank has considered that those who benefit from participating in the implementation of monetary policy should also contribute to an efficient payment system.

RIX participants have a principal account with the Riksbank, where balances are recorded, and a loan account, where credit is recorded.¹⁷ A RIX participant can be granted intraday loans against collateral in accordance with the basic principle that says that a RIX participant also has access to intraday credit.

There are also clearing institutions among the RIX participants.¹⁸ It may seem that a clearing institution should not need intraday loans, since it only mediates payments between other institutions. But the payment system will be more efficient if an institution can make its own payments. The introduction of a central counterparty function can thereby be facilitated without creating further

¹⁷ A participant can also have a liquidity settlement account and a central bank credit account with the Riksbank. These accounts are to facilitate securities settlement in Euroclear Sweden and are therefore administered by that clearing institution. In addition, there are five LOM accounts with special settlement procedures that the counterparty can choose to participate in. See Appendix H3 to Terms and Conditions for RIX and monetary policy instruments.

¹⁸ A clearing institution mediates payments between its members (or their customers) and functions as a central counterparty in relation to a member (or its customer). The following clearing organisations are RIX participants: Bankgirocentralen, CLS Bank, EMCF, Euroclear Sweden and NASDAQ OMX.

concentration to a number of settlement banks. Consequently the Riksbank also provides intraday loans to clearing organisations.

Only credit institutions can be *counterparties in foreign exchange transactions*. Unlike the monetary policy counterparties, a counterparty in foreign exchange transactions does not need to be a RIX participant.

COLLATERAL

According to the Sveriges Riksbank Act, the Riksbank can provide loans for monetary policy purposes, but these must only be granted against adequate collateral. In December 1999, the Executive Board of the Riksbank decided to make some changes to the collateral management process. The aim was to become more flexible with regard to the securities the Riksbank accepts as collateral for loans. There was also an intention to harmonise the Riksbank's regulations with those of the Eurosystem with regard to the assessment and risk control of collateral. The parts of the Riksbank regulations for RIX and monetary policy instruments that concern collateral thus by and large follow the principles of the Eurosystem.

Since then the Riksbank has routinely examined whether securities issued by the Swedish government and Swedish mortgage institutions should be approved as collateral. When investigating securities issued by issuers other than the government and mortgage institutions, the Riksbank uses an application procedure. A counterparty can send an inquiry to the Riksbank as to whether a given security is eligible as collateral.

As part of the management of the financial turmoil of 2007-2008, the Riksbank extended the number of debt instruments eligible as collateral to enable greater lending from the Riksbank. Consequently, on 13 December 2007 the Riksbank decided to accept covered bonds issued by the counterparty itself, or by an institution closely related to the counterparty, as collateral for credit in RIX or as part of the monetary policy operational framework. At that time it was considered that the risk associated with covered bonds was so low that they could be accepted as collateral, even if they were issued by the counterparty itself or by a related institution. At the same time the Riksbank wanted to aim for diversification of the securities a counterparty put up as collateral. It was therefore decided to restrict the proportion of a counterparty's collateral that could be issued by one and the same counterparty or group of related counterparties to a maximum of 25 per cent of the total value of the collateral pledged by the counterparty.

At the outbreak of the financial crisis the Riksbank decided on 22 September 2008 to change the above-mentioned restriction from 25 per cent to 75 per

cent.¹⁹ The change was deemed to have a positive effect on the efficiency of the money and bond markets while at the same time not significantly increasing the Riksbank's credit risk. On 8 October 2008 the restriction was completely removed.

Does the operational framework need to be changed?

As part of the review of the Riksbank's operational framework for monetary policy we have also studied and compared other central banks' systems with the Riksbank's system, see Chapter 5. We can note that the Riksbank's operational framework is relatively simple, transparent and efficient in an international comparison. It is therefore important that in our future efforts to develop this framework we always carefully weigh the advantages we wish to achieve against the disadvantages that might entail our framework becoming unnecessarily complicated, less transparent and less effective.

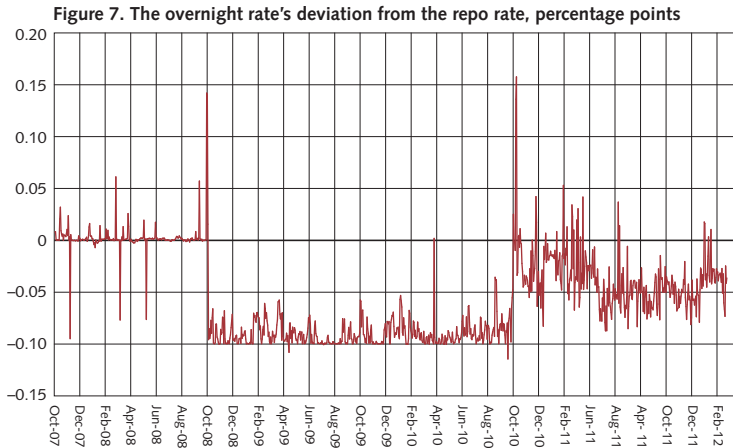
Bearing this in mind, we will in this section discuss the question of whether the operational framework is built up in such a way that the Riksbank is sufficiently prepared in terms of competence, market presence and appropriate instruments to be able to efficiently manage shocks to the financial system. First, however, we must focus on the more concrete issue of how well the operational framework performs its task of stabilising the intraday rate around the repo rate signalled by the Executive Board.

We have reached the conclusion in the course of our review that the operational framework for the implementation of monetary policy in Sweden is well able to stabilise the intraday rate both under normal conditions on the financial markets and during a financial crisis. Figure 7 shows that during the entire period from October 2007 to the end of December 2010, the overnight rate remained largely within a deviation interval no greater than 0.10 percentage points above or below the repo rate. After the Riksbank began to implement its extraordinary measures in the form of long-term loans to the banking system in October 2008 and until the extraordinary measures were withdrawn in October 2010, the overnight rate was pushed down to the deposit rate through fine tuning operations. This meant that the overnight rate was 0.10 percentage points below the repo rate. As the banking system was able to invest its liquidity surplus in the fine-tuning operations, the downward pressure on the overnight rate was limited to a maximum of 0.10 percentage points below the repo rate.

Unlike most other central banks, the Riksbank does not explicitly state a target for the *overnight rate*, despite this being the operational target for the Riksbank's monetary policy. Instead, the Riksbank stipulates that the *repo rate*, which is the most important reference rate for the Riksbank's monetary policy operations and

¹⁹ See Sveriges Riksbank, basis for decision Ref no. 2008-728-KAP.

standing facilities, will remain at a particular level. This relationship can cause confusion over which interest rate the Riksbank is actually trying to steer. The clarity of the operational framework for monetary policy could thus be improved if the Riksbank began to signal a desired level for the overnight rate. This could increase the transparency of the operational framework even further, without needing to radically change it.



Source: Eklund and Åsberg Sommar (2011)

During the recent financial crisis, the Riksbank implemented a number of extraordinary crisis measures without needing to make any radical changes to the operational framework for monetary policy.

The crisis measures largely entailed the Riksbank

- lending Swedish kronor to the banks at longer maturities
- lending US dollars to the banks at one-month and three-month maturities
- deciding to allow more types of securities and to extend the range of securities accepted as eligible collateral for loans from the Riksbank
- extending the number of counterparties allowed to participate in the fine-tuning transactions
- introducing a new category of counterparty: restricted monetary policy counterparties.

Similar measures were taken at roughly the same time by other central banks. Unlike a number of other central banks, however, the Riksbank did not buy any securities. This made the exit process for the Riksbank much simpler when the extraordinary measures were no longer needed.

We can note that the Riksbank dealt very successfully with the crisis with these relatively limited measures. But this does not mean that the next crisis can be dealt with in the same way. There are therefore good reasons for considering whether the Riksbank needs to improve the readiness of the operational framework to deal with future crises and in that case how this should be achieved.

As part of our review we have identified some areas that merit further inquiries. First, the Riksbank has no mechanism apart from the standing deposit and lending facilities and fine-tuning transactions to deal with any frictions in the interbank market that arise as a consequence of an uneven balance in liquidity between the banks. Such frictions are increased by the fact that the banks introduced a restriction at the time of the financial crisis which means that an individual bank may not have a deficit of more than SEK 10 billion at the close of the day. This restriction means that the banks now try to avoid deficits on the overnight market by meeting their liquidity needs one day earlier, in other words via loans that run from tomorrow to the next day (T/N - Tomorrow/Next loans).

The operational framework is ultimately based on the banks realising that they all gain from balancing liquidity between them at an interest rate close to the repo rate at the close of the day. A bank that has a liquidity surplus today may need to borrow from other banks tomorrow to cover a deficit, and all banks thus stand to gain from the friction-free balancing of liquidity at the close of business. A weakness of this is, however, that it gives individual banks the possibility to abuse the system and indulge in strategic gambits. Individual banks may refuse to cooperate for strategic reasons. Banks with deficits may then be forced to borrow overnight from the lending facility at a penalty rate. The consequence of such frictions when balancing liquidity between banks is an unnecessary volatility in the overnight rate.

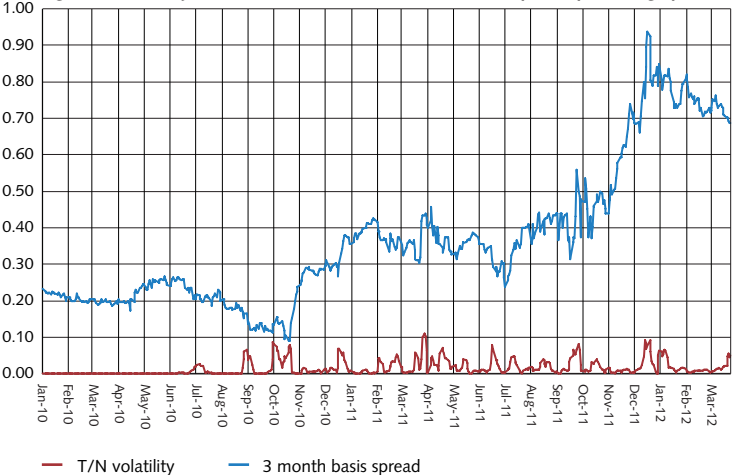
It is also difficult to reduce frictions on the interbank market, since the banks do not lend to each other without collateral if there is a counterparty risk in their transactions. However, they would be able to lend to each other against collateral intended for intraday loans overnight that they have deposited with the Riksbank. At present, however, the banks cannot use the collateral deposited for this purpose for administrative reasons.

Second, the Riksbank has no framework for steering the interest rate for the T/N maturity. The reason for highlighting this rate in this context is that interest rate derivatives in Sweden, unlike many other countries, are based on the T/N rate and not the overnight rate. This means that the development of the T/N rate has a direct connection to other interest rate instruments and the formation of interest rates in these submarkets.

As we have noted previously, a stable overnight rate is a necessary but not sufficient anchor for stabilising the formation of interest rates at longer maturities.

The rate on the market for the T/N maturity used to be firmly anchored at 0.10 percentage points above the overnight rate. In connection with the phase-out of the Riksbank's extraordinary measures in the form of long-term lending in October 2010, volatility on the T/N market became high at the same time as the three-month rate rose in relation to the overnight rate (see Figure 8). This indicates that the monetary policy transmission mechanism has started to function less well. Nor does it seem to be sufficient that the overnight rate remains within a narrow interval around the repo rate for it to be considered that monetary policy has been implemented in an effective way.

Figure 8. Volatility in the T/N rate and three-month basis-spread, percentage points



Note. Volatility is calculated as the standard deviation of the T/N rate's deviation from the repo rate, calculated using a five-day rolling window. The basis spread is calculated as the three-month interbank rate minus the three-month STINA rate, which is the average T/N rate for a three month period. It reflects the risk for three-month loans on the interbank market.

Third, the Monetary Policy Department at the Riksbank did not have a portfolio of domestic assets and hence no systems or routines adapted to the direct purchase of Swedish securities. Consequently, it would have taken the Riksbank a long time to begin conducting unconventional monetary policy when necessary through quantitative easing.²⁰ When the Riksbank's portfolio of Swedish securities was disposed of in 2000, it was considered that a domestic portfolio did not fulfil any monetary policy function. However, this conclusion rests on the premise that the markets are effective, which means that central-bank interventions have no long-term impact on the formation of interest rates. The financial turmoil and crisis

²⁰ Quantitative easing means that the central bank buys assets and finances these purchases by increasing the banks' reserves in the central bank. The purpose of such a measure is to push down interest rates for longer maturities.

of 2007-2010 have shown, however that it cannot be assumed that the markets will always function effectively. We have also seen that short-term interest rates may approach zero in a crisis situation. If further stimulation of the economy is desired in such a situation, one alternative is to directly influence long-term interest rates by buying bonds on the market. It is very unusual for a central bank not to have a portfolio of assets in its own currency. Other central banks trade in bonds in their own currency routinely and can thereby take measures at very short notice to directly influence domestic bond yields in a situation where this is called for. Early on in our work on a review of the Riksbank's operational framework we noted that the Riksbank's ability to provide liquidity in a crisis needed to be strengthened. For this reason the Riksbank in May 2012 decided to acquire a portfolio of government bonds in Swedish kronor. The purpose was to ensure that the Riksbank has the system and competences needed to be able to repo, buy and sell Swedish bonds at short notice.

Finally, in practice it has proved difficult to extend the Riksbank's circle of counterparties. It is true that the Riksbank introduced the category of *restricted monetary policy counterparty* in spring 2009 to facilitate funding for credit institutions that were not monetary policy counterparties of the Riksbank. However, only a few institutions decided to avail themselves of this opportunity. Nevertheless, this has meant that the Riksbank has an infrastructure in place that enables it to rapidly lend money to more counterparties in a crisis. What the Riksbank's circle of counterparties should look like is an important question that must not be forgotten in the ongoing work with ensuring the Riksbank's capability of providing liquidity in a crisis situation.

References

- Eklund, Johanna and Åsberg Sommar, Per (2011) "The Swedish market for balancing liquidity between the banks overnight 2007-2010", *Sveriges Riksbank Economic Review*, 2011:1. Sveriges Riksbank.
- Gardholm, Henrik and Gerwin, Joanna (2011), The Riksbank's dividend in the past two decades, *Economic Commentary* No 2, 2011. Sveriges Riksbank.
- Holmberg, K. (1996), "The Riksbank's management of short-term interest rates", *Sveriges Riksbank Quarterly Review* 4, 1996.
- Hörngren, Lars (1994), The Riksbank's new interest rate management system, *Sveriges Riksbank Economic Review*, 1994:2. Sveriges Riksbank.
- Kronstedt Metz, Pia (2005), The Swedish Market for Balancing Liquidity in *Sveriges Riksbank Economic Review*, 2005:4.
- Mitlid, Kerstin and Vesterlund, Magnus (2001) "Steering interest rates in monetary policy – how does it work?" *Sveriges Riksbank Economic Review* 2001:1, Sveriges Riksbank.
- Nessén, Marianne, Sellin, Peter and Åsberg Sommar, Per (2011) The framework for the implementation of monetary policy, the Riksbank's balance sheet and the financial crisis. *Economic Commentary* no. 1, 2011, Sveriges Riksbank.
- Sveriges Riksbank, press release no 11, 9 March 1998.
- Sveriges Riksbank, basis for decision Ref no. 2008-728-KAP. Change in the rules regarding limitations for collateral in the form of secured bonds issued by the counterparty or by an institution with close links to the counterparty for credit in the RIX payment system. (The document can be found at www.riksbank.se under Press releases 2008-09-22: "Changed collateral requirements for credit in RIX".)
- Sveriges Riksbank (2005), *The Riksbank's Management of Interest Rates – Monetary Policy in Practice*.
- Sveriges Riksbank (2008), *Terms and conditions for RIX and monetary policy instruments*, October 2008.
- Terms and conditions for RIX and monetary policy instruments, Sveriges Riksbank, August 2011. The document can be found at www.riksbank.se under Financial stability – the RIX payment system – Conditions and instructions.
- Terms and conditions for RIX and monetary policy instruments, Appendix H3 – Instructions for RIX, Sveriges Riksbank, October 2010 (published separately).
- Terms and conditions for RIX and monetary policy instruments, Appendix H4 – Instructions for collateral, Sveriges Riksbank, May 2010 (published separately).
- Terms and conditions for RIX and monetary policy instruments, Appendix H9 – Instructions for Counterparty application, Sveriges Riksbank, April 2009 (published separately).

■ The Swedish market for balancing liquidity between the banks overnight 2007-2010

This chapter uses statistics for executed transactions from the Riksbank's payment system RIX to study the functionality of the overnight market and to determine whether monetary policy is being implemented efficiently. The study shows that, both before and during the crisis, the overnight rate for the banks varied within the band deemed by the Riksbank to represent efficiently implemented monetary policy. At the same time, the result shows that the deviation of the overnight rate from the repo rate and the level of volatility in the overnight rate have both increased since the outbreak of the financial crisis.

The study also shows that the level of activity on the overnight market was low during the financial crisis. The level of activity did not increase until October 2010, when the Riksbank's last fixed-interest rate loan with a one-year maturity fell due. However, the banks' liquidity planning seems to have changed slightly after the crisis. Banks that previously systematically financed large deficits on the overnight market have done this to a significantly lesser degree since October 2010.

To explain the determination of interest rates, from the repo rate to longer market rates, it is important to understand how the markets for loans with short maturities function. It is particularly important to study the market that the Riksbank has the greatest ability to steer, which is to say the Swedish market for balancing liquidity between the banks overnight – the overnight market.

Market rates with longer maturities are mainly determined by expectations of future overnight rates and the risk premiums associated with each maturity. An operational framework in which the overnight rate is stable and predictable thus contributes towards stabilising the development of interest rates with longer maturities. So that the overnight rate may provide a stable foundation for the development of interest rates with longer maturities, the Riksbank strives to hold the overnight rate stable and close to the repo rate. The indicator that the Riksbank currently uses to assess whether monetary policy is being implemented efficiently specifies that the overnight rate should not deviate from the repo rate by more than 10 basis points. The ongoing monitoring of how the overnight rate is developing in comparison with the repo rate thus forms an important part of the assessment of how efficiently the Riksbank is implementing monetary policy.

Even if a stable overnight rate forms an important precondition for the efficient implementation of monetary policy, it is not the only criterion. An equally important criterion is the influence of the overnight rate on interest rates with longer maturities. Frictions or limitations that prevent the overnight rate from being reflected in longer interest rates may be a sign of inefficiency. However, this study focuses solely on the overnight market.

To assess the functionality of the overnight market and whether monetary policy is being implemented efficiently, it is not enough to just study pricing. It is also important to study activity on the overnight market in terms of turnover and the number of transactions. Frictions in the overnight balancing of liquidity between banks should certainly be noticeable through their effect on the overnight rate, but this gives us no information on what may lie behind them. The Riksbank can gain a better understanding of the distribution of liquidity among the banks by monitoring the level of activity and the banks' behaviour on the overnight market. This will also provide the Riksbank with an understanding of the extent to which individual banks are motivated to adopt strategies that promote their own interests at the cost of impairing the functioning of the overnight market.¹

In this chapter we use transaction data from the Riksbank's payment system RIX to assess the functionality of the overnight market and to map the overnight balancing of liquidity between the banks. We use the same data to establish measures of how efficiently monetary policy is being implemented by examining the extent to which the overnight rate on the market for balancing liquidity deviates from the repo rate. The Riksbank has not previously used transaction data in its current analysis and, consequently, a section of this article describes the data being used.²

The chapter begins with a short description of the Swedish market for balancing liquidity overnight, that is to say the overnight market. In the following section we describe the statistics that form the basis of the study. It then analyses the average overnight rate and its deviation from the repo rate. To assess whether monetary policy is implemented effectively, it is not enough to analyse the market pricing for balancing liquidity. Therefore, we devote a section to the analysis of the microstructure of the Swedish market for balancing liquidity overnight. It analyses transaction volumes, turnover and the significance that the behaviour of the various participants has for the balancing of liquidity. We end the chapter with

1 Henckel et al. (1999) discuss the manner in which the mutual negotiating strength of the banks can influence the interest rates for overnight loans and the central bank's role in maintaining an efficient overnight market.

2 Eklund (2009) uses transaction data from the payment system RIX to analyse the Swedish overnight market. Particular focus is placed on contagion risks between the banks resulting from their mutual exposure in the form of overnight loans in Swedish kronor.

a discussion where we note that monetary policy is implemented effectively even though turnover in the overnight market fell dramatically during the financial crisis.

The market for balancing liquidity overnight and the Riksbank's policy rate

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, on their own behalf or on behalf of their customers. Payments in Swedish kronor between banks are made via transfers between their accounts in the Riksbank's payment system RIX. The Riksbank provides the means of payment in Swedish kronor and determines the conditions for deposits and borrowing by the banks to and from their accounts in RIX. This also forms the core of the Riksbank's ability to steer the interest rate, as described in the previous chapter.³

Overnight data

The analysis in this article is based on transaction data from the Riksbank's payment system RIX dating from October 2007 to the end of December 2010. The analysis thus covers both the financial crisis of 2008 and 2009 as well as part of the period before the crisis. It also covers a brief period after the crisis, when the Riksbank had withdrawn the extraordinary measures adopted during the crisis, as well as when the last of the three extraordinary monetary policy fixed-rate loans with maturities of one year had matured (6 October 2010).

The average interest rate on the Swedish overnight market has been calculated using the payments registered in the RIX system as overnight loans, and which also have an overnight maturity – that is where a repayment of the loan is registered for the following business day and is not a transaction with the Riksbank.

