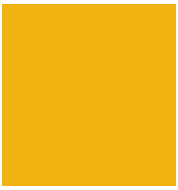
Sveriges Riksbank Economic Review

2014:2

SVERIGES RIKSBANK



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Dear readers,

Following the global financial crisis, intensive work is under way on many fronts in several central banks. This involves contributing to stricter regulations for the financial system and clarifying the objectives of the central banks and how monetary policy is affected by new macroprudential policy tools. There is also a need for a more in-depth analysis of how the functioning of the economy may have changed since the crisis. The central banks also monitor technological developments with regard to new means of payment and analyse their effects on financial stability and on the monetary policy transmission mechanism. This issue of the Riksbank's journal contains four articles related to these issues.

- Roberto Billi and Anders Vredin analyse whether a financial stability objective should affect central banks' monetary policy. Using many concrete examples from Sweden and other countries, as well as economic theory, they show that monetary policy and financial stability are closely related to one another, particularly in connection with financial crises. They therefore argue that financial stability should be an objective for monetary policy. This applies regardless of whether the central bank has the responsibility for financial stability (as in the United Kingdom), or whether this responsibility is shared with other public authorities (as in Sweden). The central banks need to continue to develop tools to estimate how an objective for financial stability and decisions on macroprudential policy measures should be taken into account in monetary policy.
- Elin Eliasson, Emil Jansson and Thomas Jansson analyse the so-called bail-in tool, which is a central part of the Bank Recovery and Resolution Directive adopted by the EU in the spring of 2014. This Directive contains regulations regarding plans and tools to manage banks in various stages of financial problems. The bail-in tool gives the authorities the right to, in combination with other measures, write down a bank's liabilities, or to convert the liabilities to share capital to recapitalise the bank. The article analyses the bail-in tool from a Swedish perspective. The authors examine how the introduction of such a tool might affect the major Swedish banks' funding costs, debt structure and investor base. They have also studied possible contagion effects, both direct and indirect, of actually using the tool on one of the major Swedish banks. The introduction of the tool is expected to lead to somewhat higher total funding costs for Swedish banks. The direct contagion effects, at least to other banks, of using the bail-in tool should be limited, while the indirect effects could be greater in Sweden than in other countries, as the Swedish banks are so closely interconnected and heavily dependent on market funding.

- Christina Håkanson analyses the matching between job vacancies and jobseekers on the Swedish labour market in the wake of the financial crisis. Earlier, both the Riksbank's and the National Institute of Economic Research's analyses showed that matching on the labour market had deteriorated since the crisis. Ms Håkanson follows up these analyses using different methods and data sources and shows that the matching problems remain with regard to employees and employers, particularly when statistics from Arbetsförmedlingen (the Swedish Public Employment Service) are analysed. One important reason is that the composition of the unemployed group has changed. The percentage of people with a weaker attachment to the labour market has increased – this includes larger shares of younger and older people and people born abroad. Although the picture of how difficult the matching problems are is affected by the data source used, the conclusion in the article is that the part of unemployment due to poorer matching probably cannot be reduced by means of more expansionary monetary policy.
- Björn Segendorf analyses the virtual currency Bitcoin, which was created to enable anonymous payments made independent of governments and banks. The article describes how the transactions are verified and implemented by a decentralised network of users. The advantages for the users are anonymity/integrity and flexibility. There are also incentives to invest in new hardware resources as the most successful participants receive new Bitcoins. The disadvantage is that Bitcoin is not covered by consumer protection and is not under public supervision. There are also confidence problems of a technical nature for Bitcoin to be able to grow as a means of payment. Use of Bitcoin is therefore still limited – both in Sweden and abroad. The article concludes with a more general discussion of the future for virtual currencies.

Read and enjoy!

Claes Berg, Tomas Edlund, Kristian Jönsson and Cecilia Roos-Isaksson

Contents

Monetary policy and financial stability – a simple story

Roberto M. Billi and Anders Vredin*

Roberto M. Billi works at the Research Division of the Riksbank and Anders Vredin is head of the General Secretariat, Sveriges Riksbank.

The depth of the recent financial crisis in many economies has forced policymakers and researchers to rethink thoroughly the connection between monetary policy and financial stability. Many argue that central banks, because of their key role in the financial system, should assume greater responsibility in preventing financial crises. Before the recent financial crisis, a common view in central banking was that, rather than deliberately leaning against potential financial imbalances, it is better to just mop up after financial crises. Because overborrowing likely contributes to financial imbalances, many now welcome the emergence of an array of micro and macroprudential policies to limit borrowing. But neither such new policies nor monetary policy can be expected to completely rule out the possibility of a financial crisis.

Introduction

In such a context, this article argues for acknowledging financial stability as an explicit objective of monetary policy, because financial stability and monetary policy are so closely linked that it is not possible to separate them. We argue that this view is based on both practical experience and economic theory, despite the still-modest progress made by economic research in integrating monetary policy and financial stability considerations. Admittedly, several difficult questions remain unanswered, and even unasked, regarding an appropriate role for monetary policy in supporting financial stability. Nevertheless, the article provides a perspective that arguably fits well with standard notions of monetary policy as found, for example, in many macroeconomics textbooks.

We begin our simple story with examples of central banks that explicitly acknowledge the importance of financial instability considerations in their monetary policy decisions. Next, we use a simple model of the central bank's decision problem to describe the connection between monetary policy and financial stability. We then consider a description of modern money markets to explain the complex channels by which monetary policy affects the economy. Finally, we review recent experience before, during and after the recent financial crisis to show the influence of monetary policy on credit conditions and risk-taking. The overall picture is of a strong connection between monetary policy and financial stability considerations.

* We thank Claes Berg, Peter Englund, Marvin Goodfriend, Lars Hörngren, Stefan Ingves, Eric Leeper, Jim Nason, and Pehr Wissén for valuable input, although any shortcomings in the content remain ours.

Central banks attach importance to financial stability

In practice, many central banks already incorporate financial stability considerations into their monetary policy frameworks.[1] A very clear example is the Bank of Canada, which states that "the Bank must also make a judgment about the most appropriate horizon for returning inflation to target, so as to minimize the economic and financial volatility that these actions may cause".[2] Other central banks have made similar statements. For example, the Reserve Bank of New Zealand states much more generally that it takes into account "the soundness and efficiency of the financial system" when deciding monetary policy.[3] Norges Bank has stated that it sets the policy rate such that it counteracts the build-up of financial imbalances.[4] And the Bank of England has announced that its monetary policy decisions are related not only to how it expects inflation and unemployment to develop, but also to potential threats to financial stability.[5]

Based on these statements, it is not particularly surprising to claim that many central banks already attach special importance to financial stability. It is, however, more controversial to argue whether financial stability can be viewed as an explicit objective of monetary policy. To shed light, guidance can be sought in legislation, economic theory, and practical experience. Before proceeding, we can summarise what legislation says about Sveriges Riksbank.

The Sveriges Riksbank Act states that "the objective of the Riksbank's activities shall be to maintain price stability. The Riksbank shall also promote a safe and efficient payments system".[6] This objective is entirely consistent with EU regulations, in which it is stated that the European System of Central Banks (ESCB) shall define and implement monetary policy, but also "promote the smooth operation of payment systems" and "contribute to the smooth conduct of policies pursued by the competent authorities relating to the prudential supervision of credit institutions and the stability of the financial system" (Article 127 of the EU treaty).[7] The EU regulations thus give the national central banks a certain amount of responsibility for the payments system and the financial system.

The Riksbank equates its task regarding a safe and efficient payments system with financial stability: "A safe and efficient payments system requires a stable financial system so that payments and the supply of capital can function smoothly (...) The Riksbank has chosen to define financial stability as meaning that the financial system can maintain its fundamental functions and also has resilience to disruptions that threaten these functions" (Sveriges Riksbank, 2013a).[8]

1 This claim has been made by several others before, see for example Bryant, Henderson and Becker (2012).
2 Bank of Canada, see www.bankofcanada.ca/wp-content/uploads/2010/11/monetary_policy.pdf
3 Reserve Bank of New Zealand, see www.rbnz.govt.nz/news/2012/4941968.html
4 Norges Bank, see www.norges-bank.no/pages/88292/MPR_1_12.pdf
5 Bank of England, see www.bankofengland.co.uk/publications/Pages/news/2013/096.aspx
6 Sveriges Riksbank, see www.riksbank.se/en/The-Riksbank/Legislation/The-Sveriges-Riksbank-Act
7 European Central Bank, see www.ecb.europa.eu/ecb/tasks/html/index.en.html
8 Such an interpretation of the term financial stability is not uncommon, see Schinasi (2004).

Although there is no self-evident definition of financial stability, most policymakers and economists would agree that financial stability is important or even crucial for monetary policy.[9] First of all, adverse shocks in financial markets are likely to curb economic activity. One prominent example is the occurrence of a banking crisis that leads to a credit crunch, a fall in aggregate demand, and thus downward pressure on inflation. Secondly, and related, disruptions in financial markets can impair the effectiveness of monetary policy in stabilising the economy. At the same time, however, how to actually predict and prevent the occurrence of a financial crisis remains controversial.[10]

A simple model of monetary policy and financial stability

In light of economic theory, it is reasonable to argue that central banks have good reasons to include a financial stability objective in their monetary policy frameworks. To clarify, let us consider the assignment of responsibilities for monetary policy and financial stability in the context of a simple economic model.

For example, for the sake of argument, let us consider the implications of the central bank having three explicit objectives, namely stabilising inflation and economic activity and maintaining financial stability.[11] Woodford (2012) explains why this may be a desirable formulation of the central bank's objectives, from a theoretical perspective. Woodford's argument is, briefly, that imperfections in credit markets may reduce welfare through mechanisms that are not fully reflected in forecasts for inflation and economic activity. Such a formulation of the central bank's objective function is also consistent with central banks' practices, judging from the policy statements presented above.

To pursue its objectives, the central bank might have two types of policy tools at its disposal. One set of instruments may be labelled monetary policy and includes the central bank's short-term interest rates on loans to banks, but possibly also other conditions for such lending. Another set of instruments may be the recently introduced macroprudential policies.[12] One example of a macroprudential policy tool is a counter-cyclical capital adequacy requirement for banks; other examples are liquidity requirements for the banks, as well as restrictions on household debt in relation to pledged assets (LTV ratios) or in relation to income (LTI ratios). In such a setting, economic theory offers some guidance as to connecting monetary policy and financial stability, as opposed to a complete division of those responsibilities among separate authorities.[13]

9 See Dudley (2013), King (2013), Ingves (2014), Stein (2014) and Yellen (2014) for more detailed discussions.
10 See, for example, Rajan (2005) for a discussion of various risk indicators and further literature references.
11 Economic research offers some guidance regarding the choice of good measures of inflation, economic activity, and financial stability. Such research also indicates that central banks should monitor a range of indicators to assess performance with respect to each objective, see Woodford (2012).
12 The arguments that follow do not rely on the existence of macroprudential tools. Similar arguments would still hold if the analyses concerned two different instruments of monetary policy instead.
13 For simple and intuitive examples, see Bryant, Henderson and Becker (2012), Cechetti and Kohler (2012), Svensson (2012) and Woodford (2012). See Smets (2013) for a broad literature review.

