

The Fall of Bagehot – Monetary policy implementation during the financial crisis

Jesper Berg

Danish Financial Supervisory Authority, mail: jb@ftnet.dk

Abstract: The purpose of this article is to provide an introduction to monetary policy implementation and the challenges posed by the financial crisis. Monetary policy implementation is normally about setting a short-term interest rate. This apparently simple task is complicated by additional objectives, e.g. in relation to the development of a money market, as well as the necessity to decide on a number of parameters, such as collateral, timing, counterparties and quantitative restrictions on the supply of liquidity. The apparent attempt to both control quantities (liquidity) and prices (interest rates) is one of the more mind bugging aspects of monetary policy implementation. The financial crisis has demanded great flexibility in relation to the setting of parameters, and one of the consequences has been that the distinction between monetary policy lending and the lender of last resort role of central banks in the spirit of Bagehot has become blurred. Central banks have also moved beyond setting a short-term rate as financial markets became disconnected. As central banks wisely opted for influencing prices (interest rates), the attempt at also controlling quantities was set aside and central bank balance sheets ballooned. However, this proved insufficient and central banks first loosened virtually all other parameters related to their lending operations and subsequently went beyond traditional short term lending, only to discover that even more was needed.

Keywords: Central banking; lender of last resort; monetary policy operations; open market operations; interest rates

JEL: E43; E52; E58

1. Introduction¹

In most textbooks the implementation of monetary policy is considered a trivial issue. In the older – and even in some newer – textbooks, you set some measure of money or central bank liquidity that has an impact on real activity and inflation. With the advent of the Taylor rule and New Keynesian economics, you set the interest rate on the central bank's supply of liquidity, which then influences real activity and inflation (Woodford (2003)). The key intellectual issues have been the transmission of monetary policy and the objectives, and not how the central banks managed to set the interest rate.

The financial crisis that began in the summer of 2007 has generated a lot of activity in central banks in the area of monetary policy implementation – the setting of interest rates and influencing commercial banks holdings of central bank liquidity. The issues have proven anything but trivial. As an example the Federal Reserve went from having 3 lending facilities to having 15 and its balance sheet has increased by more than a factor of four putting it in competition with the largest US banks for the spot as the biggest bank in the US.

The classical and still very readable book on central bank operations is Bagehot's *Lombard Street* (Bagehot (1873)). Bagehot is most famous for his rules on how central banks should act as lenders of last resort:²

The end is to stay the panic; and the advances should, if possible, stay the panic. And for this purpose there are two rules: First, that these loans should only be made at a very high rate of interest. This will operate as a heavy fine on unreasonable timidity, and will prevent the greatest number of applications by persons who do not require it. The rate should be raised early in the panic, so that the fine may be paid early; that no one may borrow out of idle precaution without paying well for it; that the Banking reserve may be protected as far as possible. Secondly, that at this rate these advances should be made on all good banking securities, and as largely as the public ask for them. The reason is plain. The object is to stay alarm, and nothing therefore should be done to cause alarm. But the way to cause alarm is to refuse someone who has good security to offer. The news of this will spread in an instant through all the money market at a moment of terror; no

1. This article is based on the notes I have used for my lectures on monetary policy implementation at the Central Banking seminars on monetary policy implementation as well as my inaugural presentation at Copenhagen Business School as Adjunct Professor at the Institute of Finance in August 2015. Comments from Kim Abildgren, Morten Linneman Bech, Jacob Gyntelberg and David Bentow, as well as two anonymous referees are gratefully acknowledged. Lars Navntoft Henningsen and Mads Drachmann Kolding have provided valuable research assistance. However, any errors remain my responsibility.
2. It could be argued that Bagehot's principle is not about monetary policy implementation, but about financial stability. However, as shall be seen later, during the financial crisis there was a blurring of lines between monetary policy implementation and measures to contain financial instability in more or less the same way as in Bagehot's days. However, Bagehot also addresses monetary policy implementation in regard to other objectives than safeguarding financial stability. In addition, his description of the development of banking as well as many other elements makes *Lombard Street* very readable.

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one can say exactly who carries it, but in half an hour it will be carried on all sides, and will intensify the terror everywhere.

The severity of the financial crisis is perhaps best illustrated by the fact that what for 135 years were considered best practice, although not always observed - that central banks could stop a banking panic through offering ample short term liquidity – proved insufficient to stop the panic (Berg and Bech (2009)).

The purpose of this article is to provide an inductive introduction to the problem of implementing monetary policy. The inductive approach is intended to give the reader a better understanding of why, what seems like a trivial problem is slightly more complicated. Thus, we will start out with a very general and basic set up, and we will confront it with the reality and discuss its limitations. Additional layers of complications and trade-offs will be added, and hopefully by experiencing the many potential pitfalls, the reader will come away with a better understanding.³

Comparing central bank operations across countries makes it evident that there are many ways to skin a cat. This article will make comparisons of the respective choices made by the Federal Reserve, The ECB, The Bank of England, and Danmarks Nationalbank. All of the central banks on their websites provide a wide array of publications that explain their implementation ranging from the very technical aspects to the more general, e.g. Danmarks Nationalbank (2009).

The article is intended to provide students as well as economists that are not specialists in the area of monetary policy implementation with an understanding of the issues. It is a positive externality, if the article also stirs the thoughts of colleagues in the field of monetary policy implementation. However, it is impossible in an article like this to cover all aspects of monetary policy implementation. Readers interested in the most comprehensive overview are instead referred to Bindseil (2005) and Bindseil (2014).

The article focus on the first phase of the financial crisis, where the issue was primarily one of money market functionality, but also touch on the post Lehmann phase, where the monetary policy transmission more generally broke down and truly unconventional measures were needed, cf. Borio and Disyatat (2009). The article does not cover the specific issues related to the ECB being a central bank for otherwise independent states.

The structure of this article is that section 2 briefly describes the generic monetary policy problem, and the question is posed: Why can a central bank not limit itself to have one lending facility with one rate. Section 3 addresses the other parameters involved in central bank lending operations, while section 4 deals with

3. The inductive approach also reflects my exposure to teaching MBAs, both as a student and as a teacher. The typical MBA class starts with students making an erroneous interpretation of a case study. As new information is added, the student revises her hypothesis, and ends with a realization that the world is very different. Nothing is as effective as learning from mistakes. This compares to the traditional deductive approach, where one starts with a set of assumptions and deducts what is right.

central bank operations that go beyond short term lending operations. Section 5 concludes.

Implementing monetary policy has proven to be a non-trivial problem. There are trade-offs as in all economic issues and the choice of parameters have both intended as well as unintended effects. The financial crisis has increased the challenges, but at the same time it has given central banks a unique experience in observing how their choices influence the behaviour in the system. There is a lot of historical legacy, idiosyncrasies and path dependency in central banks choice of operational frameworks. The experience from the financial crisis should allow for reflection on, what has been helpful and what are historical artefacts.

2. The generic problem of monetary policy and a simple operating procedure

The perceived wisdom today is that monetary policy should aim at securing some form of price stability through setting short-term interest rates.