In addition to a number of commercial banks (11-14 during the period covered by this study), the Swedish National Debt Office also participates on the overnight market. Unlike in a number of other countries, the government sector through the Swedish National Debt Office turns to the banks, rather than the central bank, to manage its daily liquidity. The Swedish National Debt Office acts on the overnight market under the same conditions as the banks, with the difference that it may only invest in the Riksbank's standing facilities, and then at an interest rate of 0 per cent. The Swedish National Debt Office does not have the right to borrow from the Riksbank, as this could be considered to be monetary financing of the central

³ See Nessen et al. (2011) for a more detailed review of the Riksbank's operational framework.

government debt. This means that the Swedish National Debt Office's position in the RIX system, that is whether the Swedish National Debt Office has a lending or deposit requirement, does not affect the Riksbank's position towards the banking system.

Whether transactions with the Swedish National Debt Office are included in the analysis depends on which question is to be answered. If the aim is to study how efficiently monetary policy is being implemented, the Swedish National Debt Office should be included, as transactions with the Swedish National Debt Office affect the average interest rate, which forms the basis for the formation of interest rates with longer maturities. If, on the other hand, the aim is to study how well the overnight market functions between commercial banks, the Swedish National Debt Office should not be included. The reason for this is that lending to the Swedish National Debt Office is considered to be a risk-free overnight investment for the commercial banks. Consequently, transactions with the Swedish National Debt Office have been included in the analysis of the overnight rate in the next section. However, in the analysis of activity on the overnight market, the emphasis lies on transactions exclusively between the commercial banks.

In this study, particular emphasis has been placed on the analysis of how the functioning and structure of the bank's overnight balancing of liquidity changed during the financial crisis and what the consequences of this may have been for the implementation of monetary policy. Consequently the collected transaction data has been divided into four periods:

- *Period 1:* The period prior to the collapse of the investment bank Lehman Brothers, from 5 October 2007 until 14 September 2008.
- *Period 2:* The period from the collapse of Lehman Brothers until the Riksbank started to issue loans in foreign currency and Swedish kronor for longer maturities, 15 September until 1 October 2008.
- *Period 3:* The period of the crisis during which the Riksbank's lending in foreign currency and Swedish kronor is in place, 2 October 2008 until 6 October 2010.
- *Period 4:* The period after the withdrawal of the extraordinary measures adopted during the crisis and the maturity of the final fixed-interest rate loan with a maturity of one year, 7 October 2010 until the end of December 2010.

SCOPE AND RELEVANCE

The current transactions included in the analysis correspond with the liquidity equalising transactions made by the banks overnight to even out any deficit or surplus of Swedish kronor arising in their accounts in the payment system RIX. These loans are standardised deposit contracts in which the loans are made without collateral. The banks also make overnight transactions in the form of repos⁴ and swaps⁵. Data reported directly by the banks to the Riksbank indicates that the overnight market in Swedish kronor for repos and swaps is not inconsiderable in extent and that its pricing may differ from that on the overnight market. However, overnight transactions in the form of repos and swaps are not captured by the statistics.

At the same time, the analysis only includes overnight loans made between banks that are members of RIX. However, outside RIX there exist a number of banks that equalise their liquidity by taking overnight loans with their correspondent banks, who are members of RIX. These transactions and the interest they generate are not directly captured by the data existing in the RIX system. On the other hand, the transactions are captured indirectly by the analysis, as they affect the correspondent banks' net balances and thus the correspondent banks' overnight loan requirements.

Transactions are registered one by one in the RIX system as they are carried out. The banks themselves classify which transactions are to be defined as overnight loans on the basis of certain criteria. For each separate loan, the following information exists:

- the amount of the loan, in Swedish kronor
- the amount of the repayment, in Swedish kronor
- the names of the transaction's parties
- the date of the transaction (applicable from the start of October 2009).

The calculation of the average overnight rate is based on a total of almost 5 700 transactions between banks, and between banks and the Swedish National Debt Office during the period 5 October 2007-31 December 2010. Tables 1 and 2 present statistics for the underlying loans.

4 *Repo*: A financial instrument resembling a loan. The seller in the transaction transfers a security to the purchaser in the transaction. At the same time, the seller commits to buy the security back from the purchaser at a given point in time for a price determined in advance. (The term is a shortened form of *repurchase agreement*.)

5 *Swap*: A bilateral agreement to exchange a specific currency or interest rate in return for another currency or interest rate for a predetermined period, according to specific conditions.

Table 1. Turnover in Swedish kronor on the overnight market, daily average

	PERIOD 1 2007-10-05– 2008-09-14	PERIOD 2 2008-09-15– 2008-10-01	PERIOD 3 2008-10-02– 2010-10-06	PERIOD 4 2010-10-07– 2010-12-31	PERIOD 1–4 2007-10-05– 2010-12-31
SEK billion					
Total overnight loans	45.2	45.8	15.1	25.3	25.1
<i>between commercial banks</i>	39.3	40.1	5.7	10.1	16.3
<i>with the Swedish National Debt Office</i>	5.9	5.7	9.3	16.1	8.8
Riksbank's fine-tuning operations	0.3	0.2	109.5	11.4	68.8

Table 2. Number of transactions on the overnight market, daily average

	PERIOD 1 2007-10-05– 2008-09-14	PERIOD 2 2008-09-15– 2008-10-01	PERIOD 3 2008-10-02– 2010-10-06	PERIOD 4 2010-10-07– 2010-12-31	PERIOD 1–4 2007-10-05– 2010-12-31
Number of transactions					
Total overnight loans	12.5	12.7	4.1	9.7	7.0
<i>between commercial banks</i>	11.3	11.6	2.7	5.5	5.5
<i>with the Swedish National Debt Office</i>	1.2	1.1	1.4	4.2	1.5
Riksbank's fine-tuning operations	0.7	0.6	8.2	4.1	5.6

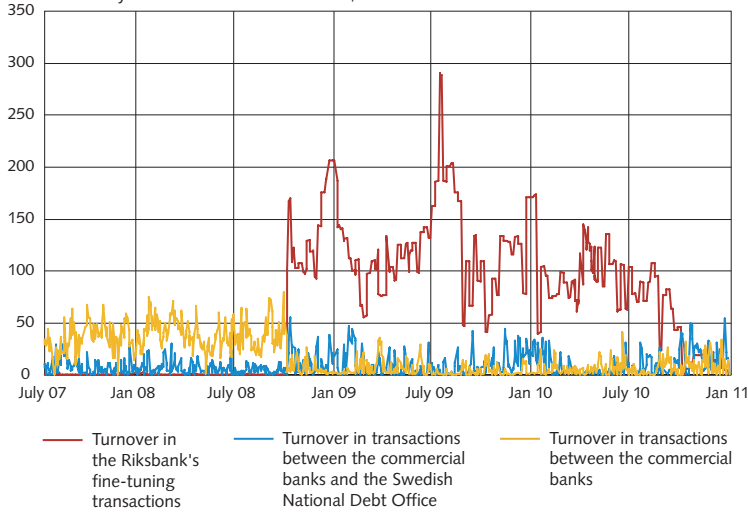
From the table, it can be seen that turnover and the number of transactions, both total and between commercial banks, decreased considerably during the period (see also Figure 1). The major change took place when the Riksbank implemented its first measures to strengthen liquidity during the crisis. The consequence of these measures was that the banking system as a whole, including all banks in the RIX system, received a liquidity surplus regarding the Riksbank. Both the number of transactions between commercial banks and the value of these decreased to an average of one-third of the number and value existing prior to the crisis, as well as prior to the Riksbank's introduction of its liquidity-strengthening measures.

With the discontinuation of the extraordinary measures and the maturation of the Riksbank's fixed-interest rate loans with maturities of one year, a large portion of the extra liquidity that existed in the banking system has been withdrawn. This has led the level of turnover and number of transactions on the overnight market to approach the pre-crisis levels. However, even after all of the extraordinary loans have fallen due, liquidity in the banking system towards the Riksbank remains higher than it was before the crisis. The Riksbank is thus offering Riksbank certificates with maturities of one week. However, the banking system seems to prefer to invest its surplus in the Riksbank's fine-tuning operations. This has reduced the banks' need to borrow from other banks overnight to even out the liquidity deficit in the payment system at the end of the day. By period four, the

sum of the number of overnight loans and the Riksbank's fine-tuning operations, as well as the total turnover of these, have returned to the pre-crisis levels.

Figure 1. Turnover in Swedish kronor on the overnight market, July 2007-December 2010

Transactions with the Riksbank and Swedish National Debt Office, and transactions exclusively between commercial banks, SEK billions



Overnight rate

In this article, the overnight rate has been calculated as the difference between the value of the loan and its repayment, divided by the value of the loan.⁶ To make overnight rates comparable over time, the difference – known as the spread – between the observed overnight rate and the current repo rate has been calculated so that:

$$r_{i,t} = \frac{V_{i,t+1} - V_{i,t}}{V_{i,t}} \times 360, \text{ where } r_i \text{ is the interest rate calculated for each}$$

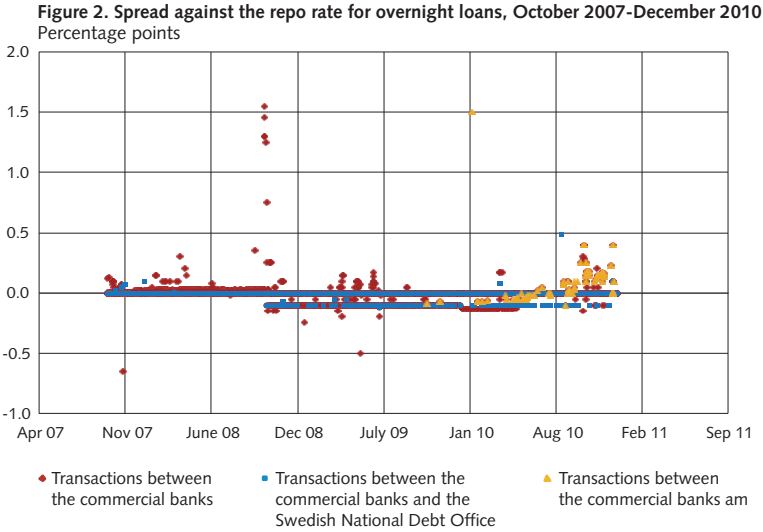
transaction, V_t is the amount of the loan i expressed in Swedish kronor and V_{t+1} is the amount of the repayment.

$$spread_i = r_i - repo_t$$

The average overnight rate for a certain day has been calculated partly as the volume-weighted average of each day's overnight rates, and partly as the

⁶ Neither the interest rate nor the time to maturity of the loans are specified in the data that the analysis is based upon. By pairing loans and repayments between the same counterparties and of about the same amount, but with the opposite direction of flow, on the following business day, the (implied) overnight rate can be calculated.

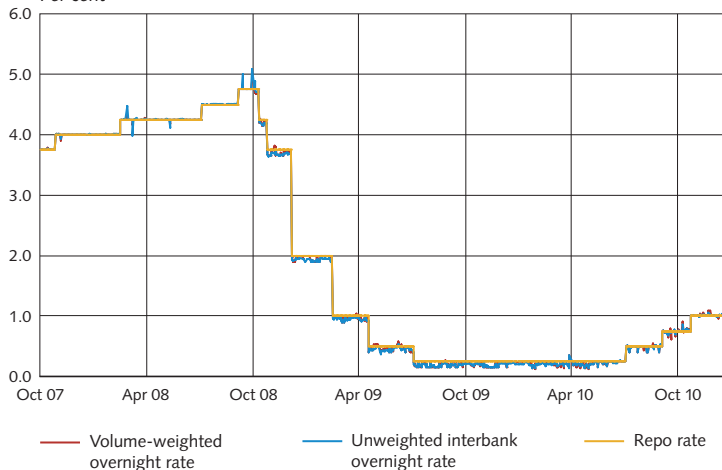
arithmetical mean value. Both methods lead to the same conclusions. However, when the average interest rate is calculated as the arithmetical mean value, all overnight loans receive the same weight in the calculation. The consequence of this is that extreme values have a very strong influence on the calculated overnight rate. When the overnight rate is calculated as the volume-weighted mean value, the impact of the extreme values is reduced – as long as these cases concern small overnight loans. The volume-weighted average is preferable because it does not require an evaluation of which extreme values are to be included in the calculations, as these represent the correct values. Neither does it require an evaluation of which extreme values are to be excluded on the grounds that they are incorrect. Figure 2 shows the spread against the repo rate of overnight loans during the period.



Note. Transactions *between commercial banks and* refers to loans between commercial banks that the banks have classified as overnight loans, with time to maturity of the next business day, but which were registered before 12.00.

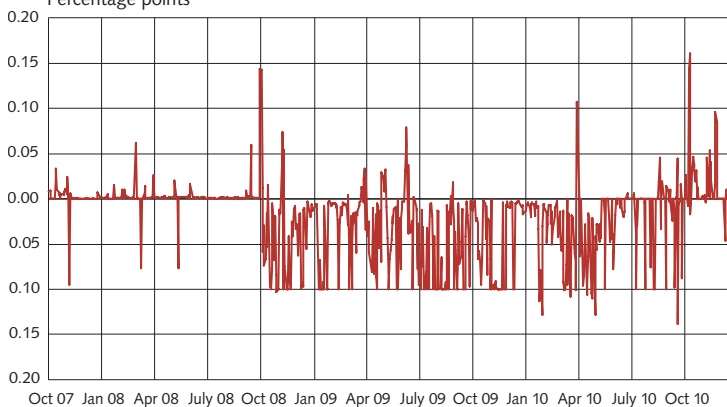
The calculation of the effective overnight rate as the volume-weighted average interest rate shows that the overnight rate lay relatively close to the repo rate over the entire period. Even so, the deviations – the spread – of the repo rate increased slightly after the Riksbank introduced its liquidity-strengthening measures (see Figures 3 and 4). Before the crisis (period 1), the average overnight rate deviated from the repo rate by an average of 0.002 percentage points. After the introduction of the liquidity-strengthening measures (period 3), the deviation was -0.034 percentage points. After these measures were withdrawn, it became 0.016 percentage points (see Table 3).

Figure 3. Average overnight rate, unweighted and volume-weighted
Per cent



Note. The calculations include transactions between commercial banks, and between commercial banks and the Swedish National Debt Office.

Figure 4. Deviation from the repo rate of the average overnight rate, volume-weighted
Percentage points



Note. The calculations include transactions between commercial banks, and between commercial banks and the Swedish National Debt Office.

Table 3. Average repo rate and overnight rate in periods 1-4, with descriptive statistics for the deviation between the repo rate and the volume-weighted overnight rate

	PERIOD 1 2007-10-05– 2008-09-14	PERIOD 2 2008-09-15– 2008-10-01	PERIOD 3 2008-10-02– 2010-10-06	PERIOD 4 2010-10-07– 2010-12-31	PERIOD 1-4 2007-10-05– 2010-12-31
Repo rate, average (per cent)	4.19	4.75	0.90	0.93	1.92
Spread to repo rate, Average					
<i>unweighted overnight rate (per cent)</i>	0.003	0.024	-0.045	0.009	-0.026
<i>volume-weighted overnight rate (per cent)</i>	0.002	0.006	-0.034	0.016	-0.019
Spread to repo rate (per cent)					
<i>Average</i>	0.002	0.006	-0.034	0.016	-0.019
<i>Max</i>	0.06	0.06	0.14	0.16	0.16
<i>Min</i>	-0.10	0.00	-0.14	-0.05	-0.14
<i>Standard deviation</i>	0.01	0.02	0.04	0.04	0.04

Note. Includes transactions with the Swedish National Debt Office. If the calculations of the overnight rate are solely based on loans between the commercial banks, the deviation of the overnight rate from the repo rate is larger than it is if all loans are considered, i.e. including loans between the commercial banks and the Swedish National Debt Office. This was the case both before the crisis and after the crisis broke out. Moreover, this difference increased after the crisis broke out.

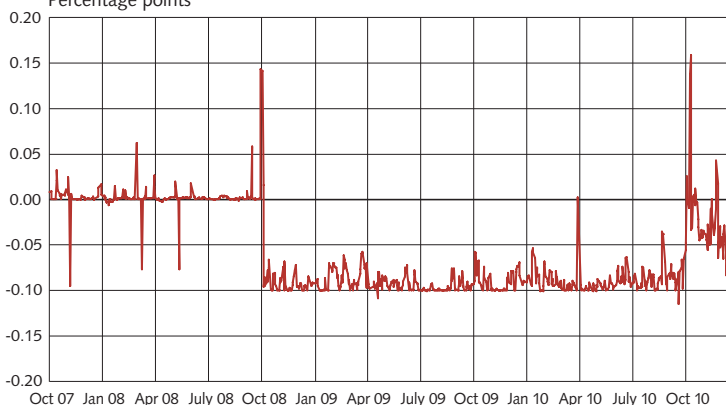
Before the crisis, the overnight rate thus only deviated marginally from the repo rate. This corresponds well with the gentlemen's agreement on the Swedish overnight market under which the banks even out their liquidity at the repo rate – without any spread. This agreement is based on the banks' understanding that the level of credit risk in overnight lending is very low and that the administrative costs of adjusting the pricing of overnight loans to whichever bank may be counterparty in the transaction would be so high as to be unprofitable. However, such an agreement can only work under the conditions that the banks use the overnight market for the same aims and that no bank exploits it for its own gain. Despite this, the fact that a small number of transactions every day deviate from the repo rate indicates that not all banks are party to the agreement.

The negative average spread during period 3 (when the Riksbank's measures were in place) is a consequence of the surplus liquidity held by all banks during that period. They were able to fine-tune this liquidity with the Riksbank at the end of the day at an interest rate of 10 basis points below the repo rate. This meant that, due to its extraordinary lending, the Riksbank acted as intermediary on the overnight market during the crisis, which reduced the banks' need to mutually equalise their liquidity positions.

Most banks thus only equalised their liquidity in Swedish kronor with the Riksbank in the fine-tuning operations. It can thereby be argued that the fine-tuning rate during this period was the banks' alternative cost for the shortest

maturity and that the fine-tuning rate should thus also be included when calculating the average overnight rate. With such a weighting, the average overnight rate is closer to (and more stable around) the fine-tuning rate, 10 basis points below the repo rate (see Figure 5). At the same time, it would not have been necessary to carry out any fine-tuning if the banks had chosen to invest the “extra” liquidity in Riksbank certificates.

Figure 5. Deviation from repo rate of the average interest rate in overnight loans and fine-tuning transactions with the Riksbank, volume-weighted
Percentage points



Note. These calculations include transactions exclusively between commercial banks, and between commercial banks and the Swedish National Debt Office. Figure B1 in the Tables appendix shows the weighted and unweighted overnight rates based on transactions exclusively between the commercial banks, i.e. excluding the Swedish National Debt Office.

During the period October-December 2010, while the average spread was certainly lower than it was during the crisis, it was still higher than it was before the crisis. One contributory factor for this is the uncertainty that arose in conjunction with the maturity of the third and final of the Riksbank’s longer fixed-interest rate loans. The maturity of the loan led the “surplus liquidity” in the banking system to largely disappear. With this, the banks were forced to equalise their daily deficits and surpluses in liquidity with each other – as they had done before the crisis. This uncertainty remained for a few days. In Figure 2, the event can be seen in the form of the greater number of overnight loans made in the morning. In Figure 5, the event can be seen in the form of the increase of the spread of early overnight loans and other overnight loans at the start of October 2010.

It is worth noting that both the number of overnight loans and the total value of these transactions have decreased considerably since the Riksbank introduced its liquidity-strengthening measures. Consequently, the fact that the spread on the overnight market has not increased to any greater extent may be a consequence of the reduction of the number of transactions. The extra liquidity supplied to the

banking system by the Riksbank has allowed the banks to execute their payments without having to risk a liquidity deficit that may force them to borrow from another bank at the end of the day. As the majority of the banks have chosen not to invest their extra liquidity in Riksbank certificates, but have retained the liquidity supplied as a reserve to be invested overnight in fine-tuning, there has been no incentive for the banks to borrow from each other on the overnight market. However, it is a fact that the banks chose to accept the cost of retaining this liquidity as an immediately available reserve in the form of overnight investments in fine-tuning, instead of investing it in Riksbank certificates. Consequently, one interpretation of the result is that the banks have not considered any increased risk by charging more for overnight loans, but, instead, have entirely refrained from executing these transactions when uncertainty has been considered to be too high.

THE VOLATILITY OF THE OVERNIGHT RATE

The indicator used by the Riksbank says that the overnight rate should not deviate by more than 10 basis points above or below the repo rate, so that monetary policy can be considered to have been efficiently implemented. The degree of compliance with this is captured by the deviation between the estimated average overnight rate and the repo rate. Parallel to this measure, the spread (also known as volatility) of the pricing of overnight loans also provides information on the efficiency of the overnight market. A high spread or volatility reflects a wide differentiation regarding the pricing of lending to different counterparties. The differentiation of pricing may reflect the risk associated with lending to different counterparties or a general insecurity on the markets, but it may also reflect the negotiating strength of different partners in the pricing of overnight loans. However, an efficiently-implemented monetary policy in which the overnight rate does not deviate by more than 10 basis points above or below the repo rate should be associated with low volatility.