In one scenario, monetary policy and macroprudential policy are coordinated. Thus, both types of policy tools (policy interest rate and macroprudential policies) are used together to pursue all three objectives (stabilising inflation and economic activity and maintaining financial stability). In this case, because the central bank ultimately has to balance its objectives, the central bank will deliberately lean against potential financial imbalances in its decisions on monetary policy, because doing so contributes to overall economic performance. As usual, it is difficult to draw straight lines between economic theory and practice. Still, a central bank that comes fairly close to this model of coordination of responsibilities is the Bank of England. In practice, the decisions on monetary policy and macroprudential policy in the Bank of England are taken by two different committees, the Monetary Policy Committee and the Financial Policy Committee, but there is an explicit aim to coordinate between monetary and macroprudential policy.[14]

In another scenario, by contrast, the responsibilities for different objectives are assigned to separate authorities.[15] In particular, for the sake of argument, assume that the central bank's task is to use the policy interest rate to stabilise inflation and economic activity, while a separate authority uses the macroprudential policies to pursue financial stability. In this case, even though responsibilities are assigned to separate authorities, each authority has to take into account the effectiveness of both monetary policy and macroprudential policy. For example, the central bank has to factor into its policy rate decisions the potential threats to financial stability, if the degree of financial stability affects inflation and economic activity.[16] At the same time, the authority in charge of macroprudential policies has to factor into its own decisions the uncertainty about the monetary transmission mechanism, if monetary policy has influence on financial stability.

A country that, at first glance, resembles to a certain extent this model of separation of responsibilities is Sweden. In fact, recent legislation in Sweden has assigned to Finansinspektionen (the Swedish Financial Supervisory Authority) the main responsibility for macroprudential policy tools. Nevertheless, a key part of the process regarding macroprudential policy in Sweden is a close cooperation between Finansinspektionen, the Riksbank, the Swedish National Debt Office, and the Government through the Ministry of Finance. Each of these authorities is assigned specific roles in the work with financial stability. At the same time, all of them are represented on the Financial Stability Council, which meets regularly to discuss issues of financial stability and how financial imbalances can be counteracted.

In both scenarios, the quantitative importance of financial stability for monetary policy, and vice versa, will of course depend on the strengths of various transmission mechanisms between disturbances to the economy and the central bank's objectives, as well as the

14 See www.bankofengland.co.uk/monetarypolicy/Documents/pdf/chancellorletter140319.pdf
15 Of course, while separate authorities could in principle coordinate, any coordination must be self-imposed.
16 This example bears resemblance with a monetary policy strategy outlined in the Riksbank's Monetary Policy Report of July 2013 (Sveriges Riksbank, 2013b), in which policy rate decisions take into account the possibility of a financial crisis occurring beyond the usual forecast horizon of two years ahead. Such a strategy is consistent with the policy recommendations given by Borio (2014).

policy response.[17] However, the practical consequences for monetary policy may not be very different between the two "models" described. In both cases, it is probably optimal for monetary policy to respond to changes in the degree of financial stability, while at the same time reacting to the forecasts for inflation and economic activity. But how strong the response of monetary policy should be is a quantitative and empirical issue.

The implication from economic theory, that monetary policy should be used to promote financial stability, is entirely consistent with the roles that central banks have had within the financial system in a historical perspective, as clearly illustrated for example by Capie, Goodhart and Schnadt: "Besides their macro objective of price stability, central banks have a micro objective of maintaining financial stability, especially in the core areas of the payment system and the commercial banks who operate it".[18] One reason why central banks have been given these roles is that a stable financial system arguably is a prerequisite for an effective monetary policy. This is because the financial markets and how they function affect the impact that monetary policy has through the interest rates that households and firms have to pay on their loans. The economic consequences of a financial crisis also have a direct impact on price stability, growth and employment. Another reason is that central banks, as providers of means of payments, have the capacity to manage financial crises and other serious disruptions in the financial system to ensure that the systems of payments and credit support a well-functioning economy at large. This follows from, among other factors, the central bank's role as a bank for the banks in normal times and occasionally as a lender of last resort: the central bank is assumed to quickly supply money to the financial system if the need arises. As noted by Smets (2013), there are even researchers who argue that, basically, price stability and financial stability are so closely linked that it is just not possible to separate these two objectives.

Based on both economic theory and the normal roles that central banks have fulfilled throughout history, it is entirely reasonable for the Riksbank to have a mandate to promote a safe and efficient payment system and for this mandate to mean that the Riksbank is responsible for promoting financial stability. But unlike the monetary policy task, the Riksbank shares its responsibility for safeguarding financial stability with other authorities.

It should be stressed that there are also arguments against giving the central bank and monetary policy responsibility for financial stability. The main argument is probably that central banks have been given a high degree of independence from the political system in order to increase the credibility of the narrower objective of price stability. Even if a broader mandate may have economic advantages, these must be weighed against possible disadvantages associated with weaker political support for independence and lowered credibility for the price stability objective. Although a detailed discussion of such issues is beyond the scope of this article, they of course remain relevant.[19]

17 See, for example, Gelain, Lansing and Mendicino (2013) and Jonsson and Moran (2014) for formal analyses of such issues. See Smets (2013) for further references.

18 See Capie, Goodhart and Schnadt (1994), pp 91-92.

19 For further discussions, see Bryant, Henderson and Becker (2012), Goodfriend (2012) and Smets (2013).

The role of central banks and modern money markets

So far we have limited our discussion to the implications for monetary policy of the central bank having an objective of financial stability. But we also have to discuss *how* monetary policy influences the degree of financial stability and other objectives.

Economic theory on the roles and effects of monetary policy necessarily relies on highly simplified assumptions, but those simplifications can make it difficult to understand important features of the recent financial crisis. This difficulty, in turn, makes it hard for policymakers to draw clear lessons from the financial crisis. For example, unlike the usual depiction of monetary policy in macroeconomics textbooks, the policy interest rate set by the central bank is clearly not the only interest rate relevant for price stability and financial stability. In modern financial markets, there is actually a vast spectrum of financial assets with varying degrees of "liquidity" and providing different rates of return.[20] How the term liquidity should be defined is not clear-cut, but one possible definition is that an asset is more liquid the "more easily" it can be used as, or converted into, a means of payment for different types of transactions. Of course, wanting an asset with relatively high liquidity comes at a cost, in the form of a reduced rate of return earned by the asset.

At the same time, banks are clearly not entirely passive subjects of monetary policy as usually depicted in macroeconomics textbooks. Banks do not mechanically convert deposits collected from the general public into loans and liquidity reserves. Rather, they obtain funding not only through deposits from the general public, but also by selling (issuing) securities on financial markets. They also make active decisions on the extent of credit risks and liquidity risks they are willing to take. The banks' liquidity risks are typically not managed by them having reserves in deposits with the central bank, but by them investing part of their funding in government bonds and other easily tradable financial assets. The interbank market also plays a role in the liquidity planning and short-term funding of banks. On the interbank market, banks lend to and borrow from each other. Banks that currently have more funding than they need for their current and planned lending can lend to other banks, and vice versa.

In the financial system, central banks steer interest rates through the interbank market.[21] The interest rates and other conditions set by central banks on their short-term lending to, or deposits from, the banks affect interest rates on the interbank market. For a bank that is able to borrow from or deposit funds with the central bank, the central bank's interest rate will be an alternative to that of the interbank market. As a result, for example, the interest rate on a three-month loan on the interbank market correlates strongly with the banks' expectations about how the central bank rate on shorter loans or deposits will develop in the next three months. Thus, like in a simple textbook model, the central bank does not directly steer the borrowing rates faced by households and firms, but the decisions of the central bank have indirect effects on borrowing rates via banks and

20 See, for example, Goodfriend (2011a) for a more detailed discussion.
21 Sellin and Åsberg Sommar (2012) describe the implementation of monetary policy in Sweden.

financial markets. The central bank influences the costs of the banks' short-term funding and liquidity management, which, in turn, combined with other factors, affects the interest rates faced by firms and households. Unlike in a simple textbook model, which for the sake of simplicity takes into account only a few types of financial assets, there is actually a vast spectrum of interest rates on different bonds and other securities for different maturities. The shorter the investment horizon, the greater the impact of the central bank's interest rate decisions on market rates.

The effects of macroprudential policies and other regulations of financial markets partly resemble the effects of monetary policy. Capital adequacy requirements for banks, for example, affect bank lending through similar channels as those through which monetary policy affects the economy. Given that monetary policy changes banks' ability and willingness to issue deposits and make loans, monetary policy has an impact on the economy. In practice, capital adequacy requirements affect credit supply in the economy by limiting banks' ability to expand lending and also by influencing bank's funding costs. The cost of equity is often greater than the cost of debt, because equity serves as a buffer against potential future losses that a bank is exposed to. In the case of bankruptcy, equity holders are repaid after debt holders. By changing the amount of capital banks are required to hold, regulators are basically influencing the banks' cost of doing business and, ultimately, the interest rates that households and firms have to pay on their loans.[22]

A closer look at how banks, and other financial intermediaries, operate shows that they increase their "leverage" during asset price booms and reduce leverage during busts. A bank's leverage is defined as the total of its assets divided by its equity. One reason for this pro-cyclicality of leverage is due to how banks measure credit risks and adjust their balance sheets when risks change (active management of economic capital and value at risk). During booms, the measured risk of credit losses falls and the banks are able to increase their lending for a given amount of equity. During busts, by contrast, the measured risk of incurring losses rises and the banks reduce leverage. Adrian and Shin (2008), who documented this behaviour for U.S. investment banks, argue that this behaviour tends to amplify cyclical fluctuations.[23] They also find that periods of accommodative monetary policy are normally associated with banks expanding their balance sheets through short-term funding (collateralised borrowing and repos). Conversely, during periods when monetary policy is tight, banks shrink their balance sheets. These effects of monetary policy suggest that the central bank can influence risk-taking in the banking system, both via the effects of monetary policy on general business conditions, and through the bank's incentives to rely on short-term funding.

Although the recent financial crisis probably had many different and still not well-understood causes, it seems very likely that central banks' actions through the channels we

22 See Cecchetti and Kohler (2012) for a discussion and an intuitive example.

23 Of course, in a general equilibrium model, non-leveraged institutions (such as households, pension funds, and insurance companies) can be expected to moderate the amplification mechanism that is due to the banks' balance sheet dynamics. Still, how fully they can offset this mechanism is unclear.

have just discussed affected both the build-up of financial imbalances that led to the crisis and dampened the negative spiral once the crisis erupted. We now broaden our discussion and show how central banks have been acting to promote financial stability since before the global financial crisis of 2008-2009.

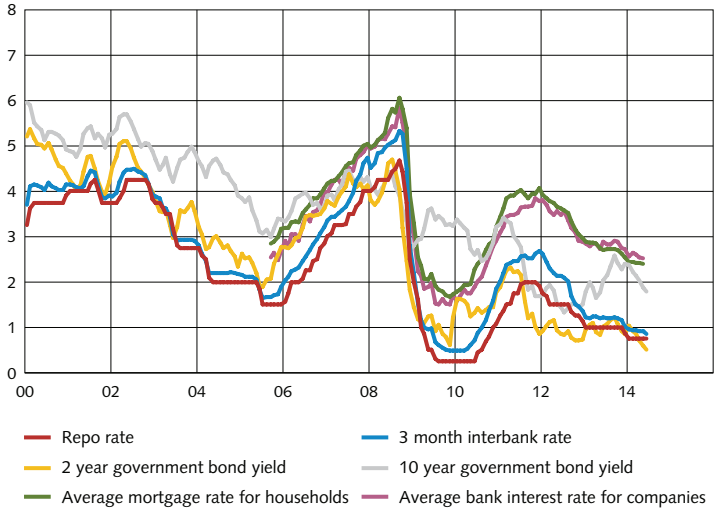
Recent experience in Sweden and abroad

The developments of central banks' actions, market interest rates and credit conditions during the recent decades, and in particular during the financial crisis, demonstrate how strong the connection is between monetary policy and financial stability.