The accepted policy rule, cf. Taylor (1993) is that central bank interest rates should respond with more than a one-to-one increase if inflation/inflation expectations go up, and respond more moderately yet still counter cyclically to the output gap.

Some countries, including Denmark, have chosen to target a fixed exchange rate towards a currency in a bigger economic area that pursues inflation targeting and thus importing price stability. In these countries monetary policy implementation has to be focused on exchange rate developments and nothing but exchange rate developments. However, the monetary policy rate is typically not the first or even the second line of defence. The first line of defence is marginal movements in the exchange rate that allow supply and demand to balance out. The second line of defence is intervention in currency markets. Despite these tools, countries that target their exchange rate have to have their hand continuously on the interest rate trigger. Therefore, their decision-making processes in relation to setting monetary policy will also differ from inflation target'ers. A monetary policy committee with external participants is not an option, when immediate reactions are needed.

Central banks are different from commercial banks because their liabilities are legal tender and they have an associated role as banker to the banks, including being the place of ultimate settlement⁴. The banking system is stuck with their position towards their central bank. If one bank wants to reduce its claim on the central bank, another bank has to increase its' claims, unless the central bank allows otherwise. The central bank and the government, if they have an account with the

4. In addition central banks are not in the business of profit optimization. Their job is to conduct monetary policy.

central bank, can change the net position of the banks towards the central bank.⁵ The banking system cannot by itself. Therefore, the banking system can always be brought into a situation, where it has either to borrow from the central bank or deposit with it. This makes it possible for the central bank to set the marginal interest rate for the banking system.

Managing the banking system's net position towards the central bank is more difficult for an exchange rate target'er that is committed to uphold a certain exchange rate. If holders of the currency do not want to hold on to the currency at the targeted rate, the central bank is forced to make it more attractive to hold the currency by adjusting the interest rate or intervening in currency markets, exchanging claims on the central bank with claims on a foreign central bank. Thus, the banking system can impose a change to its' net position.⁶ However, the central bank has the option to sterilize the change.

As Friedman and Schwartz (1963) noted in their *Monetary History*, every time we think we can control the economy as a machine, we discover we cannot. Our knowledge of how the economy works is still limited. Our estimates of where the economy is or was a few quarters ago are poor, our projections are worse, and there are time lags and uncertainty related to how our instruments impact the economy (See for example Arouba (2005) and Tetlow (2005)). Our theoretical frameworks of how the economy works have changed over time and the framework we had prior to the financial crisis did to a large extent consider financial developments as unimportant and with no repercussions on the rest of the economy.

Given all these problems, it would be helpful, if implementing monetary policy were a trivial problem.

The simplest form of monetary policy implementation would be to have one central bank facility, where anybody in the economy could borrow against good collateral, at any time of the day, all days of the week, and however much they wanted. The central bank would set one short-term interest rate, e.g. an overnight rate.

In this model the market would set the quantity. Does it matter, whether the central bank sets the interest rate or the quantity?

If the demand curve (D) is stable and the central bank knows it, it would not matter. By setting the interest rate (\bar{r}), the central bank would also set the quantity of liquidity (\bar{H}) and vice versa, cf. chart 1.

5. Here we disregard the possibility for shifts between the non-bank public and the banks in claims on the central bank, e.g. an increase in the general population's demand for notes and coins lowers the banks' net claim on the central bank.
6. E.g. the banking system can borrow abroad and sell the foreign exchange to the central bank that in order to maintain parity will let the foreign exchange reserve increase. As a result, the net position of banks will increase. However, there is not full substitutability, as it takes two days for foreign exchange transactions to settle.

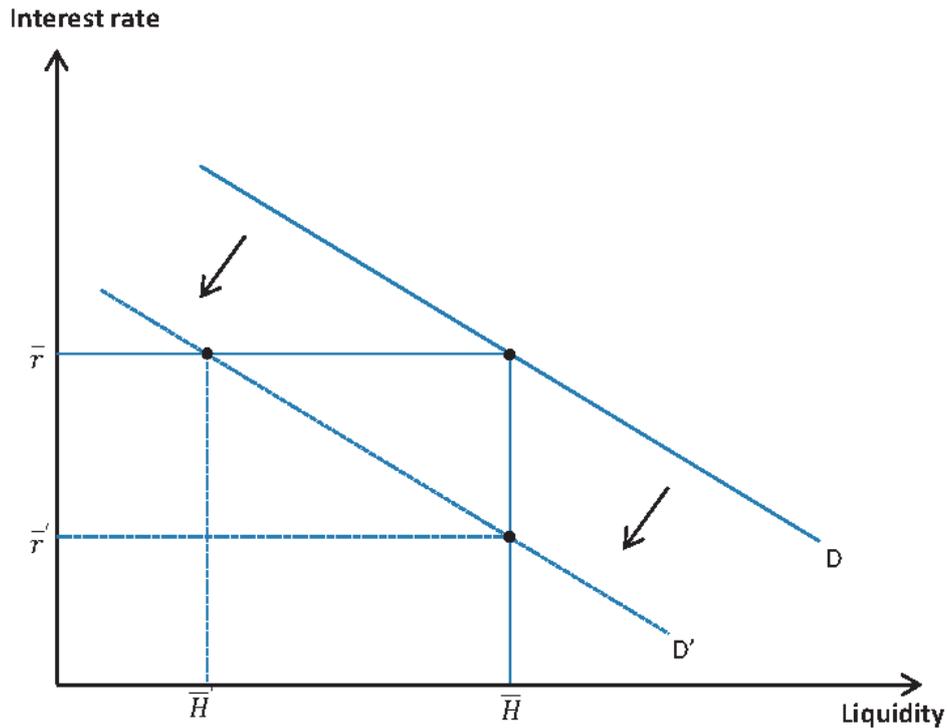


Chart 1: Setting price or quantity?

However, the demand curve is not stable and the central bank does not have perfect knowledge of what it looks like. Therefore, it becomes a question of what you want to control and what you accept not to control. In most situations, central banks are more or less equally capable of controlling the short-term interest rate and the quantity. However, although the transmission mechanism from interest rates to the rest of the economy is complex, it is less complex than the transmission from liquidity to the economy. The transmission from liquidity primarily operates through its influence on interest rates, and therefore includes an extra layer of complications. In fact, this part of the transmission mechanism is likely to be very unstable. Demand for liquidity is very interest rate inelastic, as the banks have to cover their deficit towards the central bank and have very little use for additional liquidity. Combined with an unstable demand curve, a central bank setting liquidity instead of the interest rate would be in for a turbulent ride. Thus, interest rates are the preferred choice.

When we look at the choices central banks have made, none of those we study has chosen to have one and only one facility, cf. table 1. All of them have both lending facilities and deposit facilities and typically more than one of either a lending or a deposit facility.

Table 1: Central Bank facilities pre-financial crisis

Danish Central Bank	ECB	Federal Reserve	Bank of England
One lending facility and two deposit facilities	Two lending facilities and one deposit facility	Two lending facilities and one deposit facility	One lending facility and two deposit facilities

Source: Various central banks websites.

There are at least two arguments against the simplest form of monetary policy implementation outlined above, although they are rarely discussed.