The volatility of the overnight rate can be measured in various ways. In this article, the standard deviation of the effective overnight rate per day has been calculated as follows:

$$std = \sqrt{\sum_{i=1}^N (w_i \times x_i - \mu^*)^2}$$

x_i is the spread against the repo rate for an individual transaction i , μ^* is the volume-weighted mean value of the spread on the day in question and w_i is the amount of each transaction as a proportion of the total transaction value on the day that the transaction was executed, so that:

$$1 = \sum_{i=1}^N w_i$$

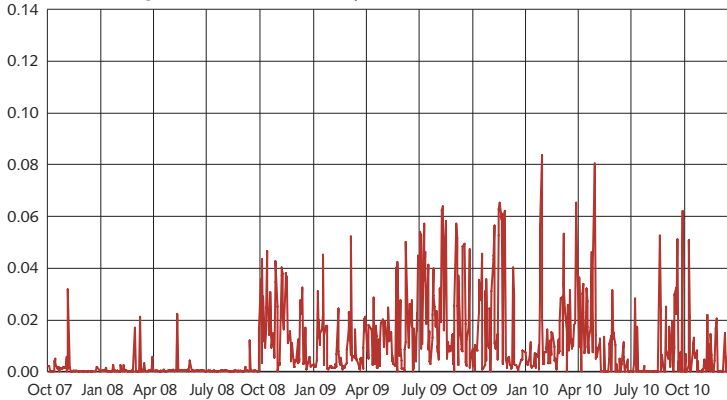
The result indicates that the volatility of the average overnight rate has increased since the financial crisis broke out (see Figure 6). However, the volatility of the overnight rate over the entire period must be deemed to be low. During the period from the collapse of Lehman Brothers until the Riksbank introduced its liquidity-strengthening measures, the volatility of the average overnight rate did not increase more than marginally. Instead, the result indicates that the volatility of the overnight rate increased after the Riksbank introduced its measures.

Seen over the entire period, volatility was highest during the second six months of 2009, during a period in the spring of 2010 and during a few days in October 2010. To a certain extent, this higher volatility is probably due to the significantly lesser number of transactions taking place during these periods, compared with before the crisis. This means that a divergent interest rate in one transaction has a greater impact on the average overnight rate and in the estimated volatility.

Nevertheless, the higher level of volatility in the overnight rate coincides with periods during which uncertainty on the financial markets abroad or in Sweden was increasing. For example, the increased volatility in the spring of 2010 coincided with the increased uncertainty over Greece's fiscal problems. The increased volatility in October 2010 coincided, in turn, with the maturity of the Riksbank's third and final fixed-interest rate loan with a maturity of one year. These periods also saw an increase in interest rates and the level of volatility in interest rates with other times to maturity. This primarily affected the *tomorrow next rate*, which is to say the interest rate applicable to loans with maturities lasting from the following day until the day after that. Following these periods of high volatility, after October 2010, volatility decreased again slightly towards the end of 2010.

One interpretation of this result is that increased uncertainty on the financial markets in general is also reflected in overnight rates. Furthermore, the statistics indicate that, in conjunction with the maturity of the Riksbank's final fixed-interest rate loan, the banks have needed a period to adjust to a more "normal" level of liquidity on the overnight market, which has led to increased uncertainty and friction on the market.

Figure 6. Volatility of overnight rates per day, October 2007-December 2010
Volume-weighted standard deviation, per cent



Volatility increases slightly when transactions with the Swedish National Debt Office are excluded from the calculations. Consequently, the presence of the Swedish National Debt Office on the overnight market seems to have a certain stabilising effect on the overnight rate. As the commercial banks can regard lending to the Swedish National Debt Office as a risk-free investment, the Swedish National Debt Office's overnight borrowing from the commercial banks forms a complement to the Riksbank's standing facilities and fine-tuning.

Turnover and borrowing behaviour on the overnight market

TURNOVER AND VOLUME

During the period October 2007-October 2008, before the financial crisis, the average value of overnight loans amounted to SEK 45 billion per day. The average number of transactions per day was 12.5 (see Tables 1 and 2). As turnover on the overnight market is related to turnover in the payment system in general, there exist certain seasonal variations in turnover on the overnight market – for example, turnover is lower during the summer months than during the rest of the year. Before the crisis, the Riksbank's transactions only answered for a lesser part of turnover. During the period October 2007-October 2008, these amounted to an average of SEK 100-500 million per day. The transactions with the Riksbank are almost exclusively fine-tuning transactions. During the same period, the Swedish National Debt Office's transactions with the banks amounted to SEK 3-14 billion per day (on average, SEK 6 billion per day), which is equivalent to about 15 per cent of the total daily turnover. Even though unease on the financial markets was evident at the end of September 2008, due to the problems faced by the US investment bank Lehman Brothers, there was no sign of a decreased number of transactions or of decreased turnover in the Riksbank's overnight data during this period.

However, as was previously mentioned, in October 2008, the Riksbank adopted liquidity-strengthening measures, including offering loans over and above the ordinary repos. A part of this extra lending was recovered by the Riksbank via the issuance of certificates, but the banks chose to retain the largest part of the extra lending as extra liquidity, investing it in the Riksbank overnight. This led to the banking system as a whole receiving a comparatively large liquidity surplus with the Riksbank. Furthermore, at the end of the day, each individual bank usually had a surplus on its account in RIX. As most banks had an investment requirement, surpluses could not be invested with other banks. This resulted in a decrease in turnover among the banks on the overnight market, both as a proportion of total turnover on the overnight market and in absolute terms.

During the period October 2008-October 2010, turnover in overnight loans amounted to an average of about SEK 15 billion per day, just less than a third of the level of overnight loan turnover before the crisis. At the same time, the Swedish National Debt Office's share of overnight loans increased. Turnover in overnight loans between the commercial banks decreased during the period to about one-sixth of the pre-crisis level, from about SEK 39 billion per day to just less than SEK 6 billion per day. Calculated as the number of overnight loans, the total number of these decreased during the period from an average of 12.5 to 4 per day. As regards loans exclusively between commercial banks, these decreased from 11 to 2.5 (see Tables 1 and 2).

Over the end of 2009 and the start of 2010, the number of transactions and turnover on the overnight market both continued to be low. However, as from October 2010, turnover has increased again. As the total liquidity in the banking system towards the Riksbank is higher than it was before the crisis (when the banking system had a deficit towards the Riksbank), the banks' need for mutual equalisation is lesser. However, compared with the period preceding the financial crisis, turnover on the overnight market continues to be lower.

BORROWING BEHAVIOUR – ACTIVITY AND NET BORROWING

Before the financial crisis, until October 2008, there were clear differences between the banks in their borrowing behaviour on the overnight market. Many banks seem, to a very great extent, to have had a strategy of either systematically borrowing or systematically investing overnight. Typically, those banks investing on the overnight market were smaller banks. The larger banks also included those who invested on the overwhelming majority of days, but this behaviour is not as marked as among the smaller banks (see Figure 7a-c).

Three of the larger banks borrowed significantly more frequently than they invested, indicating that their strategy was to fund part of their liquidity requirement in Swedish kronor on the overnight market. At the same time, the

larger banks often both borrowed and invested liquidity overnight on the same day. One possible explanation for this is that the banks' own restrictions on the extent of their exposure towards individual counterparties – limits – confine their ability to even out their entire balance with a single counterparty. Consequently, on certain days, they have been forced to resort to another bank to supply their borrowing or investment requirements. However, this seems to have worked well, on the whole – except for when one bank has been forced to use the Riksbank's standing facility.

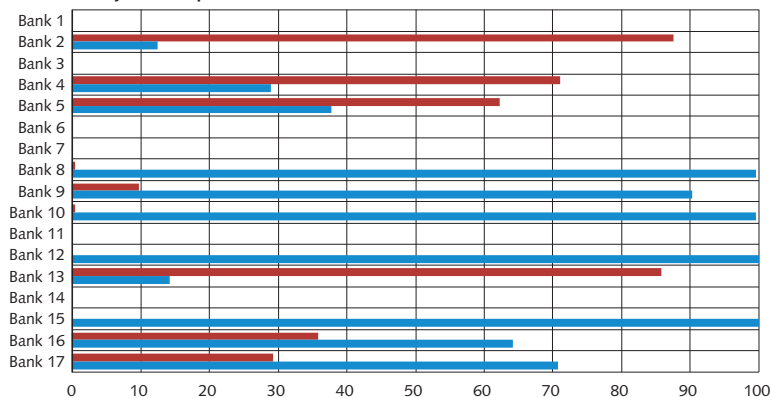
During the crisis, participation on the overnight market decreased, as did the value of the transactions being executed. Banks that had previously almost exclusively been borrowers on the overnight market borrowed significantly less frequently during the financial crisis. This is probably a result of the major liquidity surplus existing in the banking system as a whole. This resulted in a reduction of the banks' incentive to mutually equalise their liquidity – on most days, the banks had no need to borrow from other banks and could frequently fine-tune their entire deficits directly with the Riksbank.

It has been possible to observe changes in the banks' behaviour on the overnight market at the same rate as activity on the overnight market increased after October 2010. The marked lending or investing behaviour shown by the banks before the crisis can no longer be observed to the same extent. Above all, the three major banks that consistently funded deficits on the overnight market seem to have performed U-turns. Since October 2010, they have invested liquidity surpluses more often than they have borrowed to cover deficits (see Figure 7c). The amount of the banks' balances on the days that they have had a deficit on the overnight market was also smaller during the period October–December than it was before the crisis (see Figure 8).

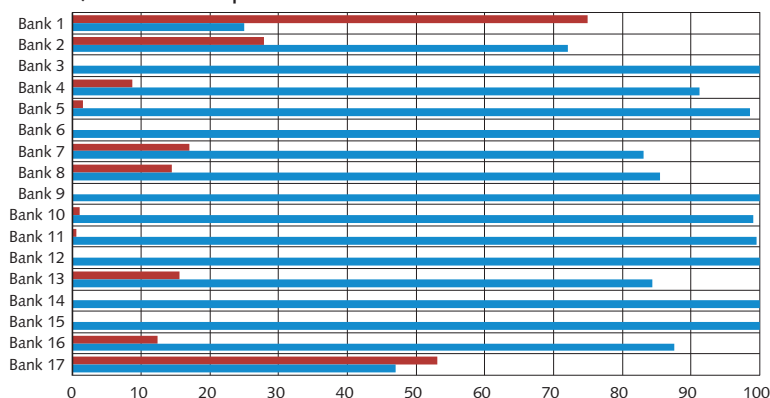
The return to balancing liquidity between the banks has thus entailed a certain change in the structure of the market for balancing liquidity between the banks in Swedish kronor (see Figure 8). As the change in the banks' behaviour is so clear, there is reason to believe that this is something that has been consciously implemented by the banks. Apart from the larger liquidity surplus towards the Riksbank held by the banking system as a whole (compared with before the crisis), it is also likely that the seemingly increased negative liquidity deficit held by the Swedish National Debt Office has contributed towards facilitating a change in the banks' behaviour.

Figure 7. Borrowing behaviour, proportion of days that the banks borrow or deposit money overnight
 Percentage of total number of days that the bank participates on the overnight market

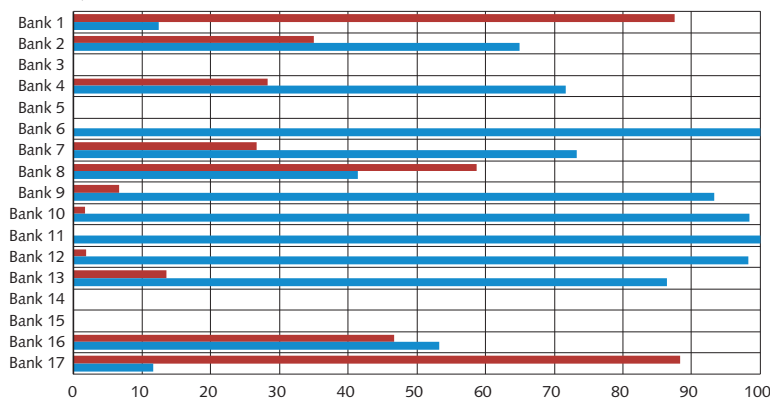
a) July 2007-September 2008



b) October 2008-September 2010

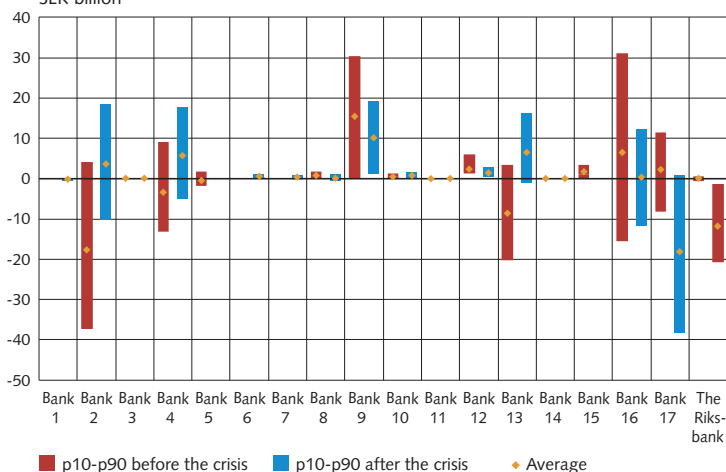


c) October 2010-December 2010



■ Percentage of total number of days with a deficit ■ Percentage of total number of days with a surplus

Figure 8. Average and variance of the banks' liquidity position in Swedish kronor balanced overnight, before and after the crisis
SEK billion



Note. The red and blue bars show the spread between the total amounts deposited (+) and borrowed by each bank (-) on average per day on the overnight market, before (red bars) and after (blue bars) the crisis. The upper edges of the bars represent the 90th percentile and the lower edges represent the 10th percentile of each period. The yellow rhombus marks the average value of each period, i.e. the bank's average overnight borrowing or deposit. These calculations include transactions with the Swedish National Debt Office and fine-tuning with the Riksbank. 'Before the crisis' refers to the period July 2007- September 2008; 'after the crisis' refers to the period October 2010-December 2010.

Note. The red and blue bars show the spread between the total amounts invested (+) and borrowed by each bank (-) on average per day on the overnight market, before (red bars) and after (blue bars) the crisis. The upper edges of the bars represent the 90th percentile and the lower edges represent the 10th percentile of each period. The yellow rhombus marks the average value of each period, i.e. the bank's average overnight borrowing or investment. These calculations include transactions with the Swedish National Debt Office and fine-tuning with the Riksbank. 'Before the crisis' refers to the period July 2007-September 2008; 'after the crisis' refers to the period October 2010-December 2010.

COUNTERPARTY PATTERNS

Before the financial crisis, transactions on the overnight market were largely made between the same counterparties every day. In other words, each bank had one or two banks with which it mostly conducted its overnight loans. This was partly a consequence of the fact that most banks almost always invested at the same time as a few almost always borrowed, which normally meant that there were very few counterparties to choose from when investing. In the few transactions conducted during the crisis, until October 2010, the counterparty patterns were approximately the same as they were before the crisis, in the sense that the banks

mostly turned to the same counterparties as previously. However, as almost all banks made fewer transactions during this period, this resulted in there also being fewer counterparties. In addition, data for this period indicates that one major bank above all had become a more important counterparty for more banks, while the other major banks considerably decreased their activities on the market, in certain cases completely refraining from making transactions with other banks.

Between October 2010 and December 2010, the counterparty patterns observed were also unchanged compared with before the crisis. The banks largely use the same counterparties as before the crisis and, as a rule, also balanced with about the same number of counterparties each day as before (one to three). The counterparties that each individual bank may turn to at the end of the day has been affected, to some extent, by the appearance and disappearance of banks in the group of banks on the overnight market, as well as by changes in the behaviour of certain banks. However, this has not led to any clear structural changes.

One change worth noting, which primarily occurred in the autumn of 2010, is the tendency for more overnight loans to be taken out during the morning, occasionally before the markets open for the day (see Figure 2). One possible explanation could be that uncertainty connected with the crisis has made the banks more cautious. One consequence of this is that the banks wanted to secure their liquidity requirements in the mornings given that there are expectations of large outflows of liquidity and the risk of facing a large deficit at the end of the day. If so, the interpretation of this is that certain banks have chosen to act early in the day so as to avoid the risk of finding themselves in a tight spot just before the market closes. This may also have affected the choice of counterparty and may also provide an explanation for the changed borrowing behaviour of certain banks.

Conclusion

Using statistics from the Riksbank's payment system RIX on executed transactions, it is possible to follow, on an ongoing basis, the pricing and activity levels on the overnight market for overnight loans between the banks. This contributes to improving the picture received by the Riksbank of how efficiently monetary policy is being implemented. The study shows that, for the period October 2007–December 2010, the average interest rate on the overnight market varied within the band deemed by the Riksbank to represent efficiently implemented monetary policy. Nevertheless, both the deviation of the overnight rate from the repo rate and the level of volatility of the overnight rate have increased since the financial crisis broke out. This indicates that the pricing of overnight loans has been affected, to a greater extent than previously, by the uncertainty prevailing on

the financial markets in both Sweden and globally. This may be due to increased uncertainty abroad, to the greater adjustment to prevailing factors of the pricing of overnight loans by the banks, or to a combination of these.

The overnight market changed with the adoption of liquidity-strengthening measures by the Riksbank in October 2008. The banking system's total netting requirements towards the Riksbank increased, which led to almost all banks being able to retain a surplus in the RIX system during the day. In addition, the need for balancing with other banks decreased, as did the opportunities for this. Overnight activity on the overnight market decreased markedly during the crisis, in terms of both turnover volumes and the number of transactions for overnight loans. During the period October 2008-October 2010, turnover in overnight loans between commercial banks decreased to about one sixth of its pre-crisis level, while, at the same time, the number of overnight loans decreased to about one quarter.

During late 2009 and early 2010, the number of transactions and level of turnover on the overnight market continued to be lower than before the crisis. However, as from October 2010, turnover in transactions between commercial banks has increased again. As the total liquidity of the banking system towards the Riksbank is higher than it was before the crisis (when the banking system had a deficit towards the Riksbank), the banks' need for mutual balancing has, in some sense, decreased – any bank with a surplus can always invest this in the Riksbank's fine-tuning operations. However, compared with before the financial crisis, turnover on the overnight market continues to be lower.

At the same time, the statistics indicate that the banks have changed their behaviour as compared with before the crisis, to a certain extent. Firstly, there are signs that, since October 2010, the banks have abandoned the borrowing or investment strategies that could be observed before the crisis, and that the amount of the banks' net balances was generally smaller during the period October-December 2010 than it was before the crisis. Secondly, there are certain indications that the banks act earlier in the day more frequently than before – they take out overnight loans during the morning, so as to avoid the risk of finding themselves in a difficult situation just before the market closes. One possible explanation is that uncertainty connected with the crisis has made the banks more cautious.

So far, the overnight rate has remained within the accepted band of 10 basis points above or below the repo rate, which indicates that monetary policy has been implemented efficiently. However, for monetary policy to be considered efficient, the way that the overnight rate is reflected in interest rates with longer maturities is equally important as having an overnight rate that is stable and close to the repo rate. One condition for the Riksbank to be able to affect longer market interest rates in a predictable manner is that the banks can expect to borrow or

invest the surpluses and deficits arising over the day on the overnight market at an interest rate close to the repo rate.

During the financial crisis, turnover on the overnight market decreased. This indicates that any uncertainty on the interbank markets has reduced activity, rather than affected pricing. Narrow limits or other restrictions affect the banks' ability to utilise the overnight market to manage their liquidity. In turn, this has repercussions on the setting of interest rates for markets with longer durations and contributes towards reducing the efficiency of a monetary policy that is focused on steering the overnight rate. At the same time, restrictions such as limits between the banks can contribute to more disciplined liquidity management, which is positive from the perspective of stability.

References

Eklund, Johanna (2009). "Market Structure, Interest rates and the Risk of Financial Contagion: An Examination of the Swedish Overnight market". Master's dissertation, Stockholm School of Economics.

Henckel, Timo, Ize, Alain and Kovanen, Arto (1999). "Central Banking without Central Bank Money". Working paper, No. 99, IMF.

Nessén, Marianne, Sellin, Peter and Åsberg Sommar, Per (2011). "The framework for the implementation of monetary policy, the Riksbank's balance sheet and the financial crisis". Economic Commentary, No. 1, Sveriges Riksbank. Stockholm: Sveriges Riksbank.

■ Operational frameworks for the implementation of monetary policy – a comparative study

In this chapter we describe the frameworks for implementing monetary policy of some inflation targeting central banks working in an environment of fairly well developed financial markets. The purpose of the chapter is to see what we can learn from the varying practices of the central banks studied.

How an operational framework is constructed depends on what the central bank wants the framework to accomplish. The precise objectives may differ somewhat between central banks. We have identified some basic objectives that we judge most central banks could agree on. From our visits and discussions with representatives from some of the central banks studied in this paper, we have found that the most important objectives for the central bank's operational framework should be to

- achieve the operational target – usually for the overnight rate – but also ensure an effective transmission to other terms;
- mitigate volatility in the shortest money market rates;
- promote an active money market;
- provide liquidity insurance.

We start with an overview of the different types of framework used in the next section. In the following sections we will discuss each objective in turn and see how some of the central banks have set up their frameworks to reach these objectives. We conclude by highlighting some interesting solutions to problems that an operational framework should be able to handle, and relate these solutions to the Riksbank's operational framework.

Different types of operational frameworks

The principal objective of the operational framework of the central bank is to achieve the operational target of monetary policy. According to Bindseil (2011) the operational target is a variable that

- can be sufficiently controlled by the central bank
- is economically relevant, in the sense that it affects the ultimate target of monetary policy (e.g. price stability)

- defines the stance of monetary policy
- gives necessary and sufficient guidance for its implementation.

Most central banks in developed countries have chosen a short-term market interest rate as their operational target – usually the unsecured overnight rate.