In the financial system, the Riksbank steers interest rates through the interbank market. But interest rates to households and firms also reflect other factors, such as the costs of banks' short-term funding and the uncertainty faced by market participants about the creditworthiness of their counterparties. Figure 1 shows the Riksbank's repo rate, its policy interest rate, together with market interest rates for different maturities and different borrowers, during the period 2000-2014. For Sweden, the most severe phase of the financial crisis was between the autumn of 2008 and the autumn of 2009. Market interest rates have generally co-moved with the repo rate; but the difference, or spread, between market interest rates and the repo rate has changed over time, reflecting both a maturity premium and a credit-risk premium for loans to households and firms.[24] Such premiums, in turn, depend on the perceived safety and efficiency of the payment and credit systems. In fact, the spread between the short-term government bond rate and the repo rate has generally been small, as government bonds are viewed as safe assets. The spread between the three-month interbank rate and the repo rate increased during the crisis, but recently fell back to its pre-crisis levels. By contrast, the spread between mortgage rates for households and the repo rate increased in the crisis and still remains elevated. Overall, the risk premium for short-term funding on the interbank market has returned to pre-crisis levels, but nevertheless risk premiums for loans to households and firms remain elevated.

24 This co-movement does not imply that the repo rate has caused the observed changes in market rates, rather it probably reflects common factors.

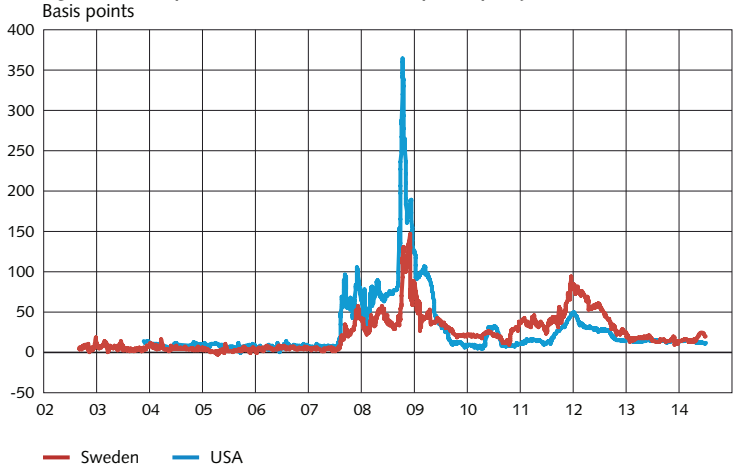
Figure 1. Swedish interest rates
Per cent



Notes. Shown are monthly averages. Government bond yields are for zero-coupon bonds.
Bank interest rates for households and companies are on new loans.
Sources: Macrobond, Statistics Sweden and the Riksbank

The financial crisis erupted in the middle of September 2008. When the U.S. investment bank Lehman Brothers collapsed, market participants' lack of confidence in the creditworthiness of their counterparties became widespread. As a consequence, access to credit on financial markets declined around the world and some markets more or less ceased functioning. Many market participants that had earlier funded themselves cheaply through short-term loans now had problems renewing these loans, and if they obtained new loans, these were much more expensive than before. The basis spread, or the difference between the three-month interbank rate and the expected overnight rate in three months' time, rose sharply in both the United States and Sweden, although to a lesser extent in Sweden (Figure 2). The basis spread rose to about 3.5 per cent in the United States and to 1.5 per cent in Sweden. But this increase in the cost of short-term funding on the interbank market did not lead to equivalent hikes in the interest rates faced by firms and households, because central banks took decisive actions to supply funding for the banking system and thereby restore confidence in the markets. Between October 2008 and July 2009, for example, the Riksbank cut the repo rate by a total of 4.5 percentage points, to the all-time low of 0.25 per cent (Figure 1). This large cut in the repo rate also limited the Riksbank's ability to use further repo rate cuts to make funding conditions for banks even more generous.

Figure 2. Basis spreads (interbank rates less expected policy rates)
Basis points



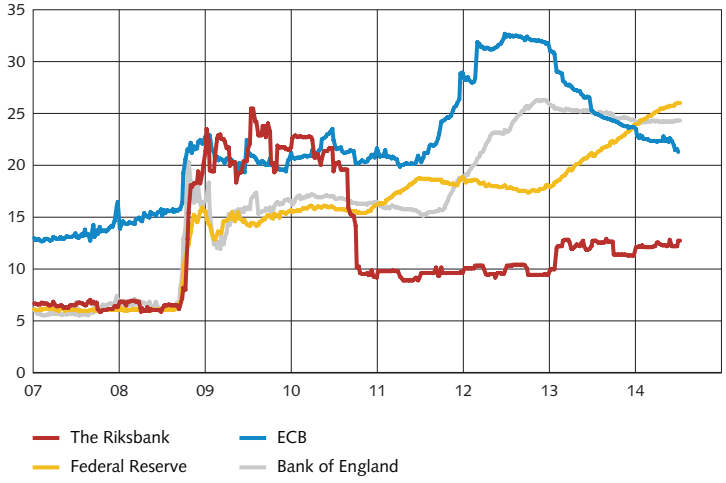
Note. The basis spread is calculated as the difference between the three-month interbank rate and the overnight swap index.
Sources: Macrobond, Reuters and the Riksbank

To further ease financial conditions, beyond what could be attained by reducing policy interest rates, many central banks took additional steps to facilitate the flows of payments and credit in financial markets. These other monetary policy measures involved, basically, the provision of loans at longer maturities than usual, accepting a broader range of assets as collateral, and extending the circle of counterparties that had access to central bank liquidity. They also involved, for some central banks but not the Riksbank, direct purchases of assets on financial markets.[25] This monetary easing resulted in an unprecedented expansion in the size of central bank balance sheets (Figure 3). For example, the Riksbank's balance sheet before the financial crisis was about 5 per cent of GDP (gross domestic product). It started to expand rapidly after the crisis erupted in the autumn of 2008 and reached well over 20 per cent of GDP by the end of the year. But it later fell to about 10 per cent of GDP by the end of 2010, as the loans extended at longer maturities to Swedish banks were repaid. Thus, the Riksbank's balance sheet has now largely returned to more normal levels than prevailed before the crisis.[26] Unlike in Sweden, however, balance sheets of other central banks, such as the Bank of England, European Central Bank and Federal Reserve, are still unusually large, relative to pre-crisis levels.

25 Some argue that such measures should be labelled "credit policy" rather than "monetary policy." See, for example, Goodfriend (2011b) for a discussion.

26 For more detailed discussions of the Riksbank's monetary policy measures during the financial crisis, see Bryant, Henderson and Becker (2012) and Elmér, Guibourg, Kjellberg and Nessén (2012).

Figure 3. Central bank balance sheets
Per cent of GDP

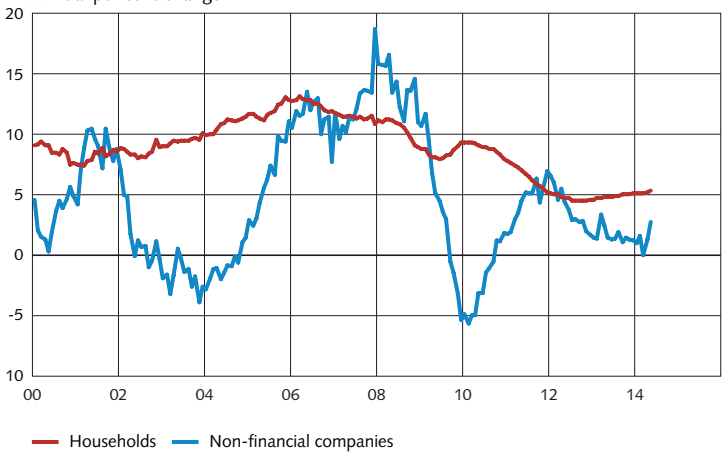


Sources: Bureau of Economic Analysis, Eurostat, Office for National Statistics, Statistics Sweden, and respective central banks

The connection between monetary policy and credit conditions is reflected in the financial system's lending to households and firms. In Sweden, bank lending to households rose about 10 per cent annually in the years before the financial crisis (Figure 4). By comparison, nominal GDP is expected to grow on average between 4 to 5 per cent annually, if average inflation is 2 per cent and average real GDP growth is between 2 to 3 per cent. Thus, in relation to economic growth, bank lending to households before the financial crisis was growing twice as fast as nominal GDP, as households were willing to borrow at such a fast pace. Bank lending to firms also surged before the financial crisis; but as a caveat this aggregate is known to be substantially more volatile than GDP, even under usual circumstances, as firms adjust spending in reaction to general business conditions. The sharp decline in bank lending to firms after the crisis erupted reflects the weak demand for credit and investments in the economy.

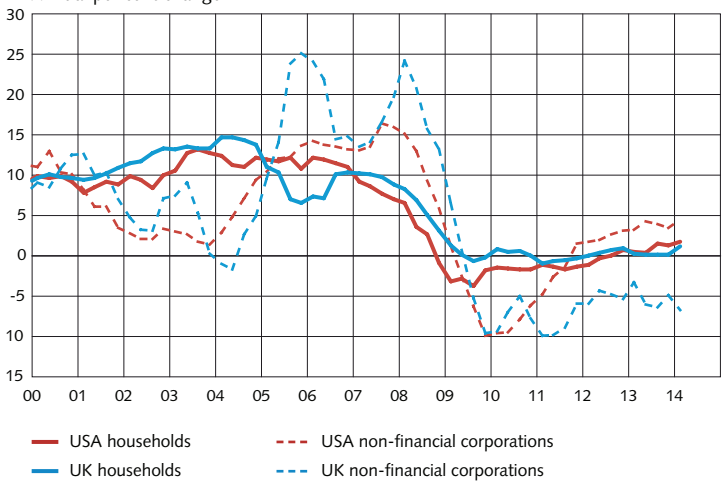
In the United Kingdom and the United States, bank lending to households and firms shows a somewhat different pattern than in Sweden (Figure 5). Credit surged in the years before the financial crisis and later plummeted, as in Sweden. But in contrast to Sweden, bank lending to households is still growing very slowly relative to pre-crisis levels. It is probable that the adjustment would have been much more abrupt if central banks had not taken decisive actions once the crisis erupted.

Figure 4. Bank lending to households and firms, Sweden
Annual per cent change



Source: Statistics Sweden

Figure 5. Bank lending to households and firms, USA and UK
Annual per cent change



Sources: Bank of England, Federal Reserve Board and Riksbank calculations

A quick summary of these developments is as follows. Before the financial crisis, risk premiums were generally low, banks had easy access to funding and credit growth was high. Most would agree this was a global phenomenon that had several causes. One notable reason was probably the high level of savings in fast-growing countries and the associated low level of real interest rates. However, the fact that risk premiums on interbank markets were very small (Figure 2) probably also reflected expectations about monetary policies. In such an environment, the banks were thus not worried about their own, or other banks', short-term funding. It seems reasonable that this widespread

feeling of certainty among banks, an expectation of continued solid economic growth, contributed to the low borrowing rates for households and firms and the high growth rates of credit.[27]

During the financial crisis, by contrast, banks faced great uncertainty about short-term funding, risk premiums rose, liquid assets became scarce, and credit growth decelerated. Central banks cut their interest rates, but this action was soon viewed as not enough to counter the negative spiral. They also felt compelled to support credit supply in other respects. Thus, central banks expanded their balance sheets in unprecedented ways.