First, central banks want to operate through banks. It was not always like that. Many central banks started as commercial banks and for a long time had non-banks as customers. Some still do, although on a limited scale. The more limited role of central banks squares well with how other public utilities have tried to leave as much as possible to the markets with all the benefits that a competitive allocation of resources provide. The existence of private money markets with market-based pricing of liquidity and credit risk gives the private banks an incentive to actively manage their own liquidity and credit risks and not passively rely on support in case of liquidity shortages. This fosters financial stability. Furthermore, market based competition might lead to more product development and facilitate the development of more efficient payment solutions.⁷

Second, if the banking system has more central bank liquidity than it needs, then the central bank cannot control interest rates through a lending facility. It will also need a deposit facility or other instruments, if the liquidity position of the banking system shifts from D to D' , cf. chart 2.

The second argument logically leads to a proposal for an amended version of the simple model. Why do central banks not offer both a lending facility and a deposit facility? The rate on the deposit facility (\bar{r}) could be the same as on the lending facility, if adequate collateral is supplied for any lending eliminating credit risk. After all, the central bank is not in the money market to make money, but to set the short-term interest rate.

7. I owe the latter point to one of the two anonymous referees.

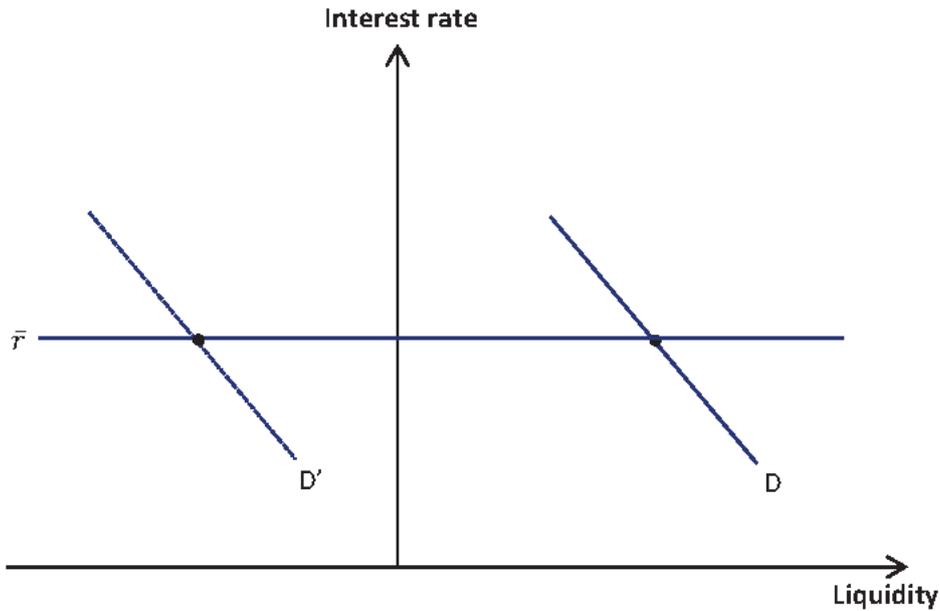


Chart 2: A Lending and deposit facility.

We can observe that central banks instead of operating with the same rate on its deposit and lending facility, has a number of different rates, cf. table 2.

Table 2: Rates on Central Bank facilities on July 1, 2007.

	Danish Central Bank	ECB	Federal Reserve	Bank of England
Lending Rate	Lending Rate (4.25)	Marginal Lending Facility (5) Refi-Rate (4)	Primary Discount Rate (6.25) Federal Funds Rate (5.25)	Standing Lending Facility (5.75/6.5)
Deposit Rate	Certificates of Deposit Rate (4.25) Current-account Rate (4)	Deposit Facility Rate (3)	Excess Reserves Rate (0)	Official Bank Rate (5.5) Standing Deposit Facility (4.5/5.25)

Source: Various central banks websites.

Deposit rates are normally lower than the lending rates, and the rates on different deposit or lending facilities differ.

The problem with the modified version of the simple model is that banks with a surplus of liquidity and banks with a deficit of liquidity cannot agree on an interest rate at which liquidity can be exchanged. Banks with a surplus will want more

than the central bank rate. Banks with a deficit will want to pay less than the central bank rate. Given a minimum of risk or transaction costs in exchanging liquidity between the banks, the banks will end up respectively depositing and lending at the central bank.

We therefore need to introduce a spread between the deposit and lending rate of the central bank, unless we accept that there will be no market beyond the central bank for exchange of secured short-term liquidity. The big question is, how large should the spread be between the rate on the lending and deposit facility to get banks that have too much liquidity to lend to banks that need liquidity.

Again we are back at the secondary objective of leaving as much as possible to the markets. Central banks prefer only supplying the banking system with its' net, rather than its' gross, need of liquidity.

If that is the objective, why do we not have a large spread, cf. chart 3? As seen in table 2, the spread between the highest deposit rate and the lowest lending rate ranges from 0 bps to 525 bps.

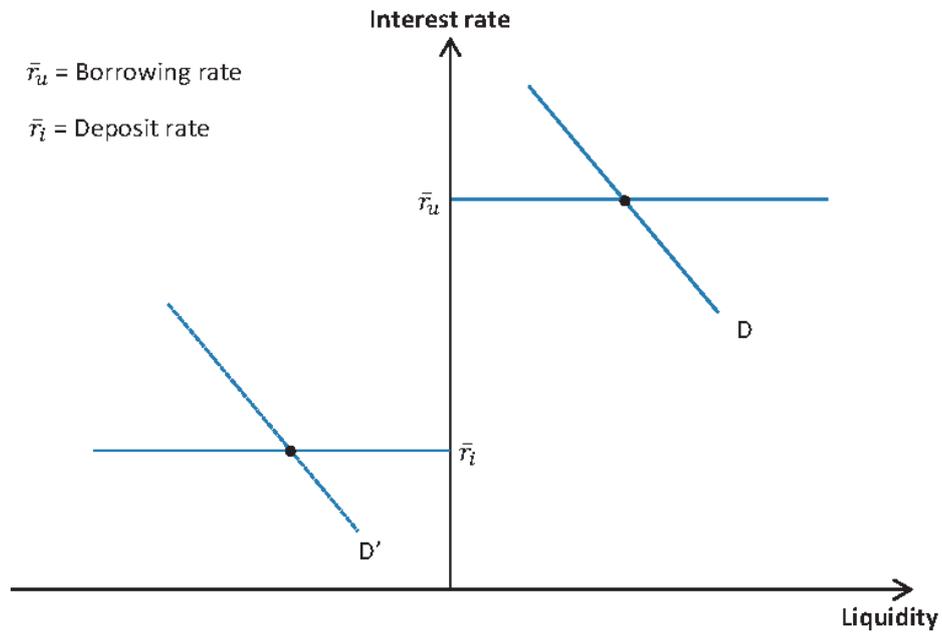


Chart 3: Introducing a spread.

The problem with a large spread is that the market interest rate will be very volatile, if the banking system frequently moves from having surplus liquidity to needing liquidity. When the banking system has surplus liquidity, market rates will move towards the deposit rate. When the banking system needs liquidity, market rates moves towards the lending rate. Thus, there seems to be a trade-off between the volatility of interest rates and getting the banks to settle their liquidity imbalances among themselves.