We will compare the frameworks for implementing monetary policy of the central banks in Australia, Canada, Sweden, Euro Area, United Kingdom, Czech Republic, Poland, Hungary, United States, Switzerland, Norway and New Zealand (a brief description of the main features of each system is given in an appendix). We have chosen to study the operational frameworks of these particular currency areas as they have inflation targeting central banks working in an environment of fairly well developed financial markets.¹ Yet some aspects of their operational frameworks differ in some important regards. We distinguish between three different groups of systems: (i) corridor systems without reserve requirements, (ii) reserve requirement systems (with or without a corridor), and (iii) floor and quota systems.

CORRIDOR SYSTEM WITHOUT RESERVE REQUIREMENTS

Most inflation targeting central banks provide standing facilities in the form of a lending facility and a deposit facility. The interest rate at which a bank can borrow money overnight from the central bank is usually 50 to 200 basis points higher than the interest rate at which the bank can deposit money at the central bank. This provides an incentive for banks with access to the central bank's standing facilities to trade overnight funds with each other, rather than with the central bank, at some interest rate in between the central bank's lending rate and deposit rate. The wider this *interest rate corridor* is the greater is the incentive for interbank trading, but the scope for volatility in the overnight interest rate will also be greater. Thus, in determining the width of the corridor, central banks face a trade-off between controlling the overnight rate and having an active interbank market.²

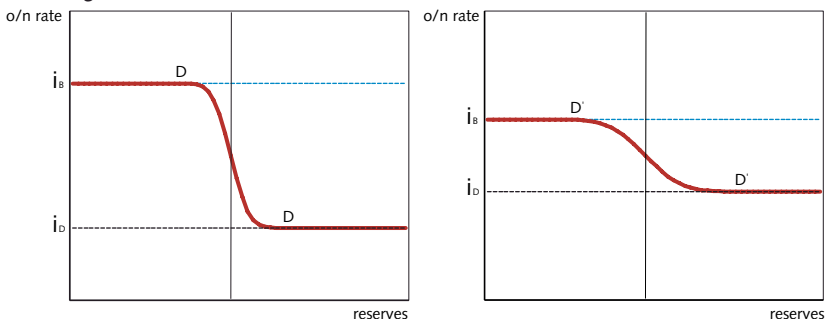
Banks' uncertainty as to whether they will have sufficient reserves at the end of the day makes them demand reserves for precautionary reasons. With a tighter supply of reserves a bank will have to bid a higher rate to obtain reserves in the overnight market, resulting in a demand curve with a negative slope. The central bank typically sets a target for the overnight interest rate and then provides the exact amount of reserves to the banking system so that demand is met at this level for the overnight rate. The target rate is usually in the middle of the corridor. If the

1 The US Federal Reserve, the European Central Bank and the Swiss National Bank would not describe themselves as being inflation targeting central banks. However, for our purposes they come close enough for us to include them in our study.

2 See Bindseil and Jablecki (2011) for a thorough analysis of this tradeoff.

central bank misjudges the amount of reserves that are demanded at the target rate, this is less critical in a narrow corridor system since the overnight rate is less sensitive to changes in reserves if the corridor is narrow, see figure 1.

Figure 1. Demand for reserves under a broad and a narrow interest rate corridor

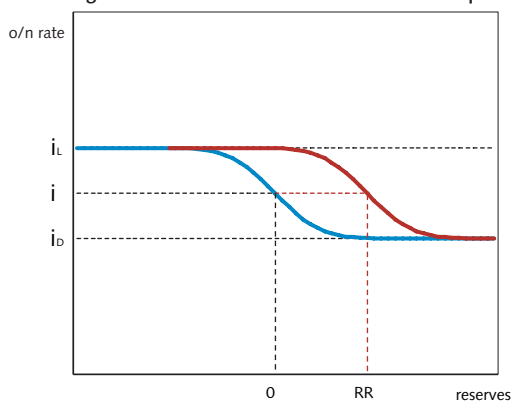


We consider two systems with narrow corridors, those of the **Reserve Bank of Australia (RBA)** and **Bank of Canada (BOC)** (both ± 25 basis points around the target rate). We also consider two systems with broad corridors, those of **Sveriges Riksbank (SRB)** (± 75 basis points) and the **Bank of England (BOE)** 27 June 2001-13 March 2005 (± 100 basis points). It should be noted that the BOE did not use a pure corridor system, since the Bank lent money through open market operations and not through a standing facility. This was followed by BOE's interim system 14 March 2005-17 May 2006, which used a narrower "corridor" of ± 25 basis points.

RESERVE REQUIREMENT SYSTEMS

The use of reserve requirements means that banks are required to hold a specified amount in an account at the central bank. The imposition of reserve requirements leads to an increase in banks' demand for reserves. In figure 2 the aggregate demand for reserves, at the interest rate i , is RR instead of zero because of the use of reserve requirements.

Figure 2. Demand for reserves under a reserve requirement regime



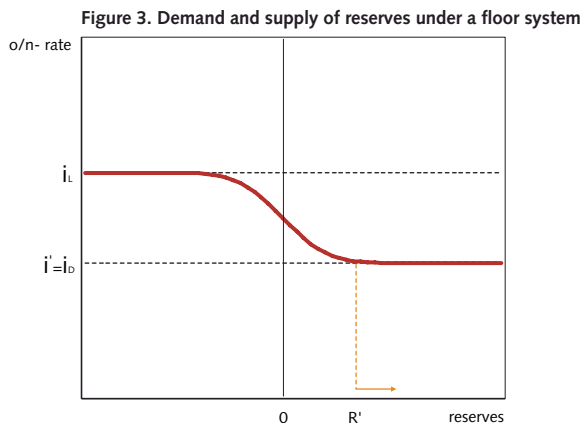
Reserve requirements have to be met either exactly or on average. Averaging means that the reserve requirement does not have to be met on a daily basis. Instead the requirement has to be met on average during a maintenance period. All of the reserve requirement systems studied in this paper use reserves averaging. The rationale for averaging is to stimulate interbank trading that should smooth overnight interest rates during the maintenance period. The central bank should provide just enough liquidity during the maintenance period so that the banks can meet their reserve requirements.

The length of the maintenance period differs between central banks. The **Eurosystem (ECB)** and the current system of the **BOE** use maintenance periods that coincide with the period between monetary policy meetings, while the **US Federal Reserve System (FRS)** uses a fixed period of two weeks. The **Swiss National Bank (SNB)** and Hungary's **Magyar Nemzeti Bank (MNB)** use a fixed period of one month. The **National Bank of Poland (NBP)** and the **Czech National Bank (CNB)** use a period of approximately one month. In the case of the CNB the period starts on the first Thursday of the month. It is different than the NBP's approach, which uses a special algorithm to derive each maintenance period in a specific year.

FLOOR AND QUOTA SYSTEMS

Under a *floor system* the central bank provides enough liquidity to the banking system to push the overnight rate close to the floor of the corridor. Given the demand schedule in figure 3, the central bank has to provide reserves equal to at least R' to get the overnight rate to be close to the central bank's deposit rate. A *quota system* is different from a pure floor system, since the central bank sets a quota for the amount of reserves that are remunerated at the key policy rate.

Deposits above the quota will be remunerated at a lower rate. Hence, under a quota system the overnight rate can take values below the key policy rate.



The **Reserve Bank of New Zealand (RBNZ)** used to have a pure floor system, but moved to a quota system (“tiering regime”) in August 2007. An individual limit (“tier”) was introduced, above which reserves are remunerated at 100 bps below the key policy rate, in order to stop the banks’ insatiable appetite for reserves. The New Zealand case is special in that they have a “fully cashed up system”. This means that there is no distinction between intraday and overnight liquidity. Banks have to hold a sufficient amount of reserves overnight in order to meet their payment obligations during the day.

Norges Bank (NB) also used to have a floor system, in which all deposits made by banks were remunerated at the key policy rate, but introduced a quota system in October 2011. The purpose of changing the system was to dampen reserves demand and boost activity in the short-term interbank market.³

The main features of the operational frameworks considered in this paper are summarised in Table 1.

³ Berghardsen and Kloster (2010) discuss floor compared to corridor systems and the NB experience.

Table 1. The main features of the operational frameworks

COUNTRY	SF CORRIDOR WIDTH, IN BASIS POINTS	OMO FREQUENCY (TERM)	RR MAINTENANCE PERIOD
Australia	50	Daily (variable)	
Canada	50	Daily (o/n)	
Sweden	150	Daily (o/n)	
UK 2001-04	200 ¹	Daily (2w), 1-3 daily (o/n)	
UK 2005-06	50 ¹	Daily (2w), 1-3 daily (o/n)	
UK (present)	50 ²	Weekly (1w)+FT	Inter-meeting
Euro Area	75	Weekly (1w)+LTROs	Inter-meeting
Czech Rep	20	3 weekly (2w)	1 month
Poland	300	Weekly (1w)	1 month
Hungary	200	Weekly (2w)	1 month
US	50 ³	Daily	2 weeks
Switzerland ⁴		Daily (1w)+FT	1 month
Norway	Quota system	Variable (variable)	
New Zealand	Quota system	Daily (variable)	

Note: Standing facilities (SF), open market operations (OMO) and reserve requirements (RR) are reported in the table. If fine tuning (FT) operations plays an important role in steering interest rates this is also reported. The Eurosystem regularly uses Long-Term Refinancing Operations (LTROs) in addition to the weekly Main Refinancing Operations (MROs).

1 BOE did not have a lending facility as such, but rather supplied liquidity via open market operations during the period 2001-2006.

2 This is the normal width of the Bank of England's operational standing facilities. Presently it is 75 basis points and BOE is de facto using a floor system by remunerating all reserves at the policy rate (Bank Rate), since the 5 March 2009. As long as Bank Rate is 0.5 per cent or lower, the rate paid on the Operational Standing Deposit Facility is zero (instead of 25 basis points below Bank Rate).

3 Since 16 December 2008 FRS cannot be said to use a regular corridor system, since the aim for the fed funds rate is a range of 0 to ¼ per cent, with reserves remunerated at ¼ per cent and the lending (Primary Credit Facility) rate being ¾ per cent.

4 SNB cannot be said to be using a corridor system as it offers no deposit facility.

Achieving the operational target

THE CHOICE OF OPERATIONAL TARGET

Several of the central banks in this study have explicitly stated an operational target in terms of the overnight rate (RBA, BOC, SRB, BOE, NBP and FRS). This is the rate over which the central bank has the most control, since it is usually fairly straightforward to estimate the demand for and supply of overnight reserves.

CNB, ECB, NB and RBNZ all state that they try to influence "short-term money market rates" without stating a target for an interest rate with a specific term. CNB focus on short-term interest rates more generally, while the focus in the ECB's Monthly Bulletin is often on the overnight rate EONIA, but developments in the 1-, 3- and 12-month EURIBOR are also extensively discussed. NB aims to keep the amount of reserves at a certain pre-specified level, a level somewhat below the sum of all banks' quotas in the system. This will normally ensure that the overnight rate (NOWA) take values around the key policy. Like NB, RBNZ also uses a quota system ("tiering regime") set at the Official Cash Rate (OCR). RBNZ monitors market interest rates in the overnight FX swap market and overnight interbank cash market to assess whether the correct amount of cash is in the system. If these securities are trading at rates that deviate from the market's expectations of the

OCR according to the relevant overnight index swap rate, it is an indication that the amount of reserves in the system needs adjusting.⁴

In the absence of reserve requirements banks' aggregate *demand for reserves* should in principle be zero. Nevertheless, in practice banks seem to prefer holding a positive amount of reserves with the central bank as a precaution against the risk of having to pay a penalty rate when unable to meet settlement obligations at the end of the day.⁵ There could also be a demand for reserves to meet prudential liquidity requirements. The central bank determines the *supply of reserves* subject to a limited number of factors beyond its control. The most important among these "autonomous factors" are the banking system's demand for currency and transactions in the government's account with the central bank. Currency demand is usually quite stable but it follows a seasonal pattern, while the government's account is more volatile. However, the central bank typically gets detailed information from the government regarding future transactions in its account at the central bank.

The precautionary demand for funds mentioned above is due to payment needs at the end of the day combined with possible frictions in the interbank market, since in the absence of frictions if some banks end up short there should be an equivalent surplus of funds that could be lent by the other banks. However, "When the last remaining creditor bank in the market must negotiate a price at which to lend resources to the last remaining debtor bank, a game situation arises in which the creditor bank may adopt a non-cooperative behavior" (Henckel et al (1999)).

Setting a target for a specific term, like the overnight rate, makes it easier for outside observers (and the bank itself) to evaluate the central bank's attainment of its operational target. On the other hand, one has to ask oneself if focusing on a specific short-term interest rate is not too simplistic. Clearly, implementing monetary policy effectively must imply having control over the transmission from overnight up to at least a 3 month term, where the money market connects with the real economy. The central banks in this study differ in how they handle this important issue. Most focus on the shortest market rates and assume that the transmission to 3 months is stable. SNB and MNB instead explicitly target the 3 month rate. Focusing on a target for the overnight rate, of course, does not mean that the central bank cannot take into account information contained in term interest rates and credit spreads.

In times of crisis the operational target may have to be modified. It is clear from the experience during the financial crisis that if the transmission mechanism is impaired the central bank should have alternative means available such that the

4 See Nield (2008).

5 The FRS does not provide intraday credit at zero interest, like the other central banks do, so there will nearly always be some demand to cover intraday payment activity.

desired monetary policy stance can be implemented. For example, at the present time BOE has an operational target for its asset purchases in order to provide quantitative easing, in addition to maintaining the overnight rate in line with its key policy rate. In the face of extreme upward pressure on the Swiss franc, the SNB on 6 September 2011 applied an additional operational target in the form of a minimum exchange rate of CHF 1.20 per euro. The SNB has committed to buying foreign currency in unlimited quantities to defend this level, given the serious impact a further appreciation is deemed to have on both prices and economic performance in Switzerland.

FORWARD GUIDANCE

Expectations about future short-term target rates can have an important impact on the economy. Hence, managing the private sectors' expectations can be used as an important implementation device. There are major differences in how much guidance central banks are willing to give on future policy decisions.

SRB and NB are at one extreme, in addition to setting and announcing a target rate, these central banks also regularly publish an interest rate path for the projected target rate. CNB publish a forecast of the 3 month money market rate (3M PRIBOR), which is used in the CNB's forecasting system to proxy for the CNB's key monetary policy rate, i.e. the two-week repo rate. RBNZ also uses a 3 month interest rates projection to reflect the future monetary policy stance. All of the interest rate projections above are presented as quarterly data. NBP instead presents annual data for projections of the 3 month WIBOR in its Inflation Report.

During the financial crisis the BOC committed to keeping the overnight rate target low for a specified period, conditional on the inflation outlook. In its announcement on 21 April 2009 the Bank stated that with monetary policy operating at the effective lower bound it found it appropriate to provide more explicit guidance than is usual regarding the policy rate's future path so as to influence rates at longer maturities. BOC also announced that it would continue to provide such guidance in its scheduled interest rate announcements for as long as the overnight rate is at the effective lower bound. This sort of forward guidance was later also adopted by the FRS. The FRS's guidance on policy rates has recently been changed from date-based to intermediate threshold-based: the current low range for the policy rate is deemed to be appropriate so long as the unemployment rate remains above 6.5 per cent, inflation between one and two years ahead is projected to be no more than 2.5 per cent and longer-term inflation expectations remain well anchored.

The BOE has taken seriously the notion that policy is made one month at a time with regard to its policy rates and provides no such guidance beyond the next monetary policy meeting. However, the Chancellor's remit for the Monetary Policy

Committee in March 2013 requests that the Committee provide in its August 2013 Inflation Report an assessment of the merits of intermediate thresholds. The RBA, ECB, SNB and MNB provide little in the way of formalised forward guidance, beyond some carefully worded verbal guidance.

DEVIATIONS FROM THE OPERATIONAL TARGET

In Table 2 we show in boldface the deviation from the target rate of the relevant interbank rate, for those central banks that have an explicitly stated target for a specific tenor. We also report the deviations for other tenors, and for central banks that do not have a target for a specific term, for completeness. In addition we present the standard 3 month basis spread – the 3 month interbank rate over the overnight index swap rate – as a measure of risk in the interbank market.

We note that the RBA and BOC frameworks, that employ a narrow interest rate corridor of +/- 25 basis points, have been extremely successful in steering the o/n-rate. The o/n rate has been on target on average in normal times (Tables 2 and 4) as well as during the financial crisis (Table 3). One common explanation is that Australia and Canada were less affected by the crisis. However, term lending in the interbank market was affected also in these countries as evidenced by the fact that the three month basis spread was quite elevated in both countries during the crisis (compare the last columns of tables 2 and 3).

Table 2. Mean of interbank rate vs. target rate spread pre-crisis (in per cent)

COUNTRY	O/N	T/N	1 WEEK	1 MONTH	3 MONTH	3 MONTH BASIS SPREAD
Australia 2001-07	0.00		0.01	0.03	0.08	0.00
Canada 2001-07	0.00			0.03	0.06	0.03
Sweden 2001-07		0.10	0.13	0.15	0.20	0.05
UK 2001-04	-0.05		-0.02	0.04	0.10	
UK 2005-06	0.01		0.07	0.09	0.11	
UK 2006-07	0.07		0.13	0.19	0.30	
Euro Area 2004-07	0.07		0.10	0.14	0.22	0.06
Czech Rep 2002-07	-0.07		0.01	0.03	0.07	
Poland 2004-07	-0.01	0.06	0.10	0.12	0.17	
Hungary 2004-07	-0.05		0.07	0.05	0.01	
US 2001-07	0.00		0.08	0.10	0.16	0.08
Switzerland 2001-07	-0.10		-0.04	-0.03	0.02	
Norway 2001-07	0.14	0.52	0.23	0.22	0.22	
New Zealand 2006-07	0.17			0.31	0.41	

Note. The pre-crisis period ends on 8 August 2007. Deviation from explicit operational target is in boldface. The basis spread is generally measured over a shorter time period starting around 2006. For Poland the WIBOR o/n rate is used here. The New Zealand operational framework went through major changes during 2006-2007, so the results presented here may not be representative of the performance of the new system.

The interest rate series used in the table are, for Australia: unsecured o/n Cash Rate and LIBOR (1W, 1M, 3M), for Canada: CORRA and Bankers' acceptances (1M, 3M)(the basis spread is based on Libor), for Sweden: STIBOR (t/n, 1W, 1M, 3M), for UK: SONIA and LIBOR (1W, 1M, 3M), for Euro Area: EONIA and EURIBOR (1W, 1M, 3M), for Czech Republic: CZEONIA and PRIBOR (1W, 1M, 3M), for Poland: WIBOR (o/n, t/n, 1W, 1M, 3M), for Hungary: BUBOR (o/n, 1W, 1M, 3M), for US: the effective Fed funds rate and LIBOR (1W, 1M, 3M), for Switzerland: Repo Overnight Index (SNB) and LIBOR (1W, 1M, 3M), for Norway: NIDER o/n and NIBOR (t/n, 1W, 1M, 3M), for New Zealand: Overnight Interbank Cash Rate and Bank Bill yields (1M, 3M).

Table 3. Mean of interbank rate vs. target rate spread during crisis (in per cent)

COUNTRY	O/N	T/N	1 WEEK	1 MONTH	3 MONTH	3 MONTH BASIS SPREAD
Australia	0.00		0.12	0.25	0.43	0.47
Canada	-0.01			0.10	0.15	0.43
Sweden ¹	-0.06	0.12	0.19	0.27	0.46	0.37
UK	-0.05		0.12	0.29	0.56	0.66
Euro Area	-0.34		-0.24	-0.09	0.23	0.59
Czech Rep	-0.08		0.11	0.30	0.53	
Poland ²	-0.54	0.04	0.19	0.07	-0.09	
Hungary	-0.31		-0.01	0.04	0.07	
US ³	-0.13		0.42	0.54	0.71	0.58
Switzerland ⁴	-0.35		-0.27	-0.18	0.05	0.23
Norway	0.14	0.51	0.44	0.52	0.73	
New Zealand	-0.11			0.28	0.28	0.43

Note. The crisis period is defined as 9 August 2007 to 31 December 2010. Deviation from explicit operational target is in boldface. See Table 2 for information about the interest rate series used in the table.

1. The o/n rates are from Sveriges Riksbank (2012). See also Eklund and Åsberg Sommar (2011)

2. The overnight rate used here is the POLONIA rate (data from 1 January 2008).

3. The period used is 9 August 2007 to 15 December 2008, since FRS later introduced a target range for the fed funds rate.

4. Switzerland switched from using the Repo Overnight Index to using SARON as the relevant overnight rate.

The RBA relies on liquidity forecasts which determine the preferred terms of the repos they offer each morning. Discretion is then used in determining the amounts allocated at the different terms. Banks are generally willing to exchange unsecured overnight funds at the target rate by convention. RBA usually does not need to perform any fine-tuning operations in addition to its regular daily operations in the morning.

The BOC uses a special form of fine-tuning. It auctions the government's deposits twice each day in order to maintain the desired level of settlement balances in the system. During the period 21 April 2009-31 May 2010 the BOC set the target rate equal to the lower bound of the interest rate corridor rather than the middle of the corridor, since they realized that providing extra liquidity to the banking system would put downward pressure on the o/n rate. Also, the width of the corridor was narrowed to 25 basis points compared to 50 basis points previously. We can see from Figure 2 (in the appendix) that this temporary floor system worked very well. The floor was a bit soft, as indicated by a value of -0.01 for the mean deviation from target in table 3, but the o/n rate continued to fluctuate very closely around the target rate.

We also note that the FRS managed to steer the overnight Fed funds rate extremely well during normal times but less so during the earlier part of the financial crisis. However, since the introduction of a target range on 16 December 2008 the Fed funds rate has consistently traded within the range 0 to $\frac{1}{4}$ per cent, see figure 10 (in the appendix).