Most would agree that, during a financial crisis, central banks should take action to stabilise financial markets and the broad economy by encouraging risk-taking in the banking system. A more controversial issue is to what extent central banks' monetary policies contribute to the build-up of financial imbalances that lead to financial crises. Because the channels by which monetary policy affects the economy are partly the same for crisis management and for normal stabilisation policy, it is entirely reasonable to argue that a somewhat less accommodative monetary policy before a financial crisis could lead to better economic performance. In this sense, in our opinion, maintaining financial stability should be an explicit objective of monetary policy, not only in times of financial crisis but also in normal times.

Concluding remarks

In recent years, central banks in most economies have had to focus on mopping up after global financial crises, while an array of micro and macroprudential policies are being developed and tested. In such an environment, policymakers and researchers are forced to rethink thoroughly the connection between monetary policy and financial stability. Should financial stability considerations be kept separate, as before the financial crisis?[28] Or should monetary policy decisions take into account the possibility of a financial crisis occurring?

We find that, in light of both economic theory and practical experience, financial stability and monetary policy are so closely linked that it is just not possible to separate them. However, the effects of monetary policy and of micro and macroprudential policies are a quantitative and empirical issue.[29] Macro models in use before the financial crisis could apparently not predict the crisis. These models thus provide insufficient (but still useful) guidance on the quantitative and empirical relationships. Indicators of credit conditions, such as credit volumes, risk premiums and house prices, were not directly taken into account in monetary policy decisions before the crisis. As new policy tools emerge, a

27 Rajan (2005) presents an overview of the signs of increased risks and their possible causes, including monetary policy. The existence of a "risk-taking channel" of monetary policy is discussed, for example, by Adrian and Shin (2008) and Jiménez and other (2014). See Apel and Claussen (2012) for a literature review.

28 An example of the separation of monetary policy and financial stability before the crisis is that the Riksbank and many other central banks published separate reports on monetary policy and financial stability. This is still the case, but the ambitions to bring the analytical frameworks closer together have been raised.

29 See Yellen (2014) for a recent statement, and further references to recent research, about the relative importance of monetary policy, macroprudential policy and other regulations.

new analytical framework has to be developed, to help policymakers make good decisions and communicate those decisions clearly to the general public. To make progress, we argue that less time should be spent debating whether monetary policy and financial stability are connected. Instead, more resources should be devoted to improving our understanding of the connections.

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The bail-in tool from a Swedish perspective

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In the spring of 2014, the European Parliament and the European Council[1] adopted the Bank Recovery and Resolution Directive (BRRD)[2]. It contains provisions on plans and tools to enable authorities in EU member states to intervene when banks[3] encounter various stages of financial difficulty. Part of the BRRD describes four resolution tools, one of which is the so-called bail-in tool. The bail-in tool empowers a resolution authority[4] to, in combination with other measures, write down a bank's liabilities to cover losses or to recapitalise the bank by converting its liabilities to equity according to a specific order of priority.

The bail-in tool and its potential effects have been greatly analysed internationally. However, there has been no in-depth analysis based on Swedish circumstances. This paper therefore aims to analyse the bail-in tool, as it is described in the BRRD, from a Swedish perspective. The analysis focuses on the four major Swedish banks, which are of decisive importance to the workings of the Swedish financial system.[5]

In this paper, we analyse how the introduction of a bail-in tool could affect the cost of funds, liabilities structure and investor base of the major Swedish banks. We have also studied potential contagion effects, both direct and indirect, of actually using the tool on one of the major Swedish banks.[6]

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1 Ultimately adopted by the European Parliament on 15 April 2014 and by the European Council on 6 May 2014.

2 Directive 2014/59/EU of the European parliament and of the Council of 15 May 2014 establishing a framework for the recovery and resolution of credit institutions and investment firms and amending Council Directive 82/891/EEC, and Directives 2001/24/EC, 2002/47/EC, 2004/25/EC, 2005/56/EC, 2007/36/EC, 2011/35/EU, 2012/30/EU and 2013/36/EU, and Regulations (EU) No 1093/2010 and (EU) No 648/2012, of the European Parliament and of the Council.

3 "Banks" in this paper refers to credit institutions and investment firms, as well as undertakings included in the same group as such firms. It is such firms for which the BRRD constitutes a framework.

4 Each country is to appoint such a resolution authority, or several such resolution authorities, with responsibility for planning for financial crises and management thereof.

5 Combined, they account for around 80 per cent of lending and receive 75 per cent of deposits in Sweden. Financial Stability Report 2014:1, Sveriges Riksbank.

6 Direct contagion effects arise because participants in financial systems borrow from each other. If such loans are impaired, losses arise for the creditor, and problems spread in the financial system. Indirect contagion effects can arise through two main channels. First, markets can assume that there are direct contagion effects, even if this is not the case. Second, if a bank experiences financial difficulty, markets might anticipate that other banks in the same system will be affected by the same problems, which can in turn lead to investors wishing to exit their investments. Indirect contagion effects are thus problems that spread in financial systems, but that are not due to direct exposures.

A new method for managing distressed banks

The bail-in tool is a key tool in the EU's new regulatory framework governing how member states are to manage distressed banks – the Bank Recovery and Resolution Directive (BRRD). The Directive is one of several regulations established in the wake of the financial crisis.

The Directive provides authorities with tools for the recovery or resolution of failing banks in a way that should prevent serious disturbances in the financial system and minimises the cost to taxpayers. The bail-in tool empowers a resolution authority[7] in combination with other measures[8], to write down a bank's liabilities to absorb losses or to convert liabilities to equity to recapitalise the bank, according to a specific order of priority.

In order to implement the BRRD, member states are to adopt and publish the requisite laws by no later than 31 December 2014. They shall apply as of 1 January 2015. However, application of the bail-in tool is not required before 1 January 2016, although there is nothing that prevents member states from deciding to apply it earlier.

At the same time as the BRRD is now adopted by the EU, the Financial Stability Board (FSB) is developing proposals on how to ensure that global systemically important banks have sufficient loss-absorbing capacity once authorities have decided to place such a bank under resolution. It is a case of the ability of the bank's liabilities side to cope with incurred losses and recapitalisation needs without needing to use public funds. The BRRD contains a calculation method for a minimum requirement with the same objective (see the section *Calculation of minimum requirement* for more details). In the FSB discussions, the concept is called Gone-Concern Loss-Absorbing capacity (GLAC).

The questions that have come under most discussion for GLAC are what criteria that must be met for an instrument to be counted as GLAC, how much GLAC should global systemically important banks hold, and where in the organisational structures of such banks should GLAC be kept?[9]

FSB intend to submit its proposal at the G20 meeting in Brisbane in November 2014 and it will be then be circulated for consultation. The plan is to also perform a comprehensive impact analysis. The prospect of the EU potentially needing to revise its rules regarding the minimum requirement (at least for global systemically important banks), if the FSB's final proposal proves too dissimilar to the BRRD, cannot be ruled out. This article is however based on BRRD in its current form.

7 Each member state is to appoint one or more resolution authority(ies), which will be empowered to apply the resolution tools. The resolution authority will be responsible for preparing for a financial crisis and management thereof. The resolution authority may be a separate authority, but the assignment can also be bestowed on a ministry, central bank or supervisory authority.

8 The bail-in tool can either be used on a stand-alone basis for the recovery of the bank under resolution, or in combination with one of the other resolution tools (the sale of business tool, the bridge institution tool or the asset separation tool).

9 See Mark Carney's letter to the finance ministers and central bank governors of the G20 countries (April 2014).

THE CONCEPT OF BAIL-IN

A bail-in tool empowers a resolution authority to, in combination with other measures, write down a bank's liabilities to absorb losses. In a scenario of a bank being placed into resolution, equity may not suffice to absorb the losses. In such a situation, the use of a bail-in tool creates additional loss-absorbing capacity in the bank. The intention is that the write-down of debt instruments should cover all incurred and expected losses. The authority is also empowered to convert debt instruments to equity to recapitalise the bank so that it may continue to function. Such conversion may take place either in combination with a write-down or as a stand-alone measure.[10]

The use of the banks' own liability side to absorb losses and recapitalise the bank means that the need to use public funds for that purpose can be postponed, reduced or completely avoided.

THE PURPOSE OF THE BAIL-IN TOOL

The bail-in tool has several, interlinked, purposes.

- Banks' creditors, rather than the taxpayers, should carry the cost of failing banks in the future.
- A reduction in implicit government guarantees. If the new rules are implemented, authorities will no longer need to choose between letting the bank fail and bailing it out using public funds. Reduced government guarantees could lead to creditors gaining more incentive to control the bank's risk-taking (see the section *Total cost of funds* for more details).
- It should be possible to recapitalise the bank swiftly while systemically important parts of the bank may continue to function at the same time. The bail-in tool theoretically enables authorities to manage a failing bank while limiting the effects on the financial system by avoiding a closure of the bank and hence liquidation of its assets. However, potential contagion effects cannot be entirely eliminated, which are further discussed in section *Potential contagion effects from application of the bail-in tool*.

An authority rescuing a bank using public funds is known as a bail-out. There are three primary reasons for authorities to perform a bail-out:

- Banks maintain critical functions of the financial system, and a failure would lead to the functions performed by the bank in question being suspended.

10 It is easiest to envisage the write-down and conversion occurring in two stages. First, share capital is reduced and liabilities are written down until all losses are absorbed, and liabilities are subsequently converted to equities. In such a case, remuneration would be payable for the conversion by means of the creditor receiving the same value in the form of equities as he pays for in liabilities. Hence, the conversion does not bring about any transfer of value. In practice, however, the bail-in can be accommodated in the conversion by means of the conversion rate established by the resolution authority also taking account of the loss absorption.

- Banks often have substantial exposures to each other, so if one bank fails, others could follow.
- A failing bank could give indirect contagion effects, such as loss of market confidence.

So, the failure of one bank could result in considerable financial instability.

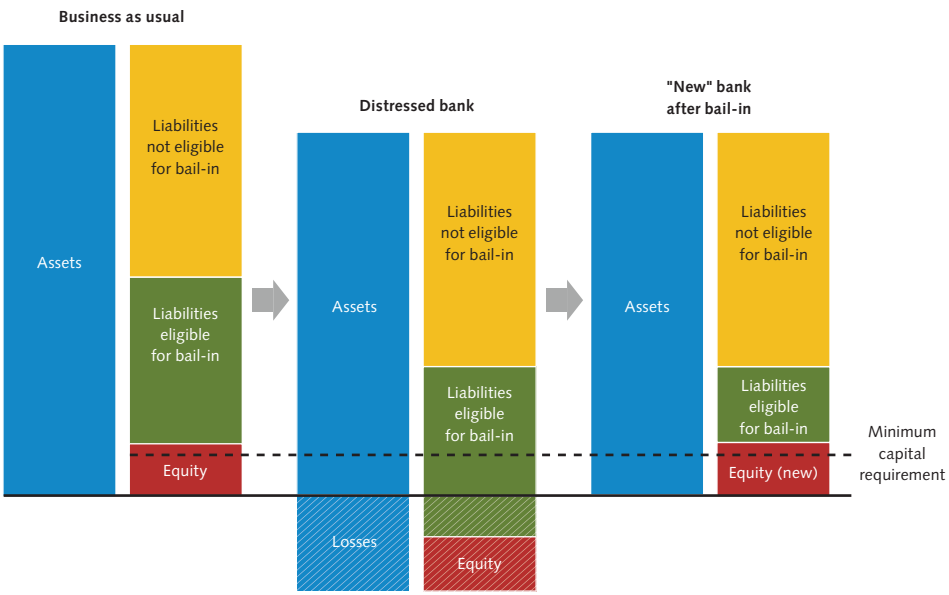
Historically, authorities have had to choose between two alternatives – letting the bank fail or bailing it out using public funds. The BRRD changes this. The intention of resolution is that there should be a way of resolving systemically important banks that does not risk triggering a financial crisis and which, at the same time, lets the bank's owners and creditors carry the cost, rather than taxpayers.