During the financial crisis this trade-off worsened. Banks became more nervous about lending money to other banks, even when there was collateral backing the loan (Gorton (2009)). Therefore, the spread demanded relative to the risk free deposit rate at the central bank increased. As a consequence, there was an increase in the necessary spread between the central banks deposit and lending rate that ensured an exchange of liquidity among the banks.

The Federal Reserve and the ECBs adjustments to their interest rate spreads and the increase in deposits at these two central banks illustrate the problem. The ECB first reduced the spread between the deposit rate and its' main refinancing rate from 100 bps to 50 bps, subsequently increased it back to 100 bps, and ended at 25 bps.⁸

The increase in deposits also reflects that banks have wanted to hold more precautionary reserves. This has added to the difficulty in figuring out, whether market rates were determined by central bank deposit or lending rates.

The structure of the money market, where banks exchange liquidity, can cause additional difficulties. In a market with many participants and a mixture of banks with liquidity surpluses and deficits, the market rate is likely to settle close to the central bank lending rate, if the banking system as a whole has a deficit. If the banking system as a whole has a surplus, the market rate will settle close to the central bank deposit rate. However, if the liquidity needs or the surplus liquidity is concentrated in one bank, then the outcome becomes less certain. It becomes a question of who blinks first.

Say there is a liquidity deficit for the system as a whole, but that is concentrated in one large bank, while the smaller banks have surpluses. The large bank may then be in a bargaining position, where it can point to the alternative for the smaller banks of the rate on the central bank's deposit facility, rather than accept the lending rate as the benchmark that would normally prevail in a situation, where there is an overall liquidity deficit.⁹

8. There is a similar spread between the main refinancing rate and the marginal lending rate.

9. The chances of having a well-functioning money market increases if it is not always the same banks that have liquidity surpluses or liquidity deficits. This makes the market function as a repeated game where a bank with a surplus knows that it might need liquidity tomorrow. This might foster a more "fair" pricing of liquidity without "corners". I owe this point to one of the two anonymous referees.

3. The setting of other parameters

The simple model involved the setting of a few additional parameters. As stated earlier:

One central bank facility, where anybody in the economy could borrow against good collateral, at any time of the day, all days of the week, and however much they wanted. The central bank would set one short-term interest rate, e.g. an overnight rate.

Our attention will now shift to the choice of collateral, the timing of monetary policy operations and who should have access to central bank facilities.

As a first step it is useful to make a distinction between different kinds of central bank lending, cf. table 3.

Table 3: The three generic central bank lending functions.

	Generally available	Ad hoc availability
Intraday	Payment system liquidity	
Term finance	Monetary policy operations	Individual lender of last resort

Central banks lend for three purposes. One, they lend intraday to help the settlement of payments and securities. The needs of the banking system for intraday liquidity often far exceeds the needs for overnight liquidity as multiple settlements of payments shift the banks positions around. A bank may need to make substantial payments in the first securities settlement of the day, only to receive even more in the next settlement. Intraday credit, as suggested by its name, needs to be settled before the close of business.

Two, central banks lend overnight or longer as part of the monetary policy operations that is the focus of this paper.

Three, banks that cannot get their liquidity needs covered in the market or through the ordinary central bank facilities will knock on the doors of the central bank to request an ad hoc arrangement. This is the classical lender of last resort operation.

Pre-crisis central banks had made very different choices with regard to the setting of parameters for their monetary policy operations, cf. table 4.

Table 4: Different parameter choices in the operational framework pre-crisis.

	Danish Central Bank	ECB	Federal Reserve	Bank of England
Accepted collateral	Government bonds and mortgage bonds	Government bonds and mortgage bonds, bank bonds, and certain bank loans	Government bonds and mortgage bonds	Government bonds
Frequency of operations	Normally weekly	Normally weekly	Daily	Normally weekly
Counter-parties	All banks	All banks	Only primary dealers	All banks
Quantity restrictions	No	Yes	Yes	Yes

Source: Various central banks websites.

In relation to *collateral*, the ECB was the central bank that accepted the widest set of collateral, while the Bank of England only accepted government bonds. The ECB model proved very useful in the early phases of the financial crisis, as banks were not constrained by their available collateral. The situation was the opposite in England, where Northern Rock¹⁰ discovered how a liquidity crisis could be mortal.

The rationale behind the ECBs approach has been stated as follows:

Somewhere on the cost schedule between the least and the most costly collateral types, the costs associated with additional collateral types will be equal to the declining marginal value of one more unit of collateral¹¹.

The costs were mostly seen as the operational costs of adding an extra item to the list (e.g. analysing needed haircut). Therefore, the ECB accepted nearly anything on the asset side of a bank's balance sheet. The implication was that the role of lender of last resort became almost integrated into the monetary policy operations. If a bank were solvent, it would nearly always be possible to find something that could be used as collateral in the ECBs ordinary operations. For a central bank that had banks from many different countries as customers, this helped avoid potentially difficult discussions on who to assist and who not to assist.

10. Northern Rock was an English bank that relied heavily on market funding of the mortgages it provided. When the financial crisis hit Northern Rock's funding dried up and the bank experienced a depositor run. The bank was taken over by the government in early 2008.

11. Bindseil and Papadia (2006).

Mervin King, the then governor of the Bank of England, had shortly before Northern Rock's demise expressed why he was in favour of a narrow list of collateral:

The provision of large liquidity facilities penalises those financial institutions that sat out the dance, encourages herd behaviour and increases the intensity of future crises¹².

Banking has always been a confidence game as described by Bagehot and modelled by Diamond and Dybvig (1983). When depositors lose confidence in a bank, there is a high risk of a bank run. Through its role as lender of last resort, central banks have been the stabilising force, when others ran. As other forms of public intervention this does influence the behaviour of private agents. Banks will be less liquid, if they know that the central bank will bail them out. The famous "constructive ambiguity", where banks are left unaware of the intention of the authorities is not a credible strategy as all are aware that it suffers from time inconsistency. It is rarely a credible policy not to lend to a bank that can post collateral, even if that collateral falls outside the list the central bank has set up.¹³

As economists we have a preference for influencing behaviour through prices rather than through rules. Bagehot's rule on lending out at a penalty rate has often been seen as serving the purpose of inducing banks to have the appropriate collateral. However, the background for the rule was that the Bank of England's banking department only had limited resources and therefore needed to ration its lending. Any penalty rate that would induce a bank to hold adequate collateral of the highest quality, i.e. government paper, to cater for situations as rare as the recent crisis would also have to be set at a prohibitive level.

Therefore, the liquidity of banks has to be regulated through other means. One of the more striking features of banking regulation was that before the financial crisis, there existed no internationally agreed standards for what constitute adequate liquidity for a bank. The regulation of liquidity had fallen through the cracks between the supervisors and the central banks.