In table 3, we can see that there has been a big gap between the POLONIA rate and the NBP reference rate.⁶ However, the gap has gradually narrowed during 2011, primarily as a result of short-term fine-tuning operations launched by the NBP in December 2010. This resulted in a gradual narrowing of the gap between the POLONIA rate and the NBP reference rate, see table 4 and figure 8 (in the appendix). Initially, the NBP resorted to fine-tuning operations on an ad-hoc basis, within the required reserve maintenance period, in order to affect the liquidity conditions prevailing in the banking sector. These were usually operations with a 2-day or 3-day maturity. As of June 2011, they were supplemented with fine-tuning operations offered at the end of the required reserve maintenance period. These enabled banks to balance their liquidity position over the entire reserve maintenance period.

6 See Kliber and Pluciennik (2011) and Lu (2012) for an evaluation of the effectiveness of POLONIA rate stabilization during the financial crisis.

Table 4. Mean of interbank rate vs. target rate spread post-crisis (in per cent)

COUNTRY	O/N	T/N	1 WEEK	1 MONTH	3 MONTH	3 MONTH BASIS SPREAD
Australia	0.00		0.08	0.16	0.28	0.43
Canada	0.00			0.13	0.19	0.25
Sweden ¹	0.06	0.17	0.26	0.38	0.62	0.47
UK	0.00		0.07	0.13	0.35	0.35
Euro Area	-0.51		-0.44	-0.31	-0.08	0.43
Czech Rep	-0.10		0.09	0.22	0.45	
Poland ²	-0.25		0.32	0.40	0.56	
Hungary	-0.61		-0.01	0.08	0.18	
US ³	0					0.24
Switzerland ⁴	-0.05		-0.03	-0.01	0.02	0.06
Norway ⁵	0.00		0.26	0.46	0.73	
New Zealand	-0.07			0.15	0.19	0.33

Note. The post-crisis period is defined as 1 January 2011 to 31 December 2012. Deviation from explicit operational target is in boldface. See Table 2 for information about the interest rate series used in the table.

1. The overnight rate is from Sveriges Riksbank (2012) for the period 1 January – 31 December 2011.

2. The overnight rate used here is the POLONIA rate.

3. The FRS uses a target range for the fed funds rate of 0 to ¼ per cent. The effective Fed funds rate has been within the target range for the whole sample period.

4. The overnight rate used here is the SARON rate.

5. The overnight rate used here is the NOWA rate and the time period is 1 October 2011 to 31 December 2012.

When evaluating the results presented in Table 3, it should be noted that the ECB is not currently aiming at steering short-term money market rates close to the ECB's policy rate. Especially since the Lehman default in September 2008, the ECB has provided the banking system with ample liquidity by changing to a fixed rate full allotment policy at longer maturities, allowing the overnight-rate (EONIA) to drift down towards the floor of the interest rate corridor.

While the overnight rate is the rate over which the central bank has the most control, this does not mean that it is the only term of interest. Indeed, in most countries the three month rate plays a special role as reference rate and is thus more directly linked to the rates encountered by firms and households. This is the reason why the SNB targets the 3-month LIBOR rate.⁷ For the same reason, the MNB's operating target is to influence interest rates with a maturity of 3 months. While the SNB has a tolerance band for the 3 month Libor, and also states whether it aims for the middle of the band or some other region within the band, the MNB's approach is less formalised. The MNB relies on its main instrument, the MNB bill, having a maturity of two weeks to be long enough for the interest rate on this instrument to sufficiently influence the 3 month interbank and secondary government securities market yields. The SNB's main operations have a maturity of one week. The SNB estimates and corrects for a risk premium and a term premium in order to determine the one week risk-free rate that will yield the desired 3 month Libor rate. This approach makes it possible to take into

⁷ Originally the SNB chose to target the 3 month rate rather than the overnight rate because it needed some flexibility in order to react to exchange rate shocks in the very short run without having to declare a change in monetary policy, see Jordan and Kugler (2004).

account that premiums may vary over time. Meanwhile, the central banks that target the overnight rate rely on the transmission from overnight to three months to be stable, while MNB relies on the transmission from 2 weeks to 3 months to be stable. It is interesting to note that the MNB and SNB have been quite successful at targeting the three month interest rate, both before and during the financial crisis, see tables 2 and 3 respectively. Elevated risk premiums caused the BUBOR 3 month rate to deviate from the MNB's main policy rate late in 2011 and early in 2012, which is reflected in table 4 (see also figure 9 in the appendix).

Since the financial crisis, MNB, NBP and CNB all experienced underbidding in their liquidity draining operations. Banks preferred to keep liquidity buffers in the central bank on an overnight basis, resulting in downward pressure on the overnight rate. SRB has also experienced underbidding. But because the bank conducts fine tuning operations at the end of each day, absorbing overnight funds at the key policy rate less 10 basis points, there has been only limited downward pressure on the overnight rate.

Reducing volatility of money market rates

Most central banks are concerned about excessive volatility in the shortest money market rates. The reason is that the higher the volatility the more blurred will be the signal of the monetary policy stance of the central bank. This kind of thinking is backed up by the empirical study by Carpenter and Demiralp (2011), showing that volatility in the overnight rate leads to higher term premiums in money markets in the US, the UK and the Euro Area. Excessive volatility could also impede the development of money markets since with a volatile overnight rate, investors face heightened liquidity risks that limit their ability to undertake maturity transformation.

Volatility in the overnight rate has been extremely low in Australia and Canada both in normal times and during the financial crisis, as can be seen in tables 5 and 6. RBA and BOC use narrow interest rate corridors of 50 basis points.⁸ In Australia the daily operation performs both the role of steering the overnight rate and of steering liquidity in the system. From a principles based perspective it would be desirable to separate the two tasks (Bindseil (2004)), but based on performance the RBA's approach seems to work extremely well. As mentioned above, the BOC auctions the government's deposits with the central bank in order to maintain the desired level of settlement balances in the system.

⁸ During the period 21 April 2009 – 31 May 2010 the Bank of Canada used a narrower corridor of 25 basis points.

Table 5. Volatility of interbank rate vs. target rate spread pre-crisis (in per cent)

COUNTRY	O/N	T/N	1 WEEK	1 MONTH	3 MONTH
Australia 2001-07	0.01		0.07	0.10	0.17
Canada 2001-07	0.02			0.10	0.19
Sweden 2001-07		0.03	0.05	0.08	0.14
UK 2001-04	0.46		0.20	0.10	0.16
UK 2005-06	0.14		0.05	0.04	0.07
UK 2006-07	0.10		0.06	0.06	0.08
Euro Area 2001-04	0.18		0.08	0.08	0.13
Euro Area 2004-07	0.07		0.05	0.07	0.11
Czech Rep 2002-07	0.15		0.05	0.05	0.12
Poland 2004-07	0.38	0.26	0.10	0.12	0.24
Hungary 2004-07	0.49		0.15	0.11	0.28
US 2001-07	0.10		0.08	0.11	0.19
Switzerland 2001-07	0.13		0.09	0.08	0.10
Norway 2001-07	0.09	0.19	0.14	0.17	0.27
New Zealand 2006-07	0.07			0.07	0.07

Note. The pre-crisis period ends on 8 August 2007. Standard deviation is used as a measure of volatility. The basis spread is generally measured over a shorter time period starting around 2006. See Table 2 for information about the interest rate series used in the table.

To stabilize the overnight rate close to the key policy rate the SRB performs fine-tuning operations at the end of each day, offering to balance the banking system's daily deficit or surplus at the target rate plus/minus 10 basis points. SRB's daily fine-tuning operation is designed explicitly to steer the overnight rate. Overnight funds typically trade at or near the key policy rate. BOE had an arrangement similar to the Swedish fine tuning facility during 2001-04, but this does not seem to have been able to stabilise the overnight rate. Volatility in the one week rate is also quite high, while the volatility at longer terms (1 and 3 months) does not seem especially high in comparison with other countries. According to Tucker (2004), the Bank of England was troubled by the high volatility in the overnight rate, even though at the time it typically did not seem to affect longer-term money market rates. A number of foreign banks and other institutions were reportedly reluctant to participate fully in the sterling money markets because of the volatile overnight rate. Tucker suggests that this might have impeded the development of the sterling overnight index swap (OIS) market. The excessive volatility in the overnight rate made the BOE change its operational framework in 2006 (both frameworks are described in the appendix). This can be contrasted with the positive development of the swap market in Canada during the same period. Among the factors that have contributed to the growth of the OIS market in Canada, Reid (2007) mentions the relative stability and predictability of the overnight rate that resulted in low bid/ask spreads.

Table 6. Volatility of interbank rate vs. target rate spread during crisis (in per cent)

COUNTRY	O/N	T/N	1 WEEK	1 MONTH	3 MONTH
Australia	0.00		0.26	0.21	0.20
Canada	0.02			0.14	0.18
Sweden	0.06	0.17	0.17	0.22	0.25
UK	0.16		0.17	0.32	0.41
Euro Area	0.31		0.37	0.43	0.46
Czech Rep	0.21		0.07	0.22	0.24
Poland	0.57	0.46	0.22	0.17	0.18
Hungary	0.41		0.14	0.12	0.19
US	0.20		0.41	0.43	0.53
Switzerland	0.33		0.25	0.18	0.13
Norway	0.10	0.34	0.30	0.35	0.27
New Zealand	0.13			0.20	0.27

Note. The crisis period is defined as 9 August 2007 to 31 December 2010. Standard deviation is used as a measure of volatility. See Table 4 for information about the interest rate series used in the table.

The ECB introduced some changes to its operational framework in March 2004 that reduced the volatility of the overnight interest rate. In table 5 we can see that volatility in the overnight vs. target rate spread was reduced from 0.18 to 0.07. The ECB wanted to ensure that the volatility in the overnight rate did not reach levels that would blur the monetary policy signalling mechanism, see European Central Bank (2006). A crucial change was to make sure that the maturity of the main refinancing operation did not span a monetary policy meeting. This was done to avoid expectations of a rate change to influence the bidding behaviour in the tender auction. Expectations of a rate decrease had resulted in underbidding, leading to a lack of liquidity in the market which put upward pressure on the overnight rate. Thus a perverse result of a *higher* overnight rate resulted from expectations of monetary policy *easing*. BOE dealt with the same overlap problem in 2005 by instead indexing the operational rate to the policy rate.

The SNB and the MNB try to mitigate volatility in the overnight rate, even though their operational targets have a maturity of 3 months. In the words of the MNB's Erhart (2004): "permanent deviation of overnight rates from the prevailing key policy rate and excessive volatility may increase the degree of fluctuation of longer-term yields as well, which would in turn reduce the efficiency of monetary transmission" (p. 7). The MNB has been gradually reducing the width of the interest rate corridor since 1998, from ± 2 percentage points to ± 1 percentage point, in order to limit the volatility in the overnight rate. The SNB instead intervenes on a discretionary basis in the overnight repo market to influence price-setting in the money market and help to stabilize short-term money market rates.

Table 7. Volatility of interbank rate vs. target rate spread post-crisis (in per cent)

COUNTRY	O/N	T/N	1 WEEK	1 MONTH	3 MONTH
Australia	0.00		0.09	0.10	0.14
Canada	0.01			0.10	0.19
Sweden	0.04	0.10	0.10	0.12	0.20
UK	0.04		0.04	0.08	0.17
Euro Area	0.22		0.24	0.27	0.29
Czech Rep	0.13		0.05	0.03	0.04
Poland	0.31		0.29	0.31	0.35
Hungary	0.24		0.03	0.07	0.15
US ¹	0.04				
Switzerland	0.10		0.08	0.07	0.07
Norway	0.10		0.09	0.16	0.22
New Zealand	0.11			0.07	0.10

Note. The post-crisis period is defined as 1 January 2011 to 31 December 2012. Standard deviation is used as a measure of volatility. See Tables 2 and 4 for information about the interest rate series used in the table.

1. FRS uses a target range for the overnight rate of 0 to ¼ per cent. Therefore, the standard deviation reported is that of the effective Fed funds rate and not the spread.

Underpinning an active money market

The money market is a collective term for markets for interest-bearing assets that are usually issued with maturities of up to one year. According to the ECB's Benoît Coeuré (2012) well-functioning, decentralised money markets are a crucial component of the financial system because of

- their contribution to market efficiency and market discipline
- their impact on financial stability and on financing conditions in the economy at large
- their role as an initial link in the chain of monetary policy transmission.

In the unsecured interbank money market lenders have incentives to collect information about borrowers and to monitor them over the lifetime of the loan. This provides incentives for banks to conduct business in a safe and sound manner.

Money markets are important as a source of bank funding, determining the amount of credit banks can extend and thereby affect the financing conditions faced by non-financial corporations and households. If liquidity in money markets dry up banks may be forced to de-leverage by selling assets. Such forced asset sales can impose externalities on other banks in the system and threaten financial stability.

Short-term interbank money market interest rates are affected by the monetary policy stance of the central bank and serve as benchmark rates for the pricing of other longer-term assets. Well-functioning money markets are therefore essential for a smooth transmission of monetary policy signals to the rest of the economy.

BOC governor Mark Carney (2008) has emphasised the importance of continuously active money markets: "The financial system should have a number

of core markets – including interbank lending, commercial paper, and repo markets for high-quality securities – that are continuously open even under stress”. Indeed, several central banks have actively supported certain segments of the money market during the recent financial crisis. During the crisis a number of central banks, for example the BOE, BOC and SRB, have been reluctant to lower their policy rates to zero because this would risk impairing the functioning of money markets.⁹

In what follows we have divided the money market into four segments:

- the short-term securities market
- the interbank unsecured market
- the short-term secured market
- the short-term derivatives market.

In the following sections we will give examples of how some central banks have helped develop and/or support these market segments.

THE SHORT-TERM SECURITIES MARKET

Central banks have an interest in an active market in government securities for (at least) two reasons. First, the government securities yield curve serves as a benchmark for monetary policy transmission. Although, in several countries the importance of the government yield curve has diminished with the development of deep and liquid markets for derivatives, such as forward rate agreements. Second, for monetary policy implementation purposes the central bank uses high-quality securities, preferably government securities, either purchased outright or accepted in repo operations. Government securities also play an important role as collateral in the central bank’s standing facilities. It has been argued that the acquisition of assets other than government securities could undermine the independence of the central bank, by subjecting it to charges that it has usurped the authority of the government by making independent fiscal policy decisions (Broaddus and Goodfriend (2001)).

In some countries the central bank has been forced to adapt its implementation strategy because of the limited volume of government securities available. This is for example the case in Australia where there is a very small amount of government debt, as can be seen in Table 8. The Australian government initiated a public review on the future of the Commonwealth Government Securities (CGS) market, releasing a discussion paper in October 2002.¹⁰ The review concluded that

9 In the case of the BOE the most important reason for not lowering Bank Rate further seems to have been uncertainty about what would happen to banks’ ability and willingness to lend at low levels of interest rates, according to the Minutes from the March 2009 MPC Meeting.

10 “Review of the Commonwealth Government Securities Market”, Australian Office of Financial Management, October 2002.

thanks to the broadening of the range of securities it accepted in its open market operations the RBA would be able to maintain its capacity to effectively implement monetary policy, even in the face of a further reduced CGS supply. However, the government decided to maintain sufficient CGS on issue to support the Treasury bond futures market. Because of the limited supply of CGS, the RBA will provide a liquidity facility to help banks fulfil the Basel III liquidity standards (we will have more to say about this facility in the section on liquidity insurance below).

As of 30 June 2012, the Australian government has Treasury Notes outstanding of only AUD 13.3 billion, but there is a liquid market for short-term securities issued by banks of AUD 254.3 billion.¹¹ New Zealand is another country with limited government debt in which bank bills is the most commonly traded instrument in the money market. The 90-day bank bill rate is a key benchmark indicator of banks' cost of funds in both New Zealand and Australia. In mid-2007 New Zealand banks were increasingly reluctant to hold other banks' bills. RBNZ responded by accepting bank bills as collateral in its overnight lending facility, in addition to New Zealand government securities. This measure contributed to a recovery in bank bill issuance over the second half of 2007 (Cassino and Yao (2011)).

Table 8. Central government total marketable debt in 2010, per cent of GDP

COUNTRY	% OF GDP	COUNTRY	% OF GDP
Australia	11.0	Canada	35.4
Switzerland	16.6	Poland	46.3
Norway	20.6	Hungary	53.7
New Zealand	26.2	United States	57.6
Sweden	32.0	Euro Area	62.7
Czech Republic	34.8	United Kingdom	78.9

Source: OECD with own calculations for the Euro Area

Other central banks have also intervened to support short-term securities markets during the recent financial crisis. In response to the strains in short-term securities markets that followed the collapse of Lehman Brothers in September 2008, both the BOE and FRS introduced facilities to backstop the commercial paper (CP) market. The BOE's Commercial Paper Facility enabled the purchase of investment grade sterling CP. It aimed to channel funds directly to the corporate sector by purchasing newly issued CP in the primary market as well as purchasing CP after issuance to support the secondary market. Under the Commercial Paper Funding Facility, the Federal Reserve Bank of New York financed the purchase of highly rated unsecured and asset-backed CP from eligible issuers through eligible primary dealers. BOC introduced the Term PRA Facility for Private Sector Money Market Instruments to support Canadian money market participants. It is interesting

¹¹ According to the 2012 Australian Financial Markets Report, Australian Financial Markets Association.

to compare the different approaches of the BOE, FRS and BOC. While BOE directly purchased CP, FRS chose a more indirect way of supporting the market by providing funding and BOC provided liquidity support to money market participants for Canadian dollar money market products, including CP, through a temporary term facility.

Even in normal times there are examples of central banks that have played an important role in fostering short-term securities markets. The ACI-STEP Task Force (2002) identifies that a key success factor for the development of the US and French commercial paper markets was the involvement of the FRS and the Banque de France in the creation and organisation of the market. The Short-Term European Paper (STEP) initiative aims to foster the integration of the European markets for short-term paper through the convergence of market standards and practices. Euro-denominated commercial paper with the STEP label is accepted by the Eurosystem for collateral purposes. However, despite the joint efforts of the Task Force and the ECB “the market for short-term securities has shown only limited signs of integration since the introduction of the euro” (ECB (2011), p. 17). Differences in legal systems and regulatory requirements are identified as the main reason for the lack of progress.

THE INTERBANK UNSECURED MARKET

Deposit transactions among the banks are used to invest temporary surpluses or borrow to cover temporary deficits, usually on an overnight term. An alternative for the banks is to use the central bank’s standing facilities. When considering the width of the standing facilities interest rate corridor, central banks face a trade-off between active trading in the interbank market and control over its balance sheet on the one hand and control of the overnight rate on the other.¹² In Table 1 we can see that the CNB uses the narrowest interest rate corridor of 20 basis points, while NBP uses the widest corridor of 300 basis points.

Some central banks have been involved in launching an overnight reference rate in the interbank unsecured market in order to help promote the development of an overnight indexed swap (OIS) market. The floating leg of an OIS will be the overnight rate. The fixed leg will then reflect the average overnight rate expected to prevail during the term of the OIS. The spread between the 3 month interbank rate and the 3 month OIS rate is a frequently used measure of the risk premium. In order to be successful a reference rate has to be calculated transparently and reflect market conditions realistically. Examples of such efforts are the ECB’s EONIA, NBP’s POLONIA, MNB’s HUFONIA and CNB’s CZEONIA.

¹² See Bindseil and Jablecki (2010) for a formal model of this trade-off.

The unsatisfactory functioning of the Norwegian short-term unsecured interbank market led the NB to make some changes to its operational framework. The ample access and low cost of reserves from the central bank under the floor system led to a poorly functioning redistribution of reserves among the banks.¹³ A new system was implemented on 3 October 2011 with reserves remunerated at the key policy rate only up to a quota. Deposits at the NB in excess of the quota bear interest at a lower rate, the reserve rate. A bank with deposits in excess of the quota will therefore have an incentive to offer the excess in the interbank market.

THE SHORT-TERM SECURED MARKET

The secured market is dominated by the repurchase agreements (repo) market. A repo is an agreement to sell an asset and simultaneously commit to buy it back from the repo counterparty at an agreed price at a future date. The price at which an asset is repurchased is equal to the price at which it was sold plus an amount of interest for the use of the cash. A repo is thus similar to a secured cash loan, except that legal ownership of the assets used as collateral is transferred from the borrower to the lender during the term of the repo.

The repo market is largely an OTC market where prices and volumes are difficult to observe in real time. The largest repo markets are those in the US, UK and Euro Area. Besides these markets, the Swiss and Canadian repo markets are quite well developed.¹⁴ In both the UK and Switzerland the central bank played a major role in establishing an active repo market.

In the mid-1990s the BOE helped create a gilt repo market in the UK. The main objective of introducing a repo market was to enhance the liquidity of the gilt market, making it more attractive to investors and lowering the costs to the government of issuing debt. But more importantly from the perspective of implementing monetary policy, it would enable the Bank to use repos rather than direct purchases of bills in its open market operations. Using outright purchases had become a problem since short-term bills were in short supply. The Bank worked closely with the relevant authorities to make the necessary changes to tax regulations and Stock Exchange rules, and with market practitioners to draw up a master legal agreement for gilt repo transactions and formulate a code of best market practice. In January 1996 the gilt repo market began, and in March 1997 the Bank started conducting daily market operations in gilt repo. In just over a year gilt repo accounted for half of all overnight transactions in the sterling money markets, according to estimates by market participants.¹⁵

13 See Norges Bank (2010).

14 For estimates of the size of the market see Financial Stability Board (2012) and the International Capital Markets Association's survey for June 2012.