APPLICATION OF THE BAIL-IN TOOL

Figure 1 gives a simplified example of application of the bail-in tool on a distressed bank's balance sheet. Initially we can see the bank under normal circumstances ("business as usual" at the far left). On the liability side, the bank has equity, liabilities eligible for bail-in (such as unsecured bonds) and liabilities that are exempted from bail-in (such as covered bonds). Which debt instruments are potentially at stake is further discussed in the section *Liabilities exempted from bail-in*.

In the next step, losses occur ("distressed bank", in the middle of the diagram). The assets decrease by the losses (the stripy blue box) and all the equity is wiped out. However, it does not suffice to cover all losses.

Figure 1. Simplified description of application of the bail-in tool on the balance sheet of a distressed bank



Subsequently, the resolution authority applies the bail-in tool. The liabilities eligible for bail-in are written down by an amount equal to the stripy green box in the middle balance sheet. Then, around half of the remaining liabilities eligible for bail-in are converted to equity (the red box in the balance sheet to the far right). The bank has now been recapitalised ("New" bank after bail-in, far right).

It is important to bear in mind that, as part of this process, a valuation of the bank will be needed. The resolution authority will, based on a valuation performed by an independent valuer, have to evaluate the extent of incurred and expected losses in order to write down and convert the right amount of outstanding liabilities. The write-down and conversion must also be sufficient for the bank to regain market confidence so that it may continue to conduct operations for at least a year. Such a valuation might have to be done under time pressure and with limited information – history has shown that distressed banks must be resolved swiftly to avoid bank runs and other funding problems. However, it is important for the valuation to be as accurate as possible. If the extent of losses is underestimated, a second round of bail-in might be required, and if it is overestimated, creditors (which have then been written down "unnecessarily") gain a fresh claim on the bank equal to the amount by which the losses were overestimated. Misjudgements on both fronts can lead to uncertainty in the process.

ALTERNATIVES TO BAIL-IN – BANKRUPTCY AND BAIL-OUT

In a bankruptcy, a bank's assets are sold and the proceeds distributed to the creditors of the bankruptcy estate. Such a procedure is generally associated with low recovery rates because the operations are divided up, assets have to be sold at low prices (compulsory sale) and costs are often incurred as a result of legal proceedings. Such costs are generally known as direct bankruptcy costs.

Application of the bail-in tool has two main advantages over bankruptcy, if the process works as intended.

- From the point of view of the bank's creditors, direct bankruptcy costs are avoided. Hence, both shareholders and creditors would likely suffer lower losses than in a bankruptcy.
- From the point of view of society, risks associated with shutting down the bank are avoided, since the idea is for the bank, or at least the parts of the bank that provide systemically important functions, to continue to operate.

However, bail-in of a distressed bank may still be problematic due to the risk of undermined market confidence, especially in a systemic crisis; that is, when the financial system as a whole sustains severe shocks. This is discussed more thoroughly in the section *Indirect contagion effects and systemic risk*.

As mentioned earlier, countries tend to bail-out banks using public funds because of the role banks play in the financial system. There are generally two types of bail-outs. The

first protects both shareholders and creditors, while the other only protects the creditors, not the shareholders. When Swedish authorities handled the banking crisis at the outset of the 1990s, parliament decided that shareholders of failing banks should not be protected against losses, but that creditors should.[11] The government guaranteed all liabilities and took over ownership of the banks which were later sold. This second type of bail-out reduces the moral hazard[12] risk compared to the first one, since shareholders then have incentives to control risk-taking in the bank (because they have to carry the losses, even in a bail-out). However, there remains a moral hazard for creditors, who have no incentives to control the bank's risk-taking if they know if they will be protected given default.

Today, state aid – including bail-outs – is regulated by the FEU treaty.[13] According to the state aid rules, owners of capital instruments in banks (such as shareholders) may not be protected against losses in the event of a bail-out. Bail-outs thus work today as the second type. When we use the term "bail-out" going forward in this paper, we will therefore refer to this type, which protects creditors but not shareholders.[14]

Compared with bail-out, it will (as intended) be more costly for a bank's creditors to use the bail-in tool. However, it will be more risky to apply the bail-in tool in terms of contagion effects. These can be both direct and indirect:

- Direct because the owners of debt instruments that may be subject to write-down can suffer losses equalling the required bail-in.
- Indirect due to e.g. reduced market confidence.

However, compared to a bankruptcy, application of the bail-in tool ought to imply that both types of risk are lower.

Both in a bail-out and in application of the bail-in tool, direct bankruptcy costs in the form of the compulsory sale of assets are avoided. Legal expenses and other costs pertaining to the process itself would also probably be lower in a bail-out and in application of the bail-in tool than in a bankruptcy.

Table 1 shows the three different resolution alternatives and compares the costs carried by creditors, direct bankruptcy costs and potential contagion effects.

If it is assumed that a bail-out protects creditors but not shareholders (as we have done above), the expected cost for the creditor[15] is zero in a bail-out. When the bail-in tool is applied, it will (as intended) be more costly for the bank's creditors ($a>0$). However, the expected cost will be lower for the creditors than in a bankruptcy ($b>a$) because the value destruction (the direct bankruptcy expenses) will probably be lower when the bail-in tool is used ($x\sim0$) than in a bankruptcy ($y>x$). In a bail-out, direct bankruptcy costs are assumed to be zero.

11 The so-called state bank support guarantee. See Ingves and Lind (1996).
12 The risk that arises from knowledge about a safety net (such as an insurance policy) affecting actions in a way that leads to an increase in the probability of an unfavourable outcome.
13 Articles 107 to 109 of the Treaty on the Functioning of the European Union – TFEU.
14 Applies, according to state aid rules, also to owners of other capital instruments, such as holders of hybrid capital and subordinate loans.
15 Except for owners of hybrid instruments and subordinated bonds.

Table 1. Illustrative comparison of resolution alternatives

	BAIL-OUT	APPLICATION OF THE BAIL-IN TOOL	BANKRUPTCY
Expected cost for the creditor	0	a (a>0)	b (b>a)
Direct bankruptcy costs[16]	0	x (x~0)	y (y>x)
Potential contagion effects	Low	Medium	High

RESOLUTION TRIGGERS

According to the BRRD, authorities shall take a resolution action only if they find that all of the following conditions are met:

- The authorities have determined that the bank is failing or likely to fail (for example, if the bank is in breach of its capital requirements or the bank is unable to pay its obligations as they fall due or requires government funding).
- There is no reasonable prospect that any alternative private-sector or supervisory measures would prevent the failure of the bank.
- A resolution action is necessary in the public interest.[17]

LIABILITIES EXEMPTED FROM BAIL-IN

The basic idea in bail-in is that all the bank's creditors should be able to contribute to recapitalisation. However, it is not considered appropriate to use the bail-in tool for all types of liabilities, as some of these may be too systemically important or too complex to be written down or converted to equity.

It follows that only a certain part of a bank's liabilities may be subject to write-down and conversion through application of the bail-in tool. These are known as eligible liabilities. The BRRD states that the following liability classes are exempt from bail-in and will thus neither be written down nor converted to equity:

- Secured liabilities (for example covered bonds[18] and repos)
- Interbank deposits with original maturities of less than seven days[19] and
- Certain other minor classes of liability such as obligations to employees and accounts payable.

Furthermore, most of the derivative contracts on the liabilities side of the Swedish banks are exempt, since netting agreements and pledged collateral will be fully taken into

16 Assume that legal expenses for bail-out are negligible.

17 The BRRD also defines how this shall be interpreted. A resolution action shall be necessary to meet at least one of the resolution objectives better than what would have been the outcome in the event of a bankruptcy and the intervention itself shall be proportionate.

18 The BRRD also exempts the derivatives used to hedge the cover pool. The BRRD also specifically protects covered bonds; "Member States shall ensure that all secured assets related to a covered bond cover pool remain unaffected, segregated and with enough funding".

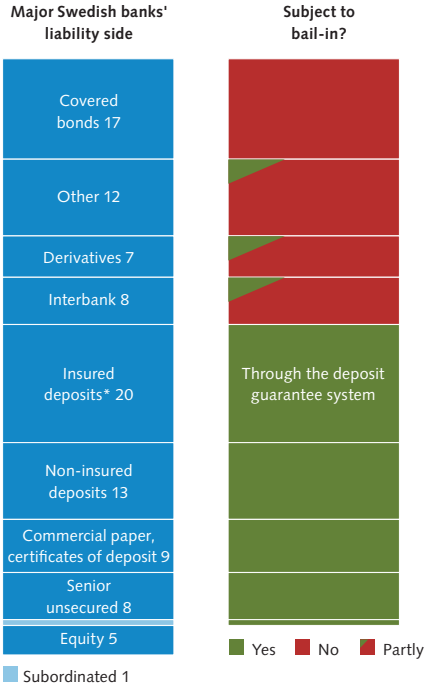
19 Interbank deposits with original maturities of less than seven days account for a large proportion of interbank deposits. Liabilities with a remaining maturity of less than seven days that have arisen through participation in systems for the transfer of payments and securities are also exempt.

account. If there is a netting agreement between two parties in a derivatives transaction (as there usually are) gross liabilities shall be netted against each other and pledged collateral deducted before the bail-in tool can be applied. Hence, the amount of derivatives that can be written down or converted is significantly lower than the amount reported under IFRS, the accounting standard Swedish banks follow.

Covered depositors will continue to be completely protected. However, if all other debt instruments that are eligible for bail-in have been written down or converted to equity, the Deposit Guarantee System (DGS) may be forced to carry losses on behalf of the depositor. The DGS may become liable for the amount which covered depositors would have lost, had they not been protected.

Figure 2 shows liabilities eligible for bail-in at the major Swedish banks. The boxes that are fully or partially red illustrate the exemptions above and the covered deposits can only be written down or converted through the Deposit Guarantee System; depositors who are protected by the DGS shall never incur any losses in connection with resolution.

Figure 2. Liabilities eligible for bail-in. Aggregate of the four major Swedish banks, percentage of total liabilities and equity, March 2014



Note. The illustration is based on the consolidated level, not institution level.
* The percentage of covered deposits for all banks except SEB is an assumption based on calculations from Barclays.
Sources: The banks' financial statements, Barclays research, the BRRD and the Riksbank

The BRRD will introduce a couple of changes compared to current Swedish legislation concerning the priority of claims in bankruptcy. The current priority stipulates, in simplified terms, that the following order shall apply in a bankruptcy:

- First, creditors with a specific right of priority (such as owners of covered bonds) shall be paid,
- then creditors with a general right of priority (such as employees),
- then owners of unsecured exposures (this includes owners of senior unsecured bonds[20] and depositors),
- then owners of subordinated debt and
- finally shareholders.