With the introduction of two new regulatory liquidity standards, the LCR and the NSFR,¹⁴ that issue has been addressed but not without difficulties. The difference between securities considered liquid according to the LCR and securities that can be used in central bank operations, including as collateral when banks borrow,

12. Paper submitted to the Treasury Committee, September 2007.

13. The pricing of assets is influenced by whether an asset is on the list of collateral that the central bank accepts. In particular, during a crisis being on the list or not could have a large impact on the price. Although central banks are not profit optimizers, taxing the issuers of assets that are on the list of collateral may be a source of revenue, and possible even a non-distortionary tax.

14. The LCR (Liquidity Coverage Ratio) requires banks to hold sufficient high quality liquidity to cover a 30-day liquidity outflow under stressed market conditions. The NSFR (Net Stable Funding Ratio) requires banks to at a minimum maintain a balance between the maturity distribution of short-term liabilities and short term assets.

will give rise to operational difficulties for central banks and in some instances make the LCR a meaningless metric.

With respect to the *timing* of monetary policy operations, table 4 shows the frequency of the main operations. The Federal Reserve operates on a daily basis, whereas the other three central banks have chosen weekly operations. Those central banks that only conduct their main operations on a weekly basis by necessity need their operations to have a minimum maturity of a week.

The argument for weekly operations is again the desire to leave as much as possible to the banks. Weekly operations are in some cases accompanied by other mechanisms that ensure stability of overnight rates, cf. below. With daily operations such mechanisms are not needed.

Most central banks allow their banks access to a marginal deposit and lending facility on a daily basis. Denmark does not have a marginal lending facility and has imposed limits on the use of the overnight deposit facility. This reflects that, different from the other central banks, Denmark has an exchange rate target. The absence of a marginal lending facility and the limits on the deposit facility is intended to limit the scope for a sudden currency outflow financed by drawing on the central bank's facilities.

The Federal Reserve had pre-crisis restricted the *participation* in their main operations to a narrow set of banks, or more precisely investment banks, the primary dealers. This could be seen as a reward for the role these banks played in the market for government securities. Few if any had expected this choice to become the Achilles Heel of the international financial system.

The limited set of banks that had access to the Fed's open market operations were largely the same banks that suddenly needed all the liquidity they could get, as a result of the liquidity guarantees they had given to off-balance sheet vehicles. These off-balance sheet vehicles had a maturity and a credit mismatch as they funded inter alia structured securities with the issuance of asset backed commercial paper. As buyers of asset backed commercial paper of between 1 and 2 trillion dollars threatened to run, the banks had to reserve whatever liquidity they had access to. As a result, the Federal Reserve's ability to supply liquidity to the banking system at large was substantially hampered.

The Federal Reserve's problem was further accentuated by the stigma associated with the use of its marginal lending facilities. All commercial banks had access to the marginal lending facility, the discount window. However, for historic reasons banks did not want to use the discount window. They were afraid of being branded as a failing bank, if they used the facility.

The other central banks did not face the same problem, as all banks that wanted access to their facilities, had access and were willing to use it. However, they faced a similar problem as the transmission from the banks to the rest of the economy became hampered by capital constraints in the banking system, cf. section 4.

An important observation is that the simple model described at the beginning of this section would eliminate the need for the classical Bagehot operation. Any bank that had anything that could be provided as collateral would at any time be able to get whatever liquidity it needed. As we shall see, this was to a considerable extent what happened during the financial crisis.

One line item in table 4 has yet to be discussed. That is the question of whether unlimited liquidity is supplied or the supply is restricted. The immediate reactions of most economists would be that if you want to set a price, it does not make sense to restrict supply. If you restrict supply, the market will normally establish its own – higher – price, cf. chart 1.

Yet, all central banks but Danmarks Nationalbank employs some form of restriction on the supply of liquidity. This is one of the most complicated aspects of monetary policy implementation for outsiders to understand.

The restrictions are typically employed as part of a complex set up that helps stabilise overnight interest rates. The complexity of the set up deserves to be questioned as central banks exit the crisis.

The ECB set up can serve as an example. In the ECB system banks are required to hold a certain amount of reserves on average per day over a period of around a month. The ECB tries to ensure that the total amount of reserves available over the period is equivalent to the amount the banks need, including a margin on top of the required reserves. Thereby the banks know that the interest rate in the inter-bank market will be close to the rate at which the ECB supplies liquidity. If the rate in the money market is above that rate, a bank needing liquidity to satisfy its reserve requirement will choose to cover its reserve requirements later in the period.

In order to set the amount of liquidity the ECB needs to supply, the ECB has to estimate other factors that influence the liquidity of the banking system. The stylized central bank balance sheet in table 5 shows these other factors.

Table 5: A stylized central bank balance sheet.

Assets	Liabilities
Net domestic assets on the private non-bank sector (NDAP)	Notes and coins (N&C)
Net foreign assets (NFA)	Government Deposits (G)
	Bank Liquidity (H)
	Equity of central bank (E)

Liquidity is the banks claims on the central bank. How can the development in these claims be estimated? They can be estimated using the bookkeeping restriction that assets equal liabilities. That restriction can be rewritten as

$$(1) \quad H = NFA + NDAP - N\&C - G - E$$

The changes to liquidity can be estimated based on the changes to the variables on the right side of equation (1). These variables are known as the autonomous factors. In practice this is a time consuming process, where in particular the government's cash flow can cause difficulties.

To add suspenders to the belt, most central banks also have marginal deposit and lending facilities, where the size of deposits are unlimited and the borrowing is only restricted by the available collateral. The rates on these facilities form a corridor around the central policy rate. These rates typically bound secured overnight money market rates, cf. chart 4.

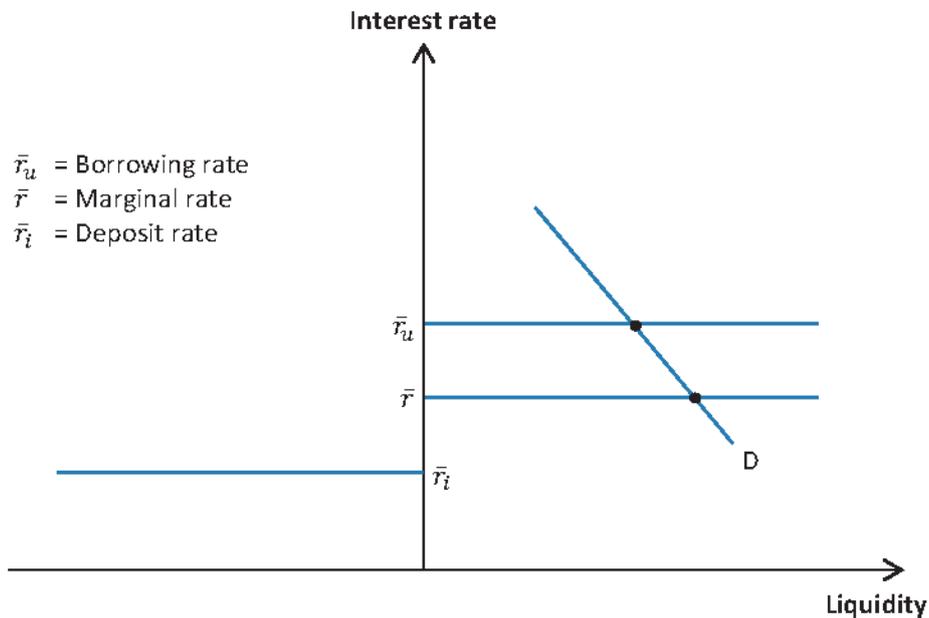


Chart 4: Interest rate corridor.