15 See "The first year of the gilt repo market" in BOE Quarterly Bulletin, May 1997 and Tucker (2004).

Like the BOE, the SNB concluded in the mid-1990s that a repo market would provide the Bank with a useful instrument for implementing monetary policy. The main instrument used at the time – an FX swap (“Devisenswap”) – had several shortcomings. The SNB was very much involved in developing the electronic repo platform on which the Bank conducts its open market operations. Thus, any bank – including such domiciled abroad – that wanted to have access to the SNB’s operations had to join the repo platform. Monetary policy repos as well as interbank repos are conveniently handled on the electronic trading platform, which is fully integrated with the securities settlement system SECOM and the payments system SIC. Trading on a secured basis on this platform proved to be very valuable in mitigating any adverse effects on money market trading volumes during the recent financial crisis, when limiting counterparty credit risk exposure was a major concern. To give a further boost to the Swiss franc repo market the SNB introduced the Swiss Reference Rates in August 2009. These reference rates are based on data from the secured money market and will provide market participants with clear benchmarks for their liquidity management. The SNB will be able to better monitor developments on the money market, using the Swiss Reference Rates (especially the overnight rate SARON). These new reference rates will help the SNB to optimise interest rate steering operations.

Today the Polish market is in a similar position to where the British and Swiss markets were in the mid-1990s. The repo market is still underdeveloped in Poland because of the legal and tax environment, lack of a widely accepted framework agreement and infrastructure shortcomings.¹⁶ As a result, such markets as unsecured interbank deposits market, buy-sell-back/sell-buy-back market and even FX swap market constitute very important liquidity management instruments for a group of domestic money market participants.

THE SHORT-TERM DERIVATIVES MARKET

Some investors and borrowers in bond markets are, according to their guidelines, only allowed to take positions in markets which enable that market risks can be managed through liquid and otherwise well-developed derivative instruments. Thus, the development of such derivatives markets can be of crucial importance for the liquidity of the overall capital market in a country.

In Table 9 we report recent data on the average daily turnover in derivatives instruments. With the exception of the US and Canada, the FX swaps market has the largest market share. In the US and Canada the interest rate swaps market is the largest market. In the US the market share of Forward Rate Agreements

¹⁶ See Financial System Development in Poland 2010, National Bank of Poland.

(FRAs) is also large compared to the FX swaps market. The options market is small in most countries.

Table 9. Average daily turnover in derivative instruments in April 2010 (in billion US dollars)

COUNTRY	FX SWAPS	FRAS	SWAPS	OPTIONS
Australia	117.5	6.7	33.6	0.3
Canada	33.9	6.5	34.6	0.6
Sweden	29.3	7.0	8.0	3.2
UK	775.4	382.0	738.6	113.9
Euro Area	283.6	77.9	251.8	27.6
Czech Rep	3.8	0.1	0.2	0.0
Poland	5.4	0.8	0.8	...
Hungary	3.1	0.1	0.1	...
US	267.1	268.4	309.3	64.1
Switzerland	182.0	20.1	58.7	0.1
Norway	17.5	3.6	8.4	0.0
New Zealand	6.4	0.8	0.7	0.0

Source: BIS Triennial Central Bank Survey 2010

In most of the countries investigated interest rate derivatives turnover has increased relative to GDP during the period 2001-2010, see Table 10. Based on the average daily turnover relative to GDP, we can distinguish three groups of countries: the financial centres (UK and Switzerland), the developed markets (Australia, Canada, Sweden, Euro Area, US, Norway and New Zealand) and the less developed markets (Czech Republic, Poland and Hungary).

A swap market of special interest to a central bank is the overnight index swap (OIS) market. In an OIS the two parties agree to exchange a fixed rate for a floating rate, where the floating rate is the overnight rate that most central banks use as an operational target. The OIS is predominantly used by market participants for hedging activities, but it can also be used to calculate the market expectations of a future change in policy. Reid (2007) mentions the BOC's adoption of fixed announcement dates for its target rate as one factor that has contributed to the growth of the OIS market in Canada.

Table 10. Interest rate derivatives turnover (daily averages in April in billions of US dollars and as a per cent of GDP)

COUNTRY/YEAR	2001		2004		2007		2010	
	Amount	%	Amount	%	Amount	%	Amount	%
Australia	9.8	1.8	12.8	1.9	22.7	2.8	40.6	4.4
Canada	9.9	1.1	12.1	1.2	20.6	1.6	41.7	3.1
Sweden	3.2	1.3	7.4	2.5	12.3	3.5	18.2	4.9
UK	237.8	14.6	563.0	29.6	957.1	43.9	1234.9	55.6
Euro Area	252.4	3.1	320.3	3.5	377.6	3.4	385.2	3.4
Czech Rep	0.2	0.1	0.6	0.2	0.7	0.3	0.3	0.1
Poland	0.4	0.1	1.0	0.2	2.7	0.4	1.6	0.2
Hungary	0.0	0.0	0.2	0.1	0.8	0.4	0.2	0.1
US	115.7	0.1	317.4	2.7	525.0	3.8	641.8	4.4
Switzerland	9.6	4.1	12.0	4.5	60.7	18.0	78.8	20.8
Norway	2.9	1.7	5.2	2.7	6.6	2.5	11.9	4.3
New Zealand	0.3	0.3	1.3	1.3	2.8	2.3	1.5	1.2

Note. Interest rate derivatives are Forward Rate Agreements (FRA), Interest Rate Swaps and Options.
Sources: BIS Triennial Central Bank Survey 2010 and OECD iLibrary

Providing liquidity insurance

At times, even a well-run bank can suffer an unexpected shortage of liquidity. To mitigate the adverse effects of such a shortage, the central bank provides back-stop liquidity insurance to both individual banks and to the banking system at large. In Table 11 we have divided liquidity insurance into three parts depending on the severity of the liquidity event: (i) standard liquidity insurance, (ii) discretionary liquidity insurance, (iii) emergency liquidity assistance.

STANDARD LIQUIDITY INSURANCE

The most immediate short-term form of standard liquidity insurance is the central bank's standing facilities for lending funds overnight. These can help banks cope with frictions in the interbank market. As the recent financial crisis showed, banks are inclined to reduce not only the amount of funding they are willing to provide, but also the term of that funding. Faced with pressures in funding markets, resulting in a shortening of the terms at which funding is available, the central bank may have to provide funding at longer terms than overnight to more directly backstop the provision of maturity transformation to the economy.

All of the central banks in our study offer a standing overnight borrowing facility to cope with frictions in the interbank market. RBNZ temporarily extended the term on its borrowing facility (Overnight Reverse Repo Facility) from overnight to up to a term of at most 30 days, during the worst phase of the financial crisis. The FRS likewise increased the maximum maturity of primary credit loans to 90 days during the most acute phase of the crisis.

Table 11. Permanent liquidity insurance schemes provided by central banks

CENTRAL BANK	STANDARD LIQUIDITY INSURANCE		DISCRETIONARY LIQUIDITY INSURANCE	EMERGENCY LIQUIDITY ASSISTANCE
	o/n	term		
RBA	Standing Facility	Daily OMOs	Committed Liquidity Facility	At the RBA's discretion
BOC	Standing Liquidity Facility		Par. 18 exceptional transactions	At the BOC's discretion
SRB	Standing Facility			At the SRB's discretion
BOE	Operational Standing Facility	Indexed Long-Term Repos	ECTR and DWF*	When authorised by Treasury
ECB	Standing Facility	LTRO**		At national CB's discretion
CNB	Standing Facility	2-week repo		At the CNB's discretion
NBP	Standing Facility			At the NBP's discretion
MNB	Standing Facility			At the MNB's discretion
FRS	Primary Credit Facility		Secondary Credit Facility	At the Board of Gov's discretion
SNB	Liquidity-Shortage Financing Facility			At the SNB's discretion
NB	D-loans	F-loans	Extraordinary F-loans and FX-swaps	When authorised by Treasury
RBNZ	Overnight Reverse Repo Facility	Daily OMOs		At the RBNZ's discretion

* Extended Collateral Term Repo (ECTR) and Discount Window Facility (DWF).

** Long-Term Refinancing Operations (LTRO).

Longer-term repos or lending against a widened pool of collateral was used to provide liquidity support during the recent financial crisis by most of the central banks studied. But in most cases the facilities used were only temporary measures. By contrast, the BOE have included these types of facility as a permanent feature of its Sterling Monetary Framework. In the *Indexed Long-Term Repo (ILTR)* facility, the BOE has incorporated long-term repo operations against a narrow and a broader range of collateral. These are offered monthly for a 3 or 6 month term. A greater proportion of funds can be allocated to the broader range of collateral as evidence of stress in the market increases.

In addition to the weekly Main Refinancing Operations with a 1 week term, the ECB offers monthly Longer-Term Refinancing Operations (LTROs) with a 3 month term. The LTROs were introduced to give smaller banks with limited access to the interbank market a convenient source of longer term financing. In 2002 the ECB proposed to suspend the LTROs in order to simplify the operational framework. However, after consulting with the banks, the ECB decided not to suspend the LTROs. The banks were of the view that LTROs are a key element of credit

institutions contingency plans for times of market stress and that they continue to be relevant in providing finance to smaller counterparties, see ECB (2003).

The CNB offers liquidity providing repo operations with a two week maturity. These repos are offered once a week. The banks' bids are fully satisfied at a fixed rate corresponding to the key policy rate plus 10 basis points. Liquidity providing measures were introduced in October 2008 to support the domestic financial market during the financial crisis.

The flexibility of the RBA's system of open market operations proved to be a blessing when the global financial crisis started to have adverse effects on liquidity in Australia's financial markets. Since the RBA use repos with variable terms in its daily open market operations, the Bank could quickly increase the maturities of its daily open market operations in order to address the pressure on term money market spreads during the financial crisis. These increased maturities were aimed at enhancing liquidity in the term money market. The RBNZ's system of open market operations is very similar to the RBA's and provides the same degree of flexibility. The NB's use of open market operations are also quite flexible with regard to maturities and can serve as liquidity insurance at terms longer than overnight.

DISCRETIONARY LIQUIDITY INSURANCE

The type of liquidity insurance discussed in this section may in principle be available at any time, but use of the facility is at the discretion of the central bank. Typically a wider set of collateral will be acceptable. Five of the central banks in our study use some form of discretionary liquidity insurance as a permanent feature of their operational framework. Other central banks have used temporary measures during the financial crisis that could be reinstated in the event of a new crisis.

Because of the limited amount of government debt in Australia, RBA will offer a *Committed Liquidity Facility (CLF)* from 1 January 2015 which will ensure that participating banks have enough access to liquidity to respond to an acute stress scenario, as specified under the Basel III liquidity standard. The CLF will enable participating banks to access a pre-specified amount of liquidity against a fee by entering into repurchase agreements of eligible securities outside the RBA's normal market operations. To be eligible for the facility, a bank must first have received approval from the Australian Prudential Regulation Authority (APRA) to meet part of its liquidity requirements through this facility.

The BOC may engage in *exceptional transactions* under Paragraph 18(g)(i) of the Bank of Canada Act either

- for purposes of addressing a situation of financial system stress that could have material macroeconomic consequences, or

- for purposes of implementing monetary policy where the Bank considers such transactions appropriate to reinforce a conditional commitment to maintain the overnight rate at a low level.

In buyback transactions for these purposes, the Bank may expand the range of securities and instruments that it will buy and sell beyond Government of Canada bonds and treasury bills. Under Paragraph 18(g)(ii) the BOC can buy and sell any securities and other financial instruments where the Governor is of the opinion that there is severe and unusual stress on a financial market or the financial system.

In the BOE's *Extended Collateral Term Repo (ECTR)* facility a wider set of collateral is accepted compared to the Indexed Long-Term Repo facility. The ECTR is a contingency facility that the BOE can activate when it deems this to be appropriate. Swapping government bonds for less liquid private debt securities is another way for the BOE to provide liquidity insurance. In the BOE's *Discount Window Facility (DWF)* banks can borrow gilts against a wide range of collateral and for a longer period, normally a 30 day term. The gilts can then be used as collateral to obtain reserves in the money market. By supplying gilts rather than reserves directly the scheme does not affect the liquidity of the banking system.¹⁷

The FRS' Secondary Credit Facility provides a backup source of funding on a short-term basis, or to facilitate an orderly resolution of serious financial difficulties, for banks that do not qualify for the Primary Credit Facility (only generally sound institutions are eligible to borrow primary credit). The credit facilities are administered by the individual Federal Reserve banks.

In granting F-loans the NB can approve other types of collateral, or waive the requirement that collateral must be furnished, for financial stability reasons or to prevent an undesirable increase in short-term money market rates. These types of *extraordinary F-loan* can be used in situations where it is evident that liquidity problems are of a short-term nature and are not due to more fundamental problems.

During the financial crisis, starting on 7 November 2008, the RBNZ offered a Term Auction Facility (TAF) on Wednesdays instead of its normal daily open market operations at 9:30am. The TAF was essentially a term reverse repo with terms of approximately 3, 6 and 12 months and all RBNZ approved securities were acceptable as collateral. At its discretion the RBNZ could implement the TAF again if there was another crisis. Also on 7 November, the RBNZ introduced Reserve Bank Bill tenders. These were used, as required, to withdraw cash from the banking system and sterilise, either partially or fully, the cash injected via the TAF to maintain settlement cash at an appropriate level.

¹⁷ See Clews, Salmon and Weeken (2010) for more details. The BOE's framework for providing liquidity to the banking system has recently been reviewed by Winters (2012).

During the financial crisis the ECB has been engaged in direct purchases of assets through its Covered Bond Purchase Programme (CBPP) announced in May 2009 and its Securities Markets Programme (SMP) announced in May 2010. The aim of the CBPP was to revive the market, which had virtually dried up. The objective of the SMP was to address the malfunctioning of public and private debt securities markets and restore an appropriate monetary policy transmission mechanism. The SMP was replaced by the Outright Monetary Transactions (OMT) programme in September 2012. The new programme is potentially unlimited but comes with tough conditions attached.

EMERGENCY LIQUIDITY ASSISTANCE

For individual banks that face liquidity events with potentially systemic implications the central bank will take on the role of lender of last resort and provide *Emergency Liquidity Assistance* (ELA) against adequate collateral. Typically any type of collateral will be acceptable as long as the solvency of the bank is not an issue. When a bank has reached the point of needing a loan of last resort most of the bank's good collateral may already have been used. The remaining unencumbered assets are likely to be some part of the bank's loan book or some physical asset of the bank. The central bank can ensure adequate protection for its liquidity provision by setting an appropriately sized (generally large) haircut.

All of the central banks in our study perform the function of Lender of Last Resort (LOLR) by giving Emergency Liquidity Assistance (ELA) to a bank facing a liquidity event that could have severe effects on the financial system. The bank receiving the liquidity assistance should be judged to be solvent. In addressing the question of solvency the central banks would seek the advice of the bank regulator, in the case that bank regulation is not performed by the central bank.

In the case of the BOE, FRS and NB the Treasury (Ministry of Finance) seems to play a relatively more important role in deciding on offering ELA. But even if ELA is given at the discretion of the central bank, which is the case for most of the banks surveyed, close coordination with the Treasury is expected, even if not explicitly required.

In the UK a decision whether or not to extend ELA in any particular case, and on what terms, is at the discretion of the authorities (the BOE, HM Treasury and Financial Services Authority (FSA)) acting under the framework of the Tripartite Memorandum of Understanding (MoU).¹⁸ According to the MoU the ultimate

¹⁸ In April 2013 the FSA will be replaced by the Prudential Regulation Authority (PRA) and the Financial Conduct Authority (FCA). The former will be part of the BOE while the latter will be a separate institution. The Financial Policy Committee within the BOE will be able to make recommendations and give directions to the PRA and the FCA on actions that should be taken in order to protect and enhance the stability of the financial system. See Murphy and Senior (2013) on the institutional and functional changes made at the BOE.

responsibility for authorisation of support operations rests with the Chancellor (Finance minister). Traditional ELA has been complemented by the BOE's Discount Window Facility (DWF), since liquidity support is now available on demand provided the bank meets the conditions of the DWF. ELA may be used if those conditions cannot be met.¹⁹

NB extends loans on special terms (S-loans) to individual banks only in situations in which financial stability may be threatened without such support. If the financial regulator discovers potential liquidity and solvency problems it shall inform Norges Bank. In case of solvency problems, the Government Bank Insurance Fund shall also be informed. In most cases though, a decision about an S-loan must first be submitted to the Ministry of Finance.²⁰

Section 13(3) of the Federal Reserve Act empowers the Board of Governors of the Federal Reserve System to extend emergency liquidity assistance. It was under this emergency lending authority that, on 16 September 2008, the Federal Reserve acted to provide temporary liquidity to the American International Group, Inc. (AIG). However, with the passing of the Dodd-Frank Act in 2010 the FRS' lending powers under 13(3) have been curtailed. The new legislation prohibits the FRS from engaging in rescues of an individual corporation, such as in the case of AIG. In future the 13(3) authority can be used to provide liquidity assistance to a "participant in any program or facility with broad-based eligibility". However, such a program or facility cannot be established without the prior approval of the Secretary of the Treasury.

Conclusions

In this chapter we have studied the monetary policy operational frameworks of a dozen central banks. The experiences of other central banks could throw some additional light on the possibilities to improve the Riksbank's operational framework that we identified in chapter 1. We discuss these possibilities in light of the international experience in what follows.

COMMUNICATING THE CENTRAL BANK'S OPERATIONAL TARGET

The Riksbank's operational target is formulated as an aim to keep the overnight rate as close as possible to the key policy rate – the *repo rate*. Similarly formulated operational targets are used by the National Bank of Poland and Norges Bank. NBP aims to keep POLONIA as close as possible to the *reference rate*, while NB wants to ensure that the short-term money market rate remains close to the *sight deposit rate*. The Reserve Bank of Australia, the Bank of Canada, the Federal

¹⁹ The BOE's use of ELA during the recent financial crisis has been evaluated by Ian Plenderleith (2012).

²⁰ See Gerdrup (2005).

Reserve System and the Swiss National Bank instead announce an explicit target for a market rate with a specific term. RBA and FRS announce a target for the interest rate on overnight unsecured loans between financial institutions. BOC announces a target for the interest rate on collateralized overnight transactions. SNB announces a target range for the 3 month Libor rate, as well as an indication of where within that range the 3 month interest rate should be. The other central banks in our study do not announce an explicit operational target.

The question is if it is optimal to formulate an operational target in terms of an interest rate used in open market operations or standing facilities. Why should the operational target be tied to a certain type of operation or facility? Instead, announcing a target for a market rate with a specific term leads to clearer communication compared to involving a policy rate tied to a specific open market operation or a standing facility.

WIDTH OF THE INTEREST RATE CORRIDOR

The Riksbank uses an interest rate corridor with a width of 150 basis points. The rate on the lending facility equals the repo rate plus 75 basis points and the rate on the deposit facility equals the repo rate minus 75 basis points. The Executive Board of the Riksbank usually decides to change the repo rate in increments of 25 basis points. Because of the wide corridor relative to the incremental changes in the repo rate, the Riksbank's operational framework cannot ensure that the overnight rate moves in the right direction following a repo rate change. Meanwhile, this has not proved to be a problem thus far.

It is interesting to note that the two central banks with the best track record in achieving their operational targets, including mitigating volatility around those targets, have both used a narrow corridor system with a width of 50 basis points for the whole period studied here. In Australia overnight loans are traded at the RBA's target rate by convention, with only a few exceptions during the past few years. In Canada the overnight rate also trades very close to the BOC's target rate. The benefit of a narrow corridor for containing volatility is nicely illustrated in Figure 6 in the appendix. The Bank of England's new averaging system worked very well until the financial turmoil started in August 2007. At that time the overnight rate was able to deviate widely from the middle of the corridor. In 2009 the BOE introduced a narrower 50-basis point wide corridor with the introduction of the Standing Operational Facilities along with the Discount Window Facility, with the purpose of de-stigmatising the use of the lending facility.

A narrow corridor makes it easier for the central bank to keep the overnight rate within certain boundaries formed by the corridor rates. A narrow corridor also mitigates the adverse consequences of frictions in the interbank market, when a bank may have to use the central bank's lending facility because another bank has

refused it an overnight loan. The stigma associated with using the lending facility should be smaller the narrower the corridor is. In the case of the Bank of England, the Bank has made it clear that the new narrower corridor should be used when there are frictions in the interbank market and there should be no stigma attached to it.

LOW VOLATILITY IN THE SHORTEST MONEY MARKET INTEREST RATES

Low volatility in the shortest money market interest rates facilitates a clear monetary policy. Stable formation of the very shortest money market rates at the very short term constitutes a necessary though not sufficient anchor to stabilize interest rates at longer maturities. This is an important reason why most central banks have chosen to target the overnight rate. Even central banks like the MNB and the SNB, that have successfully targeted an interest rate with a term longer than overnight, still have to stabilize the overnight rate.

In most countries pricing of interest rate instruments are based on the overnight interest rate. In Sweden on the other hand, interest rate instruments are based on the tomorrow next interest rate. This means that in Sweden the tomorrow next interest rate has a direct link to other interest instruments and the formation of interest rates in other sub markets. A simple lesson learned from this is that other central banks target the overnight interest rate that serve as a base for the pricing of other interest instruments, while the Riksbank lacks a framework for stabilizing the tomorrow next interest rate that serves as base for interest instruments in the Swedish market.

AN ACTIVE MONEY MARKET

As we have noted previously, an active money market is essential for the transmission of overnight interest rate to interest rates with longer maturities to work satisfactorily. The main lesson learned from the operational frameworks of other central banks in this area is that central banks played a significant role in promoting the development of money markets in their respective currency areas.