There is, according to this order, no difference in priority between deposits and other unsecured exposures. However, the BRRD introduces new seniority for deposits whereby in the future, in order to cover losses and recapitalise the bank, primarily equity shall be reduced or diluted[21], and secondarily, the bail-in tool shall be used, with due consideration for the exemptions above, in the following order:

1. Subordinated debt.
2. Unsecured bonds, certificates and large corporate deposits.[22, 23]
3. Non-covered deposits from microenterprises, small and medium-sized companies and private individuals.
4. Covered deposits (eligible for bail-in through the deposit guarantee system).

According to the BRRD, member states shall ensure that the resolution authorities limit the extent of eligible liabilities held by other institutions. This means that the resolution authorities shall limit the possibility of other banks to invest in eligible debt instruments, with a view to limiting direct contagion effects to other banks.[24]

If another bank has invested in debt instruments written down through the bail-in tool, this will result in a direct loss for that bank. If the debt instrument in which the bank has invested is instead converted into equity, it will however not count as a direct loss.

20 A bond whose holder does not have a specific right of priority in the event of a bankruptcy. Unsecured bonds normally entail a higher credit risk than covered bonds, which means that the borrowing costs are higher.
21 Primarily common equity Tier 1 capital. Other capital instruments are then written down or converted before the bail-in tool is used.
22 This category also includes the other liabilities not exempted, such as interbank deposits with original maturities exceeding seven days.
23 Deposits from companies that are not defined as microenterprises or small or medium-sized companies according to the definition in Article 2.1 in the appendix to Recommendation 2003/361/EC.
24 Another regulatory framework that also has the purpose of limiting direct contagion effects is that which governs large exposures of banks, in place in Sweden. Also, this regulatory framework will be strengthened because the newly published regulations from the Basel Committee regarding large exposures enter into force in 2019.

However, the investment will change from a "normal" investment to an investment in the share capital of another financial institution. Such investments can be deducted from Common Equity Tier 1 capital.[25] So, although the conversion does not involve a direct loss, it could mean a negative impact on the capital ratios of the investing bank.

CALCULATION OF MINIMUM REQUIREMENT

There is a risk that banks could restructure their liability sides in a way that makes the bail-in tool ineffective, for example by only issuing debt instruments that are exempt from bail-in or by relying on unstable short-term funding that may disappear in times of stress.

If such a bank then suffers substantial losses, remaining debt instruments would not suffice to be written down or converted to recapitalise the bank.

To counteract this risk and ensure that banks have sufficient capacity to cover losses in the event of failure, each member state is to ensure that its banks always hold sufficient equity and eligible liabilities of long maturity that can be bailed in. This is regulated by means of a minimum requirement in the BRRD, calculated as follows:

$$\frac{(\alpha + \beta + \gamma)}{(\delta + \alpha)} \geq x$$

α = Own funds[26]
β = Unsecured debt instruments with a remaining maturity >1 year[27]
γ = Large corporate deposits[28] with a remaining maturity >1 year
δ = Total liabilities[29]
x = Minimum requirement for own funds and eligible liabilities.

The BRRD does not set out a harmonised level for the minimum requirement at EU level. Instead, the national resolution authority sets the level in consultation with the supervisory authority.[30] If they set the level at 10 per cent for a bank with total liabilities and own funds equalling SEK 100, that bank will need to hold a minimum of SEK 10 in own funds, unsecured liabilities with an outstanding maturity exceeding a year and large corporate deposits with an outstanding maturity exceeding a year. This level shall be set individually for each bank and on a consolidated basis for entire groups. In each individual case, the authorities may, according to the Directive, also decide on the distribution between own funds and different types of liabilities in the numerator.

25 According to Articles 43-48 of Regulation (EU) No. 575/2013 of the European Parliament and of the Council of 26 June 2013 regarding prudential requirements for credit institutions and investment firms (CRR).
26 Defined according to Article 72 of the Capital Requirements Directive (CRR). Own funds comprise the sum of common equity Tier 1 capital, Tier 1 capital contributions and Tier 2 capital.
27 Except for deposits.
28 Deposits from companies that are not defined as microenterprises or SMEs according to the definition in Article 2.1 in Recommendation 2003/361/EC.
29 Derivative liabilities shall be included in total liabilities on the basis of full account being taken of netting rights and pledged collateral.
30 In Sweden, Finansinspektionen is responsible for the supervision of banks.

So, there is a difference between eligible liabilities and which liabilities are included in the numerator in this requirement. The numerator does not include liabilities with shorter maturities or the deposits which are given priority. However, these can nevertheless be written down or converted (see previous section).

EXEMPTING ELIGIBLE LIABILITIES

Allowing creditors to carry part of the losses can lead to contagion effects (see the section *Potential contagion effects from using the bail-in tool)*. It may be the case that certain liabilities that should normally be subject to write-down and conversion may need to be exempted in an individual case in order to avoid contagion effects and other risks to financial stability. The BRRD therefore includes an exception. This empowers national resolution authorities to exempt certain eligible liability classes from write-down and conversion and to shift the costs that they would have carried to other eligible liability classes, or limit the extent to which certain creditors are to carry losses. However, the exemption only applies in exceptional circumstances and the authority must first have notified the EU Commission. This entails certain creditors potentially having to carry more costs than others, who should actually have had equal or worse priority. Ultimately, the costs that may be carried by an individual liability class are limited by the "no creditor worse off" principle. According to this principle, an individual creditor shall be no worse off than in regular bankruptcy proceedings.

In order for the authority to apply the exception, a number of conditions also have to be met. These relate to the possibility of using the bail-in tool in a timely manner, achieving continuity in the critical functions provided by the bank and avoiding contagion effects and value destruction for other creditors.

Another possibility, linked to the first exception, is that a resolution fund can contribute to[31] absorbing the costs and recapitalize the bank instead of the costs being shifted to other eligible liabilities. However, this requires;

- Approval from the EU Commission, and
- The write down or conversion to equity of equity and liabilities equivalent to at least 8 per cent of the bank's liabilities side or 20 per cent of its risk-weighted assets.

In addition, the second alternative can only be applied if the member state:

- Has a pre-financed resolution fund exceeding 3 per cent of the state's covered deposits,
- does not have access to the European Stability Mechanism (ESM), and
- the bank in question has a consolidated balance sheet equalling less than EUR 900 billion.

31 By an amount equalling no more than 5 per cent of the bank's liabilities side.

Based on how the Financial Crisis Commission has interpreted the BRRD[32], Sweden does not currently meet the requirement for a pre-financed resolution fund equalling at least 3 per cent of covered deposits. Sweden and other EU member states that do not have access to ESM may however apply this alternative in future once they have built up their resolution funds to that level.

In certain circumstances, the BRRD also enables member states to employ precautionary recapitalisation using public funds for banks that meet their capital requirements but which, based on a stress test, need more capital.

Analysis of how the introduction of a bail-in tool could affect the major Swedish banks

In this section, we analyse a couple of direct effects on the major Swedish banks and their funding situation from the introduction of a bail-in tool.

TOTAL COST OF FUNDS

A bankruptcy procedure as described above is generally associated with low recovery rates because the operations are divided up, assets might have to be sold at low prices (compulsory sale) and costs are often incurred as a result of legal proceedings. Such costs are generally known as direct bankruptcy costs. Because of such costs, the value of a bank is generally lower in bankruptcy than as a going concern. Through resolution, division, compulsory sale and at least part of the legal costs are avoided (see Table 1). Hence, a higher recovery rate can be expected in resolution than in bankruptcy. The lower expected bankruptcy costs will, all else equal, *reduce* the bank's cost of funding[33], because creditors expect higher recovery rates should the bank default.

If the default of a specific bank has major negative externalities, the government could have an incentive to bail it out. In the section *Alternatives to bail-in – bankruptcy and bail-out,* we defined (in simplified terms) government bail-outs in terms of creditors[34] being protected, but not shareholders. Creditors hence do not carry any losses if the bank is bailed out by the government. Hence, the risk a bank chooses to take will not be particularly important to creditors, since they will enjoy full protection if the bank defaults and is bailed out by the government.

One purpose of introducing the bail-in tool is to reduce the probability of a government bail-out and hence reduce the value of the implicit government guarantee. Consequently, the risk of creditors having to carry losses increases. This ought to lead creditors to demand higher compensation which, all else equal, ought to *increase* the bank's cost of funds.

32 SOU 2014:52. The Financial Crisis Commission was appointed to make a review of the set of rules for handling financial crisis, including the implementation of the BRRD in Sweden.
33 Defined as total interest expense/interest-bearing liabilities.
34 Except for owners of hybrid instruments and subordinated bonds.

In summary, an introduction of the bail-in tool would potentially lead to two opposite effects on the cost of funds of banks. On the one hand, lower expected bankruptcy costs should lead to a lower cost of funds. On the other hand, reduced implicit government guarantees should lead to costs increasing. These two opposite effects are analysed in more detail in Appendix A. Below, we go through these effects and how they could alter the total funding cost of the major Swedish banks, since the latter are of crucial significance to how the Swedish financial system works. Factors that could affect the funding cost are evaluated from a qualitative perspective since it would be too great a challenge to attempt to quantify the individual factors. The analysis does not take account of contagion effects. These are instead discussed in the section *Potential contagion effects from application of the bail-in tool*.

We start with the first effect; that is, an expected recovery rate that is higher than in a bankruptcy. The expected cost for creditors is much lower in the application of the bail-in tool than in a bankruptcy (see Table 1) because the direct bankruptcy costs are lower. The Financial Crisis Commission writes in its Swedish Government Official Report[35] that resolution will as a rule probably lead to much lower value destruction than a bankruptcy. This hence indicates a *reduced* cost of funds for the major Swedish banks when the framework is introduced.

If we then study the other effect – that is, a reduced probability of government bail-out – we can start by ascertaining that the credit ratings of the four major Swedish banks are currently three notches higher than what they would otherwise have been due to their "very high systemic support" (according to the credit rating agency Moody's[36]). This indicates that the probability of a government bail-out is currently high in Sweden. Swedish authorities have also historically supported banks and in 2008, the Bank Support Act was enacted, authorising the government to support ailing banks with guarantee programmes, capital injections and other appropriate measures. The Swedish government also has relatively low sovereign debt in an international comparison[37], which can be assumed to underpin the perception that the probability of government bail-out is high.

According to Standard & Poor's, this high probability of government bail-out decreases with the implementation of the BRRD. Standard & Poor's establishes that outlook for the four Swedish systemically important banks is negative because it expects implicit government guarantees to decrease over the next two years.[38] Moody's also finds that the BRRD reduces the probability of government bail-out because the probability of bail-in increases and that it is negative for senior unsecured debt in Swedish banks. This applies in particular to the four largest banks because they are most probably the ones that would receive government bail-out currently.[36]

35 SOU 2014:52.
36 Moody's Investor Service, "Sweden's Implementation of EU Bank Bail-In Plan Is Credit Negative," 15 August 2013.
37 2013. Public sector gross debt, Total economy, Per cent of GDP, IMF WEO, Forecast.
38 Standard& Poor's, "Various Rating Actions Taken On Nine Swedish Banks On Stabilizing Economic Risks And Government Support Review," 29 April 2014.