Until recently the rate on deposits at the Federal Reserve was zero.

Danmarks Nationalbank has until very recently generally accepted greater volatility in the overnight interest rate. The view has been that as long as slightly longer-term money market rates, e.g. weekly rates, were stable, overnight rates did not matter much. Most other central banks either consider volatility in short term rates unnecessary or potentially hampering the transmission mechanism.

Danmarks Nationalbank controls the weekly rate by supplying the marginal liquidity through lending operations, which typically has a maturity of a week. The liquidity can either be deposited on an o/n account with the central bank or placed in central bank certificates of deposits. Operations in the latter are used to supply or withdraw liquidity within the week, whenever the autonomous factors threaten to increase deposits beyond the limit on interest earning deposits or lower deposits to less than what is required to ensure a smooth exchange of o/n liquidity. Therefore, also Danmarks Nationalbank has to project the autonomous liquidity flows.

4. Adjustments to the operational frameworks during the crisis

The financial crisis has resulted in changes to many of the parameters in the respective set of monetary policy instruments, cf. also Borio and Disyatat (2009). In this section, the analysis is limited to the parameters in table 4.

All central banks have expanded their list of accepted collateral. The Bank of England had to give up on its principles and move to an almost ECB like approach. The ECB lowered its rating requirements. Danmarks Nationalbank took the very unusual step of lending to banks without any collateral requirement going beyond Bagehot's rule. However, lending limits were set that depended on the surplus of capital in relation to solvency requirements.

Additional operations were also introduced altering the timing of monetary policy operations. Thus, already on August 9, 2007, the ECB allotted unlimited overnight liquidity at its' policy rate. However, the most important change in relation to timing was the longer maturities of the operations, which will be covered below.

In the US, where participation in the key operations had been restricted to a limited set of participants, the establishment of the Term Auction Facility opened up for the supply of liquidity to all commercial banks on similar or better (longer maturities) terms than the open market operations.

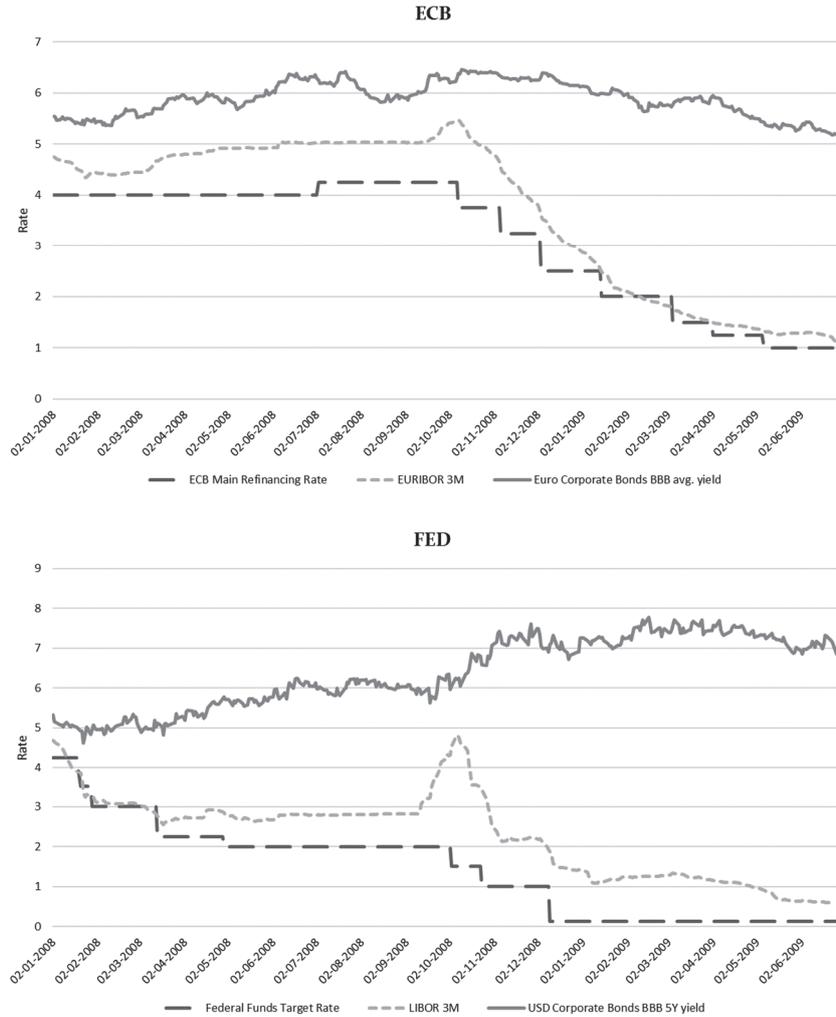
Finally, quantity restrictions were eliminated in a series of steps. The ECB started by frontloading its supply of liquidity and eventually provided full allotments in its auctions. As the central banks gave up controlling liquidity, their balance sheets ballooned.

The monetary policy implementation problem described thus far has been one of controlling some short-term interest rate. By setting the rate on the marginal liquidity of banks, central banks hope to influence the rate throughout the rest of the banking system and the economy at large. It can be compared to slashing a whip, with the central banks holding on at one end of the whip and the effects rippling out the whip. Many central banks learned the hard way over the years that holding on to the whip in more than one place could be painful. Market expectations and assessments as well as the enormous amounts of money in the markets meant that it was impossible and often painful to hold on to two or more points of the whip.

In very generic turns, the whip has two dimensions

One dimension is maturity, ranging from overnight money to 30-year bonds. Another dimension is credit risk, ranging from risk on central banks in their own currency, i.e. nil, to junk bonds. It is generally recognised that the transmission from financial conditions to the real economy mostly takes place some way out both curves. Central banks normally influence these points by setting the shortest rates and influencing the expectations that help determine these points.

As the developments in both money market rates and corporate funding rates show, the development during the financial crisis was extreme, cf. chart 5.

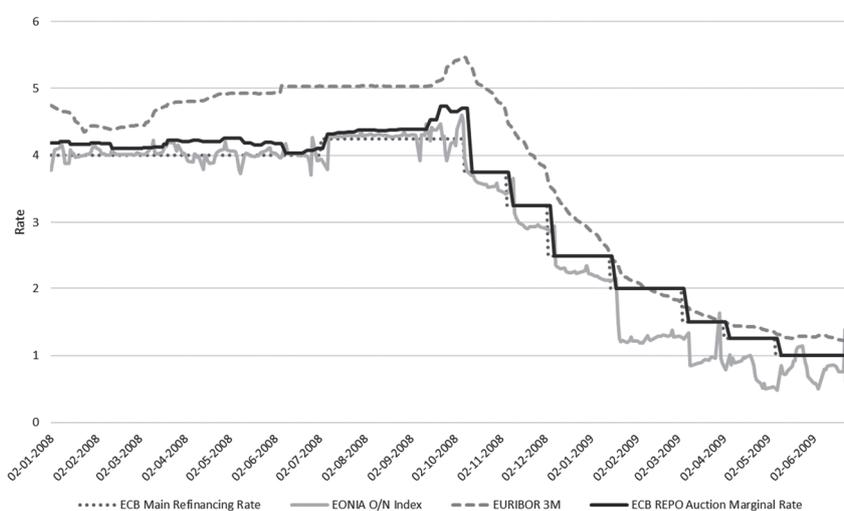


Source: Bloomberg

Chart 5: The disconnect between monetary policy rates and funding conditions.