For example, the BOE and the SNB were instrumental in creating repo markets that could be used for the central bank's open market operations. In the Swiss interbank market monetary policy repos and interbank repos are handled on the Eurex Zurich Ltd. repo platform, which is fully integrated with the securities settlement system and the payments system. This means that collateral can easily be used for dealing with either the central bank or with another bank. Such a flexible collateral management system would have been very useful also in other countries during the recent financial crisis, when secured lending was the preferred choice by banks.

Another way for central banks to promote the development of money markets is to compute and publish transaction-based rates for the maturities overnight and tomorrow next. For example, the ECB and the central banks of Poland, Hungary and Switzerland, helped pave the way for the development of markets for overnight index swaps (OIS) by launching transactional reference rates for the maturity overnight. OIS rates are useful for central banks as a measure of the market's monetary policy expectations. They are also important for central banks to assess the implementation of monetary policy and the performance of the interbank market and the monetary policy framework.

CRISIS MANAGEMENT PREPAREDNESS

A central bank naturally has to be prepared to handle the liquidity needs of financial institutions during a financial crisis. The question is to what extent these types of facilities should be a permanent part of the central bank's operational framework. The Riksbank has dismantled all extraordinary facilities and rely on being able to reintroduce them at short notice. In contrast, some other central banks use some form of discretionary liquidity insurance as a permanent feature of their operational framework.

The BOC, BOE and FED offer facilities that provide funds at longer maturities and/or against a wider set of collateral. The BOE's *Extended Collateral Term Repo (ECTR)* facility is a contingency facility that the BOE can activate when it deems this to be appropriate. Swapping government bonds for less liquid private debt securities is another way for the BOE to provide liquidity insurance: In the BOE's *Discount Window Facility (DWF)* banks can borrow gilts against a wide range of collateral and for a longer period, normally a 30 day term. The gilts can then be used as collateral to obtain reserves in the money market.

Further examples are provided by the NB and the RBA. In case of need NB may provide funds at longer maturities by adapting existing instruments (F-loans) used in day-to-day liquidity management. In view of the short supply of government securities in Australia, the RBA will offer a facility to help banks meet the Basel III liquidity standard from 1 January 2015.

We note that central banks differ in how far they have gone in making the facilities for providing liquidity in a crisis permanent. How to ensure that the central bank has preparedness to handle a financial crisis without reducing the incentives for commercial banks to manage their risks on their own is a big challenge.

Appendix: Descriptions of operational frameworks

Australia

The Reserve Bank of Australia's operational target is an announced target for the interest rate on overnight, unsecured loans between financial institutions.

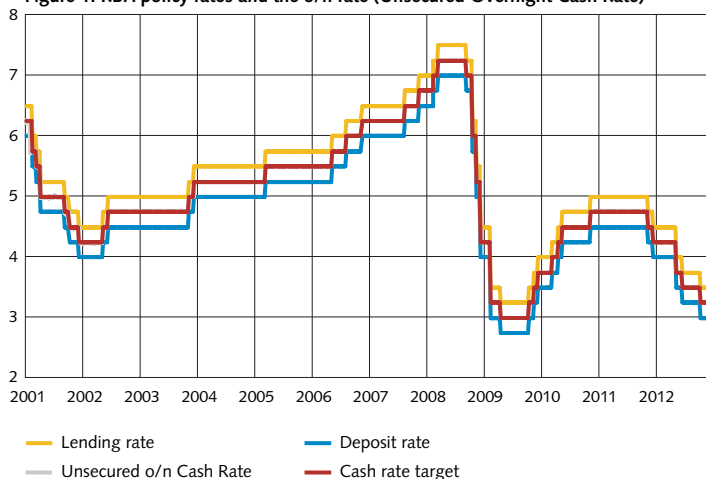
Daily buffers at the individual bank level are offered in the form of standing facilities. Counterparties can obtain funds on a secured overnight basis at 25 basis points above the target overnight rate. Positive balances are remunerated at 25 basis points below the target overnight rate, so banks try to minimise their excess reserves at the RBA. Thus, there is a 50 basis points wide interest rate corridor with the target overnight rate in the middle.

As a rule, the RBA manages its balance sheet so that there is a system cash deficit each day, which means that the Bank has to supply funds on a daily basis to its counterparties. Market operations are conducted primarily through repos. Occasionally, market operations include outright securities transactions and foreign exchange swaps.

The RBA aims to have repos unwind on days when autonomous factors are injecting liquidity (or withdrawing only a small amount). Two or three preferred terms are published in connection with the RBA's morning operation, usually with terms between overnight and 30 days. Subject to liquidity management constraints, allocations across the preferred terms are made on the basis of the relative value of bids.

A second round of market operations can be undertaken in the event that banks' exchange settlement balances fall low enough that there is upward pressure on the overnight rate. However, second rounds are used only occasionally (four times in the last financial year).

Figure 1. RBA policy rates and the o/n rate (Unsecured Overnight Cash Rate)



Canada

The Bank of Canada's (BOC) target for the overnight interest rate refers to the rate on collateralized, market-based overnight transactions, with the Canadian Overnight Repo Rate Average and the overnight money market financing rate used as proxies.

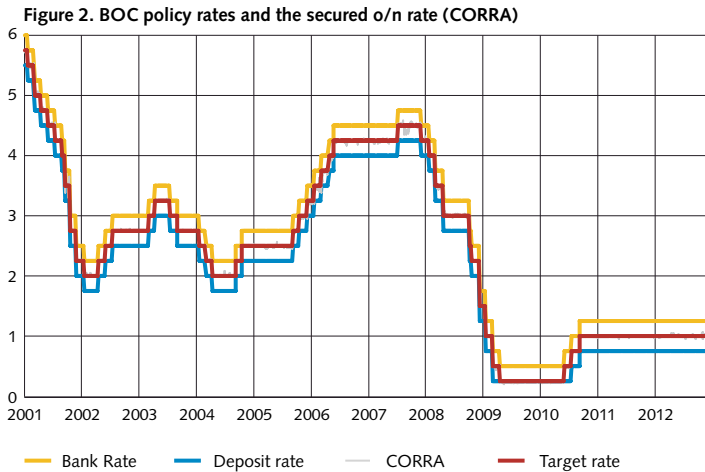
Daily buffers at the individual bank level are offered in the form of standing facilities. Counterparties can obtain funds on a secured overnight basis at 25 basis points above the target overnight rate (*Bank Rate*). Positive balances are remunerated at 25 basis points below the target overnight rate. Thus, there is a 50 basis points wide interest rate corridor with the target overnight rate in the middle.

A unique feature of the BOC's system is the auction of government deposits at the Bank. These Receiver General auctions are intended to neutralise the net impact of any public sector flows between the Bank's balance sheet and that of the financial system in order to maintain the desired level of settlement balances in the system. Auctions are held twice daily, the first at 9.15 and the second at 16.15. The morning auction is largely secured and has broader participation. The afternoon auction is for payment system participants only and is unsecured.

The Bank monitors the overnight market and will offer repos or reverse repos at the target rate to reinforce the target, if market conditions warrant. This occurred on 72 days per year, on average, during January 1999-January 2008 (Engert et al (2008)). If the Bank intervenes it will usually do so at 11.45, since a large proportion of daily funding activity occurs in the morning. This is just intraday liquidity as the Receiver General auction in the afternoon is adjusted for any injection or withdrawal.

After the payments system is closed for client business at 18.00, payment

system participants have an additional half hour in which to transact with each other. This clearing of balances is mostly unsecured and will typically be done at rates close to the target rate. The Bank targets a small positive amount of settlement balances in order to alleviate transactions costs and other frictions from the end-of-day process.



Sweden

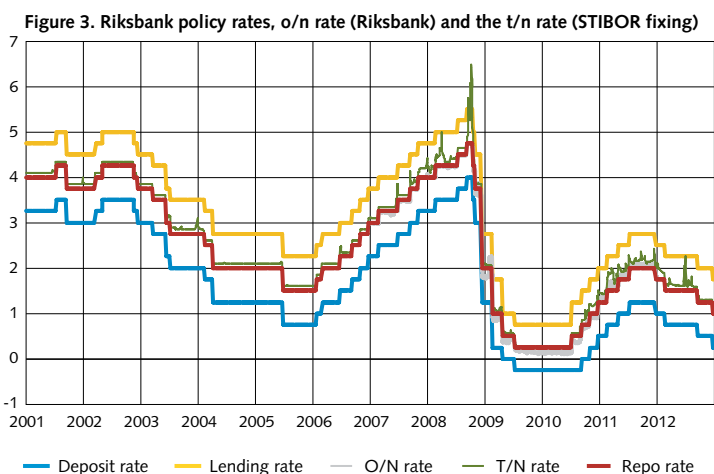
The Riksbank aims to steer the overnight rate to be close to its *repo rate* – the rate at which it conducts its weekly market operations – and thereby influence short-term market rates.

Positive balances that remain on settlement banks' accounts at the Riksbank when the payment system closes for the day will automatically be swept into the lending facility and receive a remuneration overnight equal to the repo rate less 75 basis points. Negative balances will be swept into the borrowing facility subject to a penal rate at 75 basis points above the repo rate. The National Debt Office is not allowed to maintain negative balances at the close of the payment system, while positive balances maintained overnight at the Riksbank will not be remunerated. Hence, the Debt Office will always balance its account at the end of the day.

To encourage the banks to agree on overnight rates close to the repo rate, the Riksbank stands ready to conduct fine-tuning operations every afternoon just before the payment system closes. In these operations the Riksbank offers credit against collateral or overnight deposits at an interest rate equal to the repo rate plus/minus 10 basis points respectively. The aim of fine-tuning is to balance the banking system's liquidity position towards the Riksbank by lending out funds so that the banking system can cover its deficit or deposit a surplus. The size of the

amount lent or received by the Riksbank thus depends on the banking system's position towards the Riksbank at that point in time.

Since 2001, when the Riksbank divested its portfolio of Swedish securities, almost all of the Riksbank's income has been in foreign currency, while almost all of its costs has been in Swedish kronor. Consequently, the banking system's deficit towards the Riksbank has shown a decreasing trend, meaning that the size of the weekly repo transactions with a term of one week have decreased since 2001. Instead, as of February 2010, the banking system has a liquidity surplus, which the Riksbank offers to drain through the weekly issue of one-week Riksbank certificates.



United Kingdom 2001-2006

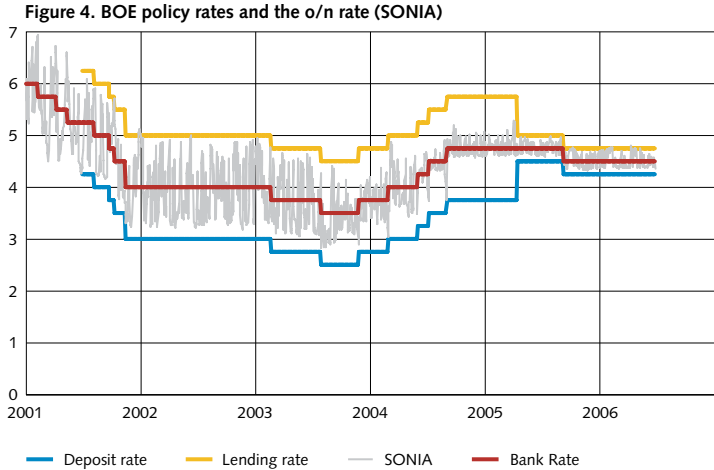
There is no mention of an operational target in the Bank of England's "Red book" of May 2002. The primary aim is described as implementing the MPC's interest rate decisions while meeting the liquidity needs of the banking system. In the Bank's Quarterly Bulletin the overnight rate (SONIA), as well as the two-week and one-month interbank rates are the focus of attention when reviewing the Bank's OMOs.

Settlement banks are obliged to maintain a minimum balance of zero on their non-interest bearing Bank of England (BOE) settlement accounts at the end of each day (or pay a penal rate). The BOE provides the liquidity needed by the banking system to achieve positive end-of-day balances on these accounts.

The BOE manages its balance sheet in such a way that its counterparties (settlement banks and others) will normally seek refinancing from it on a daily basis. This refinancing is usually conducted via repo transactions with a maturity of two weeks, although counterparties have the choice of obtaining liquidity by

an outright sale of bills to the Bank (discounted at the repo rate). There are two principal rounds of operations, one at 9.45 and another at 14.30. Sometimes there are further operations later in the afternoon designed to square off any remaining imbalances in the banking system, usually at a penal rate of interest. If there is a forecast remaining shortage at 15.30 the Bank will offer overnight repos at 100 bp above the repo rate (25 bp after 14 March 2005). These repos were not of the type or quantity associated with a lending facility found in a corridor system. At 15.30 the BOE also makes available a daily overnight deposit facility at 100 bp (25 bp) below the repo rate.

There is also a late repo facility at 16.20 p.m., made available to settlement banks, should there be a remaining liquidity shortage at the end of the day. If this liquidity shortage reflects a late revision to the day's forecast shortage by the BOE, or is due to an unexpected late Exchequer cash surplus, funds will be provided at the repo rate. However, if the late shortage is not due to one of these causes, then funds are provided at a higher rate, normally 150 bp above the repo rate. No bank is permitted to apply for more than the amount of the residual shortage.



United Kingdom 2006 – present

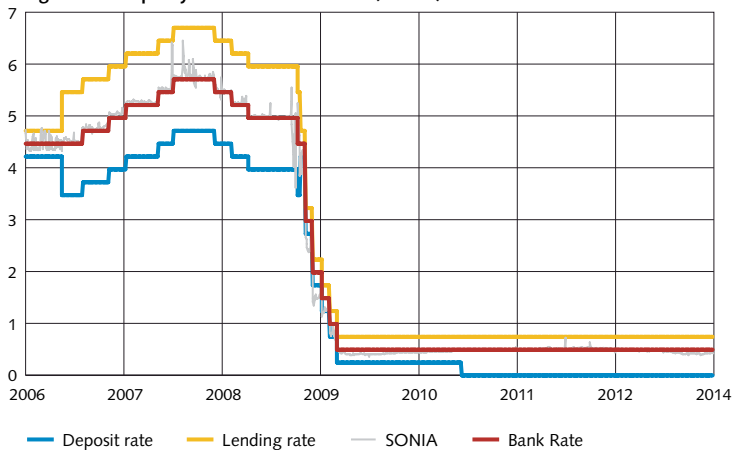
The Bank of England (BOE) manages its balance sheet with the objective of maintaining overnight market interest rates in line with *Bank Rate*, which is decided by the Monetary Policy Committee (MPC). There should be a flat risk-free money market yield curve to the next MPC decision date, with very little volatility in market interest rates at maturities out to that horizon.

For each reserves maintenance period, which runs from one MPC policy decision to the next, the MPC sets the reserves remuneration rate (*Bank Rate*) and in normal times each scheme participant sets a target for the average amount

of reserves they will hold. The possibility of arbitrage between market rates and reserves remunerated at Bank Rate is the main mechanism through which market rates are kept in line with Bank Rate. Even on the final day of a maintenance period a bank can vary its reserves holdings but still be remunerated at Bank Rate, so long as its average for the period remains within a specified target range. In normal times average reserves outside the target range attract a charge. But a bank can avoid that charge by making use of the BOE's Operational Standing Facilities (OSF). OSF allow banks to borrow overnight from the BOE at 25 bps above Bank Rate, or to deposit reserves overnight at 25 bps below Bank Rate (at the moment 50 bps below). These facility rates act as a ceiling and a floor for the interbank overnight rate. However, since 5 March 2009 the voluntary reserves scheme has been suspended and BOE remunerates all reserves at Bank Rate, de facto using a floor system.

In normal times, the BOE would supply, in aggregate, the reserves that banks need to meet their collective targets. One week operations were undertaken weekly and an overnight fine-tuning operation was undertaken on the final day of the maintenance period if required. After 5 March 2009 there is no need for these one week operations, since the banking system has ample liquidity due to BOE's asset purchases financed by the creation of reserves.

Figure 6. BOE policy rates and the o/n rate (SONIA)



Euro Area

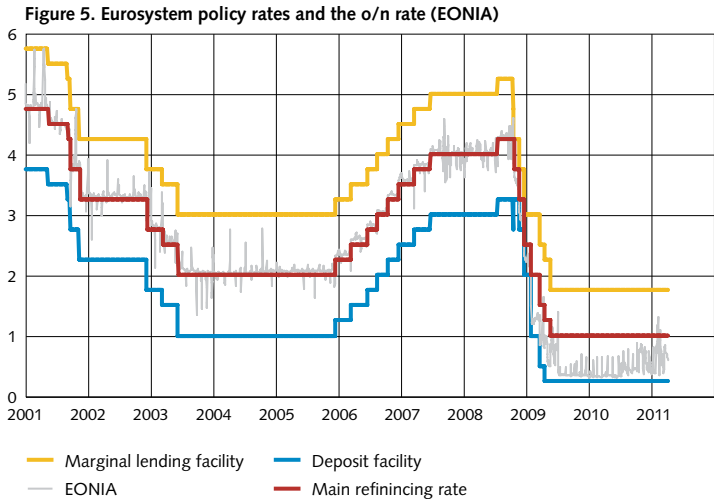
The Eurosystem does not have an explicit operational target. In the Monthly Bulletin focus is on the overnight rate EONIA, but also on 1, 3 and 12-month EURIBOR.

Credit institutions are required to hold minimum reserves on accounts with the national central banks. Reserves are remunerated at the rate on the Eurosystem's

main refinancing operations. The reserve base is defined in relation to elements of the institution's balance sheet on a date prior to the start of the maintenance period. Reserve requirements should be met on average over a period that runs from (the Wednesday after) one monetary policy meeting to the (Tuesday after the) next. The main purposes are to stabilise money market interest rates and maintain a structural liquidity shortage.

The main refinancing operations are liquidity-providing reverse transactions with a one week term conducted with a weekly frequency. In normal times these are usually executed in the form of variable rate tenders with a minimum bid rate, while currently a fixed rate full allotment policy is applied. The main refinancing rate sends a signal about the monetary policy stance of the Eurosystem. In normal times the aim is to provide counterparties with just enough liquidity to enable them to meet their reserve requirements. This often calls for a fine-tuning operation to be conducted at the end of the maintenance period. When deciding on the benchmark allotment in the weekly operations the Eurosystem has to take into account the liquidity provided in the three-month refinancing operations, which are conducted on a monthly basis (and possibly other operations). These operations are not intended to send a signal about the monetary policy stance, so they are in normal times executed in the form of variable rate tenders without a minimum bid rate (now: fixed rate full allotment).

Daily buffers at the individual bank level are offered in the form of standing facilities. For a long period, the width of the corridor was 200 basis points. Currently, it is only 75 basis points wide, with a deposit interest of zero basis points.



Czech Republic

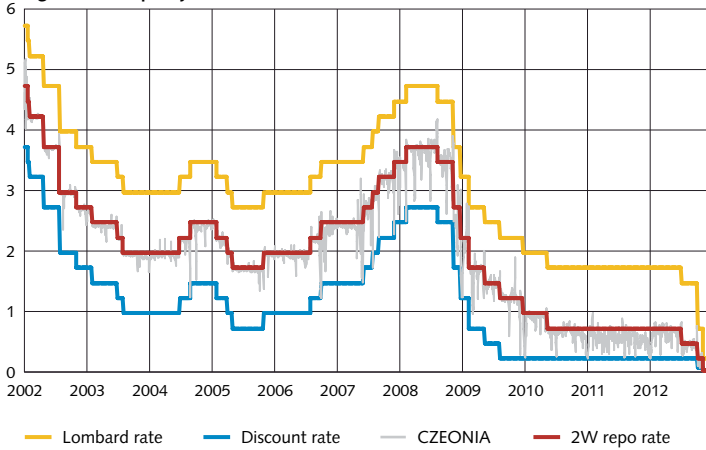
The Czech National Bank (CNB) does not have an explicit operational target. However, the CNB financial market operations are aimed at steering short-term interest rates on the interbank market.

The key policy rate is the *two-week repo rate*. Repos with a maturity of two weeks are announced three times a week. Owing to the structural liquidity surplus in the banking sector, two-week repo tenders are currently used exclusively for absorbing liquidity. The CNB conducts variable rate tenders with the declared repo rate as the maximum bid rate. Repos with shorter maturities are executed from time to time if needed. The allotment procedure follows a multiple rate (American) auction. The CNB also offers a liquidity providing repo once a week, with a 2 week term, with full allotment at the key policy rate plus 10 basis points.

Daily buffers at the individual bank level are offered in the form of standing facilities – the marginal lending facility and the deposit facility. Counterparties can obtain funds via an overnight repo at the *Lombard rate* – in normal times 100 basis points above the two-week repo rate. Deposits are remunerated at the *discount rate* – in normal times 100 basis points below the two-week repo rate. Thus, normally there is a 200 basis points wide interest rate corridor with the main policy rate in the middle. However, on 2 November 2012 the two-week repo rate and the discount rate were both lowered to 0.05 per cent and the Lombard rate was lowered to 0.25 per cent, resulting in a very narrow corridor of only 20 basis points.

Credit institutions are required to hold minimum reserves on accounts with the central bank. Reserves are remunerated at the two-week repo rate. The reserve base is the volume of banks' primary liabilities with maturity up to two years. The reserve requirements should be met on average over a reserve maintenance period of approximately one month.