If the probability of government bail-out for major Swedish banks decreases, this would indicate an *increased* cost of funds for them.

There are thus, as described above, two opposite effects on the cost of funds of the major banks. Both of these effects affect the loss given default for creditors in the event of a bank defaulting.

A bail-in tool also affects the probability of default. The BRRD provides authorities with extensive possibilities to put a bank into resolution at an early stage, if they find that a default is probable (see more in the section *Resolution triggers*). Application of the bail-in tool (in this case conversion) would then occur ahead of a regular bankruptcy, which on the one hand increases the probability of default.

On the other hand, the risk a bank chooses to take ought to be of greater importance to creditors. They might then opt to attempt to control the bank's risk-taking to a greater extent by demanding higher remuneration for lending money, or refrain from lending money to a bank that is judged too risky. This could, for example, lead to the bank choosing to issue more equity or subordinated debt to protect other creditors, hence reducing the costs of its loan financing. If a bank issues more equity, that reduces the probability of default.

In our opinion, the combined effect of all of these factors can contribute to a slightly higher cost of funds for the major Swedish banks. However, this is by no means a firm conclusion because it is difficult to quantify the individual factors with any great precision.

Besides the factors discussed above, uncertainty surrounding how the bail-in tool will be applied could lead to increased risk premia, because If creditors are uncertain about how they should calculate expected losses, they might perceivably add a safety margin onto their required interest rate.

The resolution decision[39] will be in the hands of Swedish authorities. It is possible that foreign creditors in particular see this as an uncertainty factor. This also applies to the fact that the BRRD also empowers national authorities, in certain circumstances, to exempt certain classes of liability from write-down and conversion and transfer them to costs that would have been carried by such classes to other eligible liabilities. This could also be viewed as an uncertainty factor and lead to increased risk premia.

SHIFTING OF INTEREST EXPENSE BETWEEN LIABILITY CLASSES

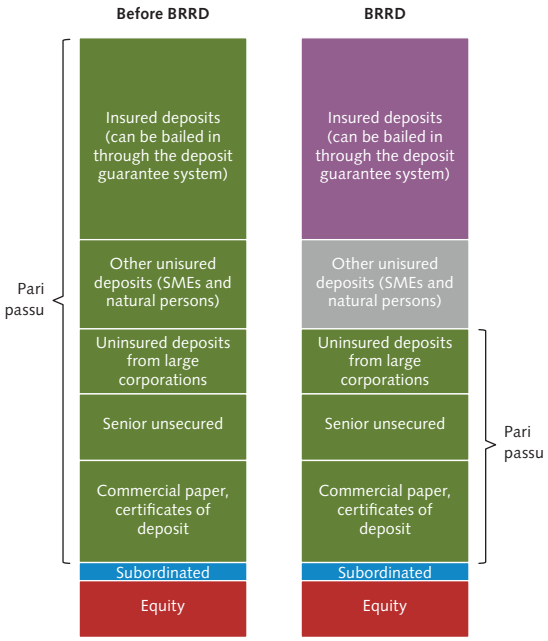
Some classes of liability will be completely exempt from bail-in (such as covered bonds). Others will get seniority when the BRRD is implemented (such as private deposits). Because certain deposits will have higher seniority, other categories will instead become more subordinated than they are today.

This ought to lead to a shift in interest expenses between different liability classes. Riskier liabilities will probably be more expensive, while liabilities with a more secure position will be cheaper.

39 and hence the trigger for bail-in.

Figure 3 shows a comparison between the order of priority for the major Swedish banks before and after the implementation of BRRD. As can be seen, some liability classes will become more subordinated than they are currently, namely unsecured bonds, certificates and non-guaranteed major corporate deposits (the green boxes in the diagram to the right). Hence, losses that would have been equally split before (between all the green boxes in the diagram to the left) will now primarily be carried by these three classes. Only if it does not suffice will losses also be allocated to non- covered deposits from SMEs and private individuals (grey box). In a third instance, they are also allocated to the deposit guarantee system (purple box).

Figure 3. Order of priority for eligible liabilities of the major Swedish banks before and after implementation of BRRD. Losses are absorbed from the bottom of the diagram.



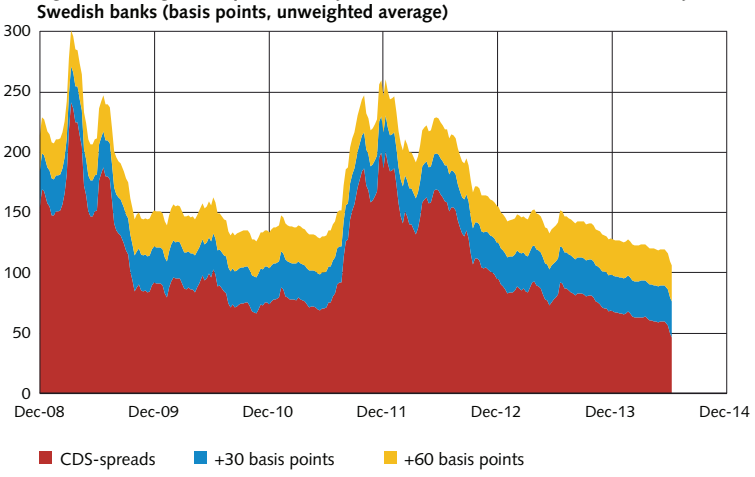
Note: For illustrative purposes, aggregate of the four major banks. The diagram does *not* show the liabilities that are partially exempt from bail-in, such as interbank deposits (read more in the section *Liabilities exempted from bail-in*). The share of non- covered deposits is based on a research report from Barclays for the three banks that do not report the share of covered deposits. The share of large corporate deposits is based on assumptions. Pari passu means that an equal degree of losses will be incurred.
Sources: The banks' financial statements, Barclays research and the Riksbank

We estimate that such subordination could lead to a cost increase of between 30 and 60 basis points for senior unsecured debt (see Appendix C for calculations) if creditors fully take their new, lower, priority into account. Figure 4 gives an illustration of how much increases of 30 and 60 basis points, respectively, would affect the Credit Default Swap spreads for the four major Swedish banks, which can be seen as an indicator of how much the cost of senior unsecured debt can increase. However, that increase could be much higher in a stressed scenario, i.e. when a bank or the financial market is encountering

difficulty for one reason or another. If the probability of default increases, creditors will demand a higher return, or refrain from investing at all in eligible debt instruments. In terms of interest expense for unsecured debt, in a relative sense the new regulatory framework benefits banks that already have a high volume of equity or subordinated debt, because it provides a "buffer" for the unsecured debt instruments (see Figure 3).

The increased price sensitivity of senior unsecured debt will, on the one hand, emit distress signals earlier on, hence inciting various participants into early action to prevent problems. On the other hand, it could make the bank's creditors more sensitive to stress. The bank could then experience funding problems earlier on. This is discussed in more detail in the section *Indirect contagion effects and systemic risk*.

Figure 4. Average CDS spreads on 5-year senior unsecured debt for the four major Swedish banks (basis points, unweighted average)



Source: Ecowin

Covered bonds might benefit from the new rules. Moody's states that "the new resolution framework will increase the probability that financial institutions will either remain going concerns or go through an orderly wind-down", and as the draft directive "explicitly exempts covered bonds from the bail-in process, it reduces the likelihood of an issuer ceasing to perform its obligations under the covered bonds following bail-in (default) of the issuer's senior unsecured debt."[40]

Moody's also states that "in cases where an issuer is subject to bail-in but emerges from resolution as a going concern/with key operating activities intact, we expect the covered bonds to benefit from the improved credit strength of the issuer following the bail-in."[41]

Fitch also states that covered bonds benefit from the new framework: "A preservation of the issuing bank as a going concern would avoid the source of covered bonds payments switching from the issuer to the cover pool. Even though the senior unsecured debt could

40 2014 Outlook – Global Covered Bonds, Moody's investor service.
41 Moody's Approach to Rating Covered Bonds, 12 March 2014.

suffer a default, covered bonds would continue to be serviced by their issuer."[42] This implies that the cost of covered bonds could decrease.

On the whole, the implementation of a bail-in tool would make unsecured instruments riskier for investors, and hence probably more expensive. At the same time, covered bonds are in a safer position and will therefore probably be cheaper. However, it is possible that account has already been taken of the introduction of the bail-in tool in the calculation of creditors, and that the price change has hence already transpired, at least partially. This shift also implies that the higher the level at which the minimum requirement for own funds and eligible liabilities (see more in the section *Calculation of minimum requirement*) is set, the more the total cost of funding could increase.

The shift in costs between various liability classes could benefit certain asset classes. Assets that are commonly funded through covered bonds, such as mortgages, could benefit from this compared with e.g. corporate loans, which are usually funded through unsecured debt.

EFFECTS ON LIABILITY STRUCTURE AND INVESTOR BASE

Since some classes of liabilities will be exempt from bail-in, banks have incentives to issue such debt instruments in order to minimise the reduction in the value of the implicit government guarantee. This implies that minimum requirements for banks might be necessary to force them to issue unsecured debt, or upper limits on the encumbrance of assets.

As described in the section *Calculation of minimum requirement*, the BRRD introduces a minimum requirement for own funds and eligible liabilities. This should reduce the risk of the Swedish banks changing their liability structures too much in favour of secured debt or short-term debt instruments.[43] The minimum requirement obliges banks to hold a minimum amount of unsecured liabilities with an remaining maturity of at least a year on their balance sheets. The extent depends on the limits that the national authorities choose to set for their banks.

The subordination of unsecured debt (see Figure 3) and the potential conversion of that type of debt instrument into equity could potentially affect who is willing to invest in such debt instruments ("the investor base").

In an investor survey conducted by J.P. Morgan in 2012[44], as many as 89 per cent of respondents considered debt eligible for bail-in as an investible asset class. However, the fact that these instruments are convertible may lead to lesser interest from traditional debt investors who may not have the skill or mandate needed to manage a potential equity exposure in the future. There is also uncertainty surrounding how such instruments will be treated in new and existing regulatory frameworks. However, both mandates and regulatory frameworks should be adapted in the slightly longer term.

42 Fitch Ratings "Covered Bonds Rating Criteria," 10 March 2014.
43 There are other new regulations that also work to extend the maturity of banks' liabilities, such as the Net Stable Funding Ratio (NSFR).
44 J.P. Morgan, "European bank bail-in survey result," 9 July, 2012.

The J.P. Morgan investor survey concluded that the greatest issue for investors would be if the new debt eligible for bail-in were rated non-investment grade. That would, according to the investors, render such debt instruments an asset class in which they would be unable or unwilling to invest. The risk of this affecting the major Swedish banks is low, however. Even if the credit ratings for unsecured liabilities were downgraded three notches (equivalent to completely removing implicit government guarantees), the credit ratings of the major banks would still be investment grade. In light of this, in our view this ought not to pose any major difficulty in the funding possibilities of the major Swedish banks when the bail-in tool is introduced.

On the other hand, it could be a problem for banks which are considered weaker, because their eligible liabilities could be downgraded to credit ratings equalling non-investment grade through the introduction of a bail-in tool, which would make it more difficult for them to issue unsecured debt. One way the banks could resolve that problem could be to issue equity, convertibles or other subordinated debt instead. That would protect other creditors from losses, in turn reducing the effects of subordination for the unsecured debt classes and would hence probably lead to better credit ratings for them.