The transmission from central bank rates to these other rates was limited at best. On top of the problems with the price link, there is likely to have been significant quantitative rationing in bank's granting of credit. Central banks were thus faced with the choice between not doing their job or potentially being hit by a whip doing their job. Most fortunately opted for the latter. The problems that central banks faced in the transmission mechanism also reduced the risks from being hit by the whip. As markets were disconnected because of severely reduced risk taking capacity, both the possibility and the need to influence the transmission increased.

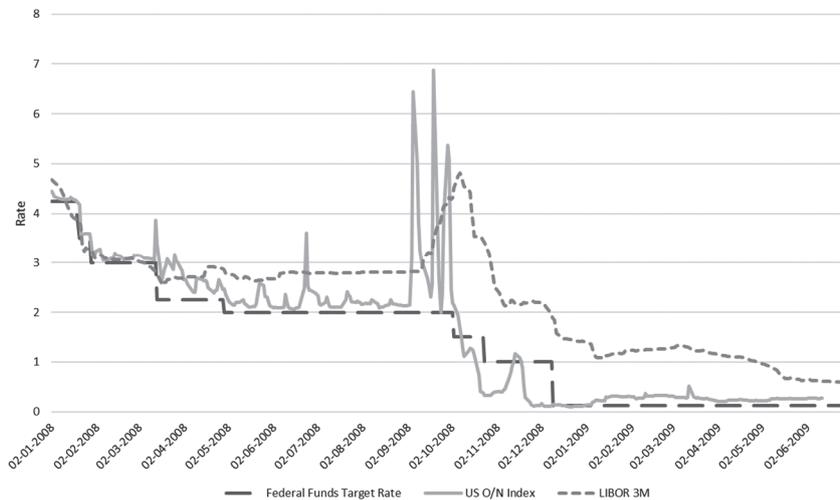
Controlling short-term rates proved difficult for central banks. For the ECB the uncertainty as whether an individual bank – as opposed to the banking system – would get enough liquidity led to overbidding and drove market rates well above the minimum bidding rate (up till late 2008). The ECB eventually responded by introducing full allotment at the minimum bid rate. This led to increased allotments, significant deposits at the deposit facility and o/n rates well below the minimum bid rates (from 2009), cf. chart 6.



Source: Bloomberg.

Chart 6: The ECBs problem in controlling short-term rates.

The Fed experienced the same problem with excess demand and market rates well above the policy rates. The Fed introduced a number of new facilities, went out the yield curve, lowered collateral requirements and even introduced swap facilities, where foreign central banks could pass on USD to their banks. As with the ECB, the FED also had issues with o/n rates being lower than policy rates, cf. chart 7.



Source: Bloomberg.

Chart 7: The Fed could not do it either.

Both banks experimented with the trade-off between interest rate volatility and getting the money market to work.

The problems in the short end seem almost of a technical nature, when compared to the problems in the long end and out the credit curve. To start with the latter, financing conditions for corporations became completely detached from monetary policy rates following the fall of Lehmann, as evidenced by rates on corporate bonds. The markets started seriously – and for good reasons – to doubt whether banks were going concerns or were about to fail as shown by the performance of bank stocks. Banks acted collectively by stopping what could be stopped in terms of commitments to the economy. In particular the Fed intervened in capital markets to ease credit conditions by setting up facilities to buy commercial papers as well as long-term bonds, including mortgage bonds. The policy was coined credit easing as opposed to quantitative easing. The ECB fairly late in the crisis committed to buying mortgage bonds, but its' focus in terms of market interventions was much more on the market for government bonds reflecting the divergence in rates on government bonds from different countries.

For the banks it was no more a question of liquidity, but of solvency. The governments took the lead role from central banks as guarantees and capital injections were introduced to restore confidence. Bagehot's advice proved insufficient. Thereby the governments exposed themselves, and yields on government bonds also became indicators of whether the governments had the capacity to save the economy. There were cases and moments, where the markets strongly signalled doubts.

As the banks capacity to bear risk diminished, the traditional transmission of central bank policies through the banking system was questioned. In particular the Fed, but also the Bank of England, started to circumvent the banking system and act not only as lender of last resort to the banks, but also to the economy at large. In assessing this policy, it is important to note that capital market financing has traditionally been much more important in the US and the UK than in the Euro area. The risk to the policy was skewing capital markets in favour of the instruments that the central bank buys. From the outside it also seems that the Euro area was constrained by capital markets differing from country to country. France has historically had the biggest corporate bond market and a very active commercial paper market. Thus, intervening in these markets in a similar manner as the FED could be seen as favouring one country rather than the area as a whole.

Central Banks balance sheets have changed substantially because of their operations in response to the financial crisis, cf. chart 8 and 9.

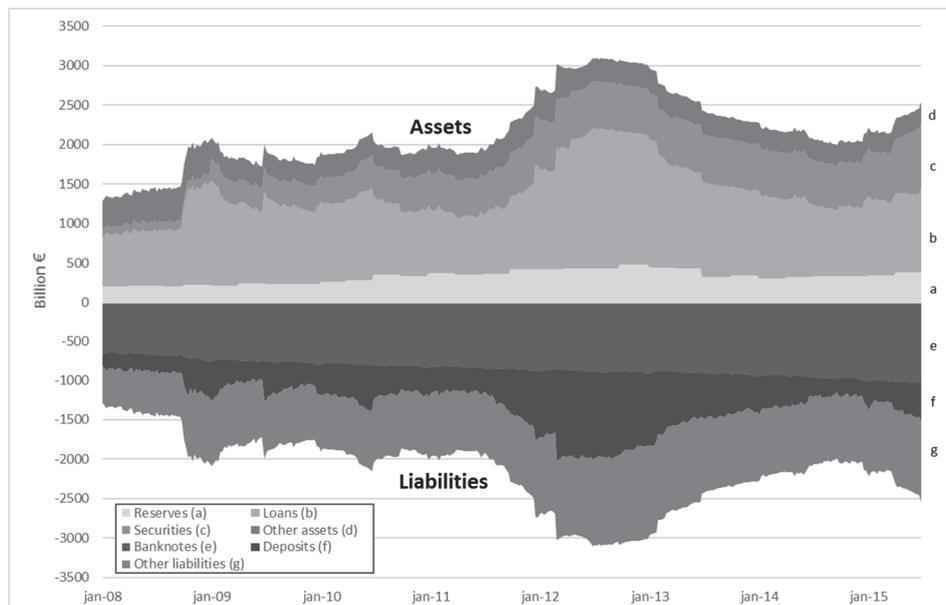
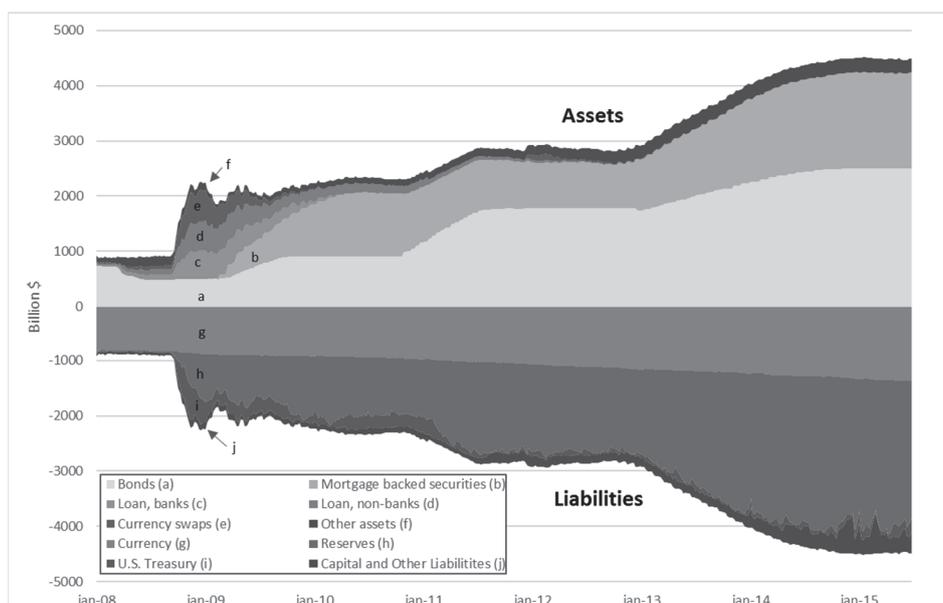