Figure 7. CNB policy rates and the o/n rate (CZEONIA)



Poland

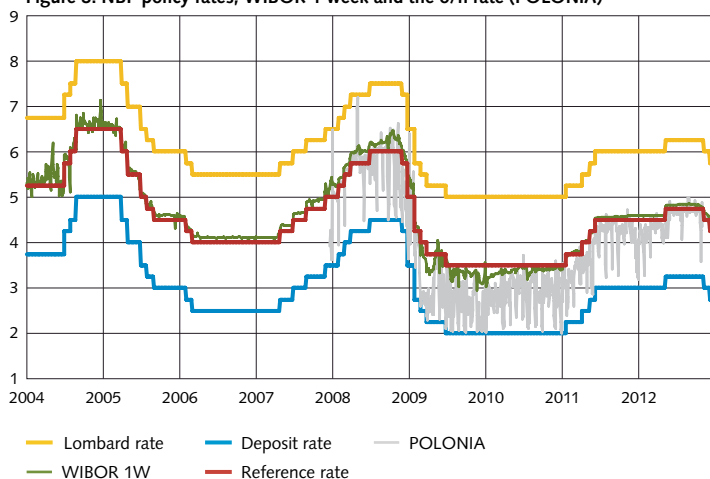
The operational target of the National Bank of Poland (NBP) was changed from a weekly rate to the overnight rate – the POLONIA rate – starting in 2008. The change was due to the rise in the share of overnight deposits in the total turnover of the interbank market. NBP aims to keep POLONIA as close as possible to the main policy rate – the *reference rate*.

The NBP is regularly draining liquidity since the banking sector is in a liquidity surplus vis-à-vis the central bank – mainly due to the inflow of EU funds and the conversion of those funds at the NBP. Hence, NBP conducts open market operations in the form of issues of 7-day NBP bills. These are offered in weekly auctions at a fixed rate at the level of the NBP reference rate. The NBP also conducts fine tuning operations at other terms if needed, to provide or absorb liquidity through short-term repos or NBP bills respectively.

Overnight the NBP provides standing facilities in the form of a marginal lending (Lombard) facility and a deposit facility. The *Lombard rate* is 150 basis points above the reference rate and the *deposit rate* is 150 basis points below the reference rate. Thus, there is a 300 basis points wide interest rate corridor around the reference rate.

Credit institutions are required to hold minimum reserves on accounts with the central bank. Reserves are remunerated at 0.9 of the NBP's rediscount rate, which in practice means that required reserves have been remunerated at least 10 basis points below the reference rate. Reserves should be met on average during a one month maintenance period.

Figure 8. NBP policy rates, WIBOR 1 week and the o/n rate (POLONIA)



Hungary

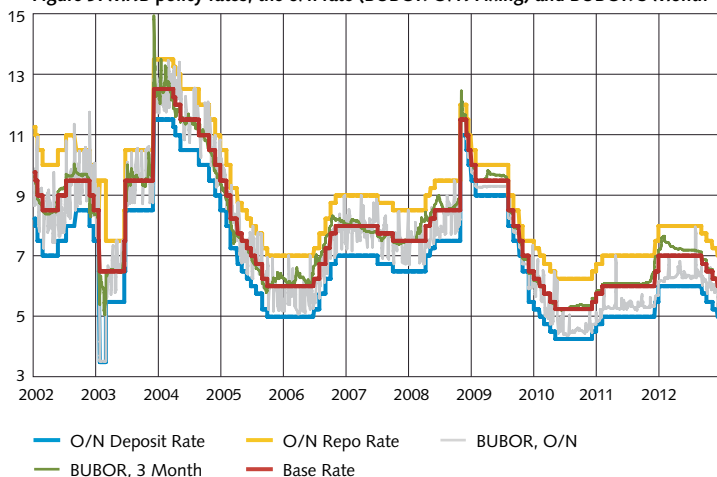
The Magyar Nemzeti Bank (MNB) has as its operating target the 3 month money market rates.

The principal policy rate of the MNB is the *base rate*, which is paid on its main policy instrument – the two-week MNB bill. Since the banking system is in a liquidity surplus the MNB regularly use the bills to drain liquidity from the system. All bids submitted by the banks in a weekly fix rate auction are accepted by the MNB without restriction. The two-week bills replaced the two-week deposits in 2007 (the MNB has used deposit-type policy instruments to drain liquidity since 1995). MNB uses outright purchases or sales of government securities only in extreme market and liquidity situations.

Overnight collateralised loans are provided by MNB automatically up to the end-of-day debit balance of a bank's account. They can also be requested separately in order to fulfil reserve requirements. Banks can deposit their excess funds in the overnight deposit facility without limitations. These standing facilities form a 200 basis points wide corridor, with the MNB's base rate in the middle, which set the boundaries for movements in the overnight rate.

Banks that take part in the reserve requirement system must hold required reserves which should be met on average over a one month maintenance period. As of November 2010 banks may select from reserve ratios of 2, 3, 4 and 5 per cent (previously only 2 per cent) and may change their decision on a semi-annual basis. The rationale for this is that banks differ significantly from one another regarding the reserve ratio which is optimal for managing their own liquidity (Varga (2010)). Required reserves have been remunerated at the MNB base rate since 1 May 2004.

Figure 9. MNB policy rates, the o/n rate (BUBOR O/N Fixing) and BUBOR 3 Month



United States

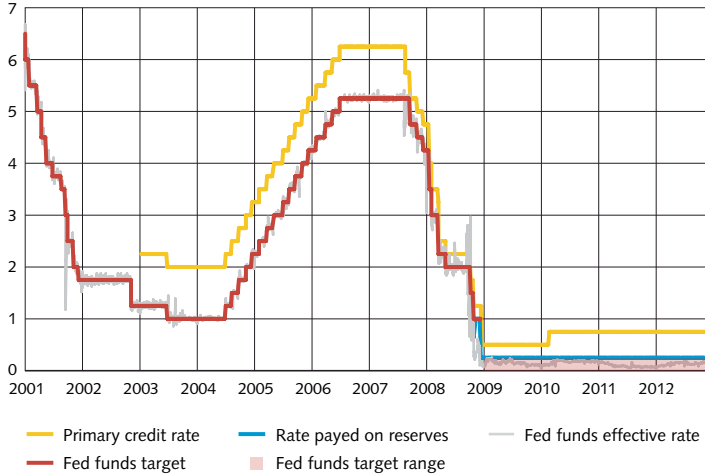
The Federal Reserve System (FRS) uses reserve requirements that are applied to deposits over a two-week period: a bank's average reserves over the period ending every other Wednesday must equal the required percentage of its average deposits in the two-week period ending the Monday 16 days earlier. Banks that fail to meet their reserve requirements can be subject to financial penalties. A small excess (or deficiency) in one maintenance period may be carried over to the next period.

In normal times the Federal Open Market Committee (FOMC) sets a target level for the Fed funds rate, i.e. the rate on unsecured (mostly overnight) interbank loans of reserve balances. In the directive from the FOMC to the Federal Reserve Bank of New York it is then stated that the trading desk (the Desk) should "create conditions in reserve markets" that will encourage Fed funds to trade at a particular level. The Desk conducts open market operations (OMOs) in the form of repos/reverse repos or outright purchases every morning with its primary dealers (government securities dealers). When the Desk sends or receives funds from the dealer's account at its clearing bank, this action adds or drains reserves to/from the banking system. In addition to these temporary OMOs, permanent OMOs in the form of purchases/sales of securities were used to accommodate the longer-term factors affecting the balance sheet – primarily the trend growth of currency in circulation.

The FRS's implementation of monetary policy has undergone substantial changes during the financial crisis. On 9 October 2008 the FRS began to pay interest on banks' required and excess reserve balances. Initially the rate paid was set at 75 bps below the lowest target federal funds rate for a reserve maintenance period. A lending facility – the Primary Credit Facility – was already in place since

2003, with the primary credit rate initially set 100 bps above the Fed funds target. However, since 16 December 2008 the FRS aims to keep the fed funds rate within a range of 0 to ¼ per cent, remunerating reserves at ¼ per cent. Since late 2008, the FRS has bought large quantities of longer-term securities via a series of asset purchase programmes with the goal of putting downward pressure on longer-term interest rates.

Figure 10. Federal Reserve System policy rates and the o/n rate (effective Fed funds)



Switzerland

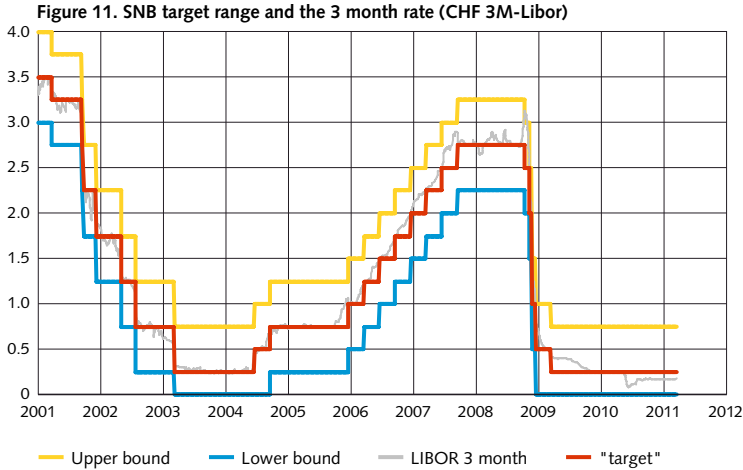
The Swiss National Bank (SNB) has an operational target range for the CHF 3 month Libor interest rate. This range is usually 1 percentage point wide, but in March 2009 the SNB narrowed the target range intending to keep the Libor within the lower part of the target range around 0.25 per cent (this was also the case during the period 6 March 2003-17 June 2004). Since 3 August 2011 the target range is 0.0-0.25% and the SNB aims for a 3 month Libor as close to zero as possible. On 6 September 2011 the SNB also set a minimum exchange rate of CHF 1.20 per euro.

Because of large foreign exchange purchases in recent years the banking system has a structural liquidity surplus relative to the SNB. Before it reached the zero lower bound on 3 August 2011, the SNB would absorb this surplus by issuing SNB bills with maturities of 28, 84, 168 and 336 days. The SNB would then manage the 3 month Libor by offering reverse repos each day with a one week maturity. The repo rate used in the fixed rate tender auctions is computed by deducting estimated risk and term premiums from the 3 month target rate. The last issue of SNB Bills took place on 28 July 2011, after which bills that fell due were no longer renewed.

The National Bank Act requires commercial banks domiciled in Switzerland to keep minimum reserves during a reporting period, which lasts from the 20th day of one month to the 19th day of the following month. Reserves can take the form of notes and coins or sight deposits held at the SNB. No interest is paid on reserves.

There is a liquidity-shortage financing facility (special-rate repo transactions) which can be used by a bank to bridge unexpected, short-term liquidity bottlenecks. The facility can also be used to ensure that minimum reserve requirements are met at the end of a reporting period. The special rate is 50 bps above the Swiss Average Rate Overnight (SARON).

All of the SNB's repo operations are conducted on an electronic trading platform. Most interbank repos also use this platform, as there are few OTC trades. SNB also uses the platform for fine-tuning operations when it judges that this is needed.



Norway

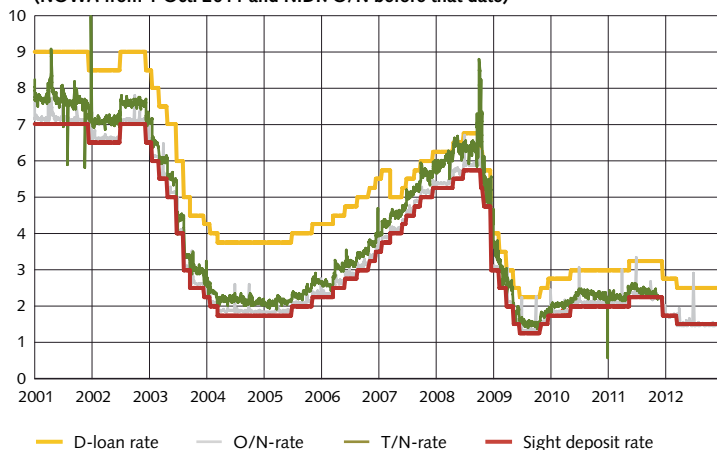
Norges Bank (NB) has stated that the objective of its liquidity policy is to ensure that the short-term money market rate remains close to the key policy rate, the *sight deposit rate*, which is the interest rate on banks' deposits at the central bank. NB ensures that the banking system has surplus liquidity on a daily basis, which the banks deposit in their current accounts at the Bank. Under the *floor system*, used before 3 October 2011, this would imply that the sight deposit rate set a floor for short-term money market rates. Surplus liquidity in the system would ensure that short-term money market rates were close to the floor.

On the basis of its liquidity forecast for the banking system, NB determines whether there is a need to offer liquidity, the maturity of the loan and the

aggregate loan amount. The liquidity is normally supplied via fixed-rate loans (F-loans). The interest rate on F-loans is determined by competitive multi-price auction and will usually be a few basis points higher than the key policy rate. The maturity is usually less than two weeks and rarely longer than one month. The overnight lending rate (on D-loans) is one percentage point above the deposit rate.

On 3 October 2011 NB made some important changes to the deposit facility. Under the new *quota system*, a limited volume (a quota) of banks' deposits in NB will bear interest at the deposit rate. Deposits in excess of the quota will bear interest at a lower rate, the reserve rate. The purpose is to enhance the redistribution of liquidity in the interbank market and boost activity in the shortest segment of the money market. Under the new system NB also drains reserves via fixed-rate deposits (F-deposits). The maturity of the deposits will reflect liquidity conditions.

Figure 12. Norges Bank policy rates, the NIBOR t/n rate and o/n rate (NOWA from 1 Oct. 2011 and NIDR O/N before that date)



New Zealand

Most central banks have a small volume of cash in their payment system overnight and provide liquidity intra-day against collateral at no cost. The Reserve Bank of New Zealand (RBNZ) instead moved to a fully cashed up system in July 2006. This means that banks have to hold sufficient funds overnight to meet their daily settlement needs, since the RBNZ does not offer intra-day credit. The reason for the change was gridlock in the payment system due to a lack of acceptable collateral and the fact the banking system is open for 23.5 hours each banking day (9am to 8.30am the next day). The RBNZ cashed up the system by swapping USD cash for reserves in the central bank.

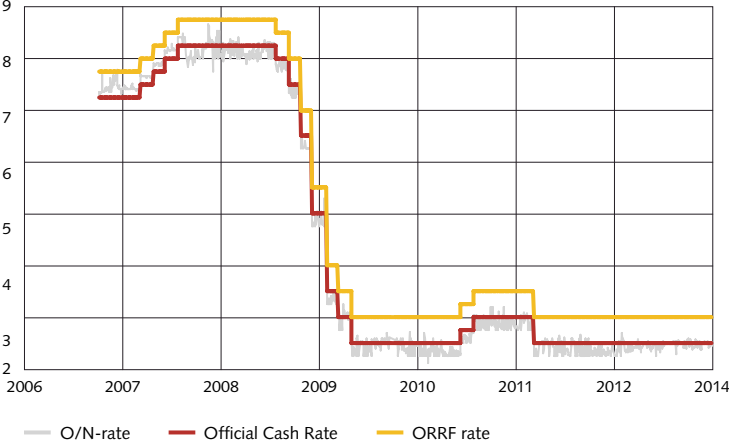
Originally all reserves were remunerated at the Official Cash Rate (OCR), which is the RBNZ's main policy rate. But in order to stop the banks' insatiable appetite for reserves an individual limit ("tier") had to be introduced, above which reserves are remunerated at 100 bps below the OCR. The "tiering regime" was introduced from 24 August 2007. If a bank is over its tier then it can usually clear those funds with another bank at 25 bps under OCR, which is market convention.

There is still a lending facility, the Overnight Reverse Repo Facility (ORRF), making funds available for banks to meet sudden unexpected cash needs. The funds are transacted on an overnight basis at 50 bps above OCR.

Each morning at 9.30 a.m. banks have an opportunity to bid for cash (or bonds) in the RBNZ's open market operations. The Reserve Bank offers reverse repos (or repos) for 1 to 4 maturity dates and sets minimum (maximum) acceptable rates. The banks favour shorter maturities, usually less than 7 days.

To keep the system cashed up the RBNZ injects liquidity using FX swaps and basis swaps. Maturity dates can range from overnight to 18 months for FX swaps (typically trade t/n to 6 months) and to 3 years for basis swaps. RBNZ monitors market interest rates in the overnight FX swap market and overnight interbank cash market, as well as the use of ORRF, to assess whether the correct amount of cash is in the system.

Figure 13. RBNZ policy rates and the o/n rate (Interbank Overnight Cash Rate)



References

- ACI-STEP Task Force (2002). The short-term paper market in Europe – Recommendations for the development of a pan-European market, Consultation Report by the Euribor-ACI Short Term European Paper Task Force.
- Bernhardsen, Tom and Arne Kloster (2010). Liquidity management system: floor or corridor? Norges Bank Staff Memo 4/2010.
- Bindseil, Ulrich (2004). *Monetary policy implementation – theory, past, and present*, Oxford University Press.
- Bindseil, Ulrich (2011). Theory of monetary policy implementation, in *The concrete euro: implementing monetary policy in the Euro Area*, Paul Mercier and Francesco Papadia (eds.), Oxford University Press.
- Bindseil, Ulrich and Juliusz Jablecki (2011). The optimal width of the central bank standing facilities corridor and banks' day-to-day liquidity management, European Central Bank Working Paper No. 1350.
- Broadbudd, Alfred and Marvin Goodfriend (2001). What assets should the Federal Reserve buy? Federal Reserve Bank of Richmond *Economic Quarterly* 87 (1), Winter 2001.
- Carney, Mark (2008). Building continuous markets, speech at the Canada – United Kingdom Chamber of Commerce, London, England, 19 November 2008.
- Carpenter, Seth and Selva Demiralp (2011). Volatility, money market rates, and the transmission of monetary policy, Finance and Economics Discussion Series, Board of Governors of the Federal Reserve System (the US), 2011.
- Cassino, Enzo and Aidan Yao (2011). New Zealand's emergency liquidity measures during the global financial crisis, Reserve Bank of New Zealand Bulletin 74 (2), June 2011.
- Clews, Roger, Chris Salmon and Olaf Weeken (2010). The Bank's money market framework, Bank of England *Quarterly Bulletin*, 2010 Q4.
- Coeuré, Benoît (2012). The importance of money markets, speech at the Morgan Stanley 16th Annual Global Investment seminar, Tournettes, Provence, 16 June 2012.
- ECB (2003). Public consultation: Summary of comments received on the measures proposed to improve the operational framework for monetary policy, 23 January 2003.
- Eklund, Johanna and Per Åsberg Sommar (2011). The Swedish market for balancing liquidity between the banks overnight 2007-2010, *Sveriges Riksbank Economic Review* 2011:1.
- Engert, Walter, Toni Gravelle and Donna Howard (2008). The implementation of monetary policy in Canada, Discussion Paper 2008-9, Bank of Canada.
- Erhart, Szilárd (2004). Driving factors behind O/N interbank interest rates – the Hungarian experiences, Occasional Papers 34, Magyar Nemzeti Bank.
- European Central Bank (2006). *Monthly Bulletin*, July.
- European Central Bank (2011). Financial integration in Europe.
- Financial Stability Board (2012). Securities lending and repos: market overview and

financial stability issues, Interim report of the FSB Workstream on securities lending and repos, 27 April 2012.

Fisher, Paul (2010). Managing liquidity in the system – the Bank's liquidity insurance operations, speech at the Loan Market Association Syndicated Loans Conference, London, 30 September 2010.

Gerdrup, Karsten (2005). Norges Bank's role in the event of liquidity crises in the financial sector, *Economic Bulletin* Q2, Norges Bank.

Henckel, Timo, Alain Ize and Arto Kovanen (1999). Central banking without central bank money, Working Paper No. 92, International Monetary Fund.

Holmberg, Karolina (1996). The Riksbank's management of short-term interest rates, *Sveriges Riksbank Quarterly Review* 1996:4.

Jordan, Thomas and Peter Kugler (2004). Implementing Swiss monetary policy: steering the 3M-Libor with repo transactions, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik*, 140(3), 381-393.

Kliber, Agata and Piotr Pluciennik (2011). An assessment of monetary policy effectiveness in POLONIA rate stabilization during financial crisis, *Bank i Kredyt* 42(4), 5-30.

Lu, Yinqiu (2012). What drives the POLONIA spread in Poland? IMF Working Paper No. 12/215.

Murphy, Emma and Stephen Senior (2013). Changes to the Bank of England, *Bank of England Quarterly Bulletin* 2013:Q1.

Nield, Ian (2008). Evolution of the Reserve Bank's liquidity facilities, Reserve Bank of New Zealand *Bulletin* 71(4), December 2008.

Norges Bank (2010). Consultative document: Changes in "Regulation on the Access of Banks to Borrowing and Deposit Facilities in Norges Bank etc." 1 October 2010.

Plenderleith, Ian (2012). Review of the Bank of England's provision of emergency liquidity assistance in 2008-09, Report commissioned by the Court of the Bank of England.

Reid, Christopher (2007). The Canadian overnight market: recent evolution and structural changes, *Bank of Canada Review*, Spring issue.

Sveriges Riksbank (2012). The Riksbank's review of Stibor, *Riksbank studies*.

Tucker, Paul (2004). Managing the central bank's balance sheet: where monetary policy meets financial stability, *Bank of England Quarterly Bulletin*, Autumn 2004.

Varga, Lóránt (2010). Introducing optional reserve ratios in Hungary, *MNB Bulletin*, October, 57-66.

Winters, Bill (2012). Review of the Bank of England's framework for providing liquidity to the banking system, Report commissioned by the Court of the Bank of England.



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