Chart 8: The development in the balance sheet of the ECB.



Source: ECB and Fed websites.

Chart 9: The development of the balance sheet of the Fed.

Both central Banks balance sheets grew substantially and the composition changed as new facilities were introduced. The growth in the balance sheets began for both the ECB and the Fed around September/October 2008. That was when they gave up on managing quantities. They had to give up on managing quantities in order to manage prices (rates). By comparing developments in chart 8 and 9 to developments in chart 6 and 7, it is evident that shortly after letting go of quantities, the repo auction rate and the o/n index rate moved towards the main refinancing rate and the Federal Funds target. With a further delay, longer term unsecured rates followed the other rates.

The problem for the central banks was twofold. One, the commercial banks wanted to hold more liquidity (deposits at the central bank) as a precaution in uncertain times. Two, the commercial banks who had liquidity did not in all cases want to lend to the banks that needed the liquidity. The bank's demand for liquidity therefore exceeded what would be expected under circumstances that are more normal. As long as the demand at the policy rates was not met, the corresponding market rates had to go up in order for the market to clear.

In the subsequent phases of the financial crisis, central banks have used balance sheet expansion beyond the objective of steering short-term rates. There is a lively

discussion on whether these policies have an impact beyond signalling rate intentions respectively influencing only the price of the assets bought. However, this debate goes beyond the scope of this article.

5. Final considerations

If central banks were assessed by normal financial standards and leaving aside their possibility to print money, they would seem highly leveraged. Their way back to normality raises some interesting questions. The issues can be split in two. The first issue is how they move from the present situation to some form of normality. The second issue is what that form of normality is.

In relation to the first issue, there is both a question of adjusting rates and adjusting quantities.

Adjusting rates will involve adjusting both the key policy lending rate as well as the deposit rates, as long as part of the banking system has a surplus position towards the central bank, and part of it is in deficit, and the two parts are not exchanging liquidity.

Adjusting quantities can be done both before and after adjusting rates, but it will have an impact on the monetary policy stance. Part of the liquidity supplied has been supplied further out the maturity and credit curve. As that liquidity is withdrawn, or rather as these positions are unwound, it will influence the supply of funding in these segments and thereby alter prices. Furthermore, to the extent that the commercial banks demand for liquidity develops at a different speed than the withdrawal of the central banks supply, it will influence money market conditions.

In relation to the second issue, the Financial Stability Forum in April 2008 recommended that

Central bank operational frameworks should be sufficiently flexible in terms of potential frequency and maturity of operations, available instruments, and the range of counterparties and collateral, to deal with extraordinary situations.

In short, central banks should be capable of playing all the parameters covered in table 4. Most likely, however, central banks will settle for a set up that under normal circumstances is more constrained, and leave the possibility to alter the parameters to when it is needed.

It may be worthwhile, however, as part of deciding on a new operational framework to conduct a more explicit cost and benefit analysis relative to the very general benchmark of

One central bank facility, where anybody in the economy could borrow against good collateral, at any time of the day, all days of the week, and however much they wanted. The central bank would set one short-term interest rate, e.g. an overnight rate.

Prior to the financial crisis monetary policy implementation was made more complicated by the additional objective, to steering short-term interest rates, of developing a money market. During the crisis financial stability became the paramount objective. Financial stability is likely to continue to be an objective for central banks. The question is, whether it will continue to have an impact on monetary policy implementation or can be addressed through other instruments.

Monetary policy instruments have evolved along national and regional paths as suggested by the earlier mentioned different choice of key parameters. There is now a possibility to let form be decided by function.

Literature:

- Aruoba, S. (2005): *Data Revisions are not Well-Behaved*, Presented at AEA Annual Meeting 2005.
- Bagehot, W. (1873): *Lombard Street: A Description of the Money Market*.
- Berg, J. and Bech, M. (2009): *Finansernes Fald*, Gyldendal.
- Bindseil, U. (2005): *Monetary Policy Implementation Theory, Past, and Present*, Oxford University Press, 2005.
- Bindseil, U. and Papadia, F. (2006): *Credit Risk Mitigation in Central Bank Operations and its Effect on Financial Markets: The Case of the ECB*, ECB Occasional Paper no. 49.
- Bindseil, U. (2014): *Monetary Policy Operations and the Financial System*, Oxford University Press, 2014.
- Borio, C. and Disyatat, P. (2009): *Unconventional monetary policies: An appraisal*, BIS Working Paper No 292.
- Danmarks Nationalbank (2009): *Pengepolitik I Danmark*, 3. Udgave.
- Diamond, D.W., Dybvig, P. H. (1983): *Bank runs, Deposit Insurance and Liquidity*, Journal of Political Economy.
- Friedman, M., Schwartz, A. J. (1963): *A Monetary History of the United States, 1867-1960*, Princeton University Press.
- Gorton, G.: (2009) "Information, Liquidity, and the (Ongoing) Panic of 2007," American Economic Review, Papers and Proceedings, Papers and Proceedings, vol. 99, no. 2.
- Taylor, J. (1993): *Discretion versus Policy Rules in Practice*, Carnegie-Rochester Conference Series on Public Policy, 39.
- Tetlow, R. (2005): *Real-Time Model Uncertainty in the United States: Robust Policies Put to the Test*, presented at AEA Annual Meeting 2005.
- Woodford, M. (2003): *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press.