Potential contagion effects from using the bail-in tool

DIRECT CONTAGION EFFECTS

Maes and Schoutens (2010) have pointed out that debt instruments that may become subject to write-down and conversion (and other convertibles) can increase the risk in the financial system as a whole. The idea is that if bail-in is implemented at one bank, it can lead to losses for other financial institutions that have invested in such instruments. This can create "a potential domino effect of institutions in distress". The risk of contagion effects if any party in the financial system encounters difficulty is thus a source of systemic risk. Moreover, they point out that if insurance companies hold significant amounts of bail-in debt, there is a risk of contagion from the banking sector to the insurance sector. Only a small proportion of the outstanding unsecured debt is currently owned by Swedish insurance companies.[45] However, this does not prevent the holding accounting for a substantial part of a specific insurance company's portfolio, and they can thus nevertheless be affected by a bail-in process.

Zhou et al. (2012) propose that contagion risks should be mitigated by limiting financial institutions' cross-holdings of eligible debt instruments (and other convertibles). For banks, there are regulations limiting the extent of their exposures to an individual counterparty.[46]

45 Around 9 per cent of outstanding unsecured bonds issued by all Swedish banks are owned by Swedish insurance companies according to Statistics Sweden. It should be noted that this data includes SEB's covered bonds and therefore it cannot be ruled out that it is the covered bonds the insurance companies actually own.

46 Such a regulatory framework is already in place in Sweden. Also, this regulatory framework will be strengthened because the newly published regulations from the Basel Committee regarding large exposures enter into force in 2019.

The BRRD also states that member states shall limit the possibility of other banks to invest in eligible debt instruments, for the very purpose of limiting direct contagion effects and ensuring that the bail-in tool can be applied.

Since the deposit guarantee system is not exempt from bail-in, the Swedish government could suffer direct losses through that. However, since the deposit guarantee system assumes the priority of depositors (which tops the order of priority for the eligible debt instruments), the risk is probably limited.

Large corporate deposits are not given priority, however (see Figure 3). Applying the bail-in tool could hence bring about contagion effects to large companies. Interbank deposits with a maturity of seven days or more also fall into this category. In a stressed situation, fear among large companies and banks of deposits being written down could trigger a run on the deposits of these two categories. The same can be said about uninsured deposits from microenterprises, SMEs and private individuals, but to a lesser extent because both of these categories enjoy priority.

Another potential issue is that investors in Swedish equity-linked bonds could be exposed to losses in a bail-in procedure. Investors in such instruments do not usually possess sufficient knowledge to assess the risk either. Equity-linked bonds have been marketed as very safe investments, but they are based on an unsecured bond that can subject to conversion or write-down through the bail-in tool.[47]

INDIRECT CONTAGION EFFECTS AND SYSTEMIC RISK

Indirect contagion effects could potentially be extensive in the application of the bail-in tool or threat thereof. Application of the bail-in tool on one Swedish bank could for example lead to a sharp decline in confidence in the other Swedish banks too, even if they have limited investments in eligible debt instruments. This would be particularly poignant in a systemic crisis scenario; that is, when the financial system as a whole sustains severe shocks.

Goodhart (2011) argues that bail-in is suitable in a situation in which failure is random and idiosyncratic – i.e. in which banks fail independently of each other – but less so in a world where failures occur in connection with systemic crises. He argues that there is a risk that when a bail-in trigger is pulled for the first bank, the market of funding for other banks will be closed as well. Hence, there is a risk that banks will be forced to sell assets, thereby exacerbating the downward spiral in asset prices during a systemic crisis.

The main investors in Swedish senior unsecured debt, both long-term and short-term, are foreign.[48] A large proportion of short-term funding is obtained through US money market funds.[49] In terms of owners of long-term unsecured bonds, available information[50]

47 In 2008, 4,000 Swedish customers invested in Acta Asset Management's equity-linked fund which was originally issued by Lehman Brothers. When Lehman Brothers went bankrupt the customers lost their money.
48 Includes certificates.
49 For more information about money market funds and how they are linked to the Swedish banking sector, see "Shadow banking and the Swedish financial system" Financial Stability Report 2014:1.
50 Through Statistics Sweden. The information is deficient, however, and the data includes SEB's covered bonds.

indicates that around 80 per cent of long-term unsecured covered bonds are owned by foreign investors. Swedish banks and mortgage institutions own around 4 per cent and the government around 3 per cent.[51] Foreign investors are mainly funds and asset managers, pension companies, insurance companies and other banks.[52] They know that the Swedish banking system is concentrated and closely interlinked[53], which increases the risk of market confidence in all the Swedish banks diminishing when the bail-in tool is applied on a Swedish bank. A fall in market confidence would also affect Swedish banks more than those in other countries because of their major reliance on market funding.

To sum up, in our view the indirect effects of applying the bail-in tool might be greater in Sweden than in most other countries because the Swedish banks are closely interlinked with each other and highly dependent on market funding.

Concluding comments

In this paper, we have analysed how the introduction of a framework containing a bail-in tool could affect the cost of funds, liabilities structure and investor base of the major Swedish banks. We have also studied potential contagion effects, both direct and indirect, of actual application of the tool on one of the major Swedish banks. We have ascertained that when a framework containing a bail-in tool is introduced, it could lead to a somewhat higher total cost of funds for Swedish banks. One reason for this is that the previously strong implicit government guarantee should decrease and risk premia potentially increase due to uncertainty about national authorities' discretion to set trigger levels. This could also lead to a shift in the cost of funding between different classes of liability. If some unsecured debts are given a lower degree of subordination than under current law, this ought to lead to a higher borrowing cost for such liabilities.

Covered bonds may on the other hand benefit from the new regulatory framework, as it increases the probability of a bank either continuing as a going concern or undergoing an orderly wind-down. As covered bonds are exempt from bail-in, they may benefit from the improved capitalisation and credit rating of the issuer once the bail-in tool has been applied. The risk of them having to obtain payments directly out of the cover pool instead of from the issuer also decreases. Thus, covered bonds can, to a greater extent than before, remain unaffected by the failure of a bank, which ought to lead to a lower borrowing cost for such liabilities.

This could in turn lead to assets usually funded by covered bonds – such as mortgages – benefiting from the introduction of a bail-in tool, unlike corporate loans, which are usually funded by unsecured debt. This ought also to affect the end customer's cost of funding.

51 Through municipalities and social insurance systems.
52 Discussions with market participants.
53 Links between banks can be direct or indirect. Direct links arise when, for instance, a bank funds another bank's lending or acts as counterparty in a financial transaction. Indirect links can arise when banks have similar exposures and are hence exposed to similar risks, or market participants choose not to differentiate between banks, but instead base their assessments of individual banks on the situation of the banking sector as a whole.

Because certain classes of liability are exempt from bail-in, there may be a risk of banks only issuing such liabilities, and in that case there would not be anything to write down in a resolution procedure. To counteract this, BRRD contains rules setting out that national resolution authorities shall set a minimum requirement governing how much capital and eligible debt instruments banks must hold on their balance sheets. This reduces the risk of Swedish banks changing their liability structures too much in favour of liabilities that are exempt from bail-in.

In our view, when the new rules are introduced, there should only be a limited risk of investors being unable or unwilling to invest in eligible debt instruments issued by the major Swedish banks. This is based on the fact that polled investors[54] have expressed that they do not view the introduction of the new regulations as a problem if it does not lead to debt instruments being downgraded to non-investment grade. The prospect of that occurring at present is not very plausible for the debt instruments issued by major Swedish banks. However, the introduction of new rules could in the short term lead to uncertainty in terms of mandates and regulations.

It is also ascertained in the paper that eligible debt instruments will probably be more sensitive to financial stress through the introduction of a bail-in tool. In a stressed situation, the cost of such liabilities ought to increase more and the bank should find it more difficult to obtain funding. Furthermore, we also believe that banks that are considered weaker could experience problems in issuing eligible liabilities.

Direct contagion effects[55] to other banks from actual application of the bail-in tool should be limited. This is thanks to existing regulations governing the large exposures of bank[56], and because BRRD sets out that member states shall ensure that the resolution authorities limit the extent of eligible debt instruments held by the banks. Other creditors may be affected, however.

Indirect contagion effects[57] (such as a sharp decline in market confidence) from application of the bail-in tool could be particularly severe in Sweden due to the closely interlinked[58] banking system and reliance on market funding of the major Swedish banks.

54 J.P. Morgan, "European bank bail-in survey result," 9 July 2012.

55 Direct contagion effects arise because participants in financial systems borrow from each other. If such loans are impaired, losses arise for the lender, and problems spread in the financial system. This is called a direct contagion effect.

56 Such a regulatory framework is already in place in Sweden. Also, this regulatory framework will be strengthened because the newly published regulations from the Basel Committee regarding large exposures enter into force in 2019.

57 Indirect contagion effects can arise through two main channels. First, markets can assume that there are direct contagion effects, even if this is not the case. Second, if a bank experiences financial difficulty, markets might anticipate that other banks in the same system will be affected by the same problems, which can in turn lead to investors wishing to exit their investments. Indirect contagion effects are thus problems that spread in financial systems, but that are not due to direct exposures.

58 Links between banks can be direct or indirect. Direct links arise when, for instance, a bank funds another bank's lending or acts as counterparty in a financial transaction. Indirect links can arise when banks have similar exposures and are hence exposed to similar risks, or market participants choose not to differentiate between banks, but instead base their assessments of individual banks on the situation of the banking sector as a whole.

In order to avoid using the bail-in tool at all, it is therefore important that the banks' resilience is strengthened through bolstered capital levels and reduced liquidity risks. The Riksbank has, in its Financial Stability Report, published a number of recommendations to this end[59].

59 See Financial Stability Report 2014:1.

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Appendix A. Theoretical foundation

In this appendix, we describe the theoretical framework underlying the analysis in the section *Total cost of funds*. Based on academic literature, we discuss possible theoretical consequences of the introduction of a bail-in tool on the cost of funds of banks. First, we analyse the effects of lower bankruptcy costs, and we then study the consequences of reduced government guarantees.

THE EFFECT OF LOWER BANKRUPTCY COSTS

Expected losses on holdings of bank bonds are usually determined by two factors. The first factor is the probability of default, $p(D)$ and the second is the loss given default, LGD. Multiplying $p(D)$ by LGD gives a measure of expected losses.

$$(1) \qquad E(loss) = E(p(D) \times LGD)$$

If expected losses decrease due to a lower $p(D)$ and/or a lower LGD, investors will demand a lower interest rate, all else equal, and the funding cost for the bank will hence decrease.[60]

If bankruptcy costs are lower in bail-in than in liquidation, then loss given default should also be lower, all else equal:

$$(2) \qquad (LGD|bail\text{-}in) < (LGD|liquidation)$$

It hence follows from equation (1) that expected losses for investors will be lower in bail-in than in liquidation. Hence, investors ought to accept a lower interest rate, which reduces the bank's cost of funds, all else equal.[61]

The introduction of a bail-in tool might however change the probability of default. Also, uncertainty and hence risk premiums might rise if the circumstances for using a bail-in tool are unclear. An explicit objective of the implementation of a bail-in tool is also to reduce the value of the current implicit government guarantees. *To summarise, it is impossible to determine with any certainty whether the introduction of a bail-in tool will actually reduce the cost of funds for banks.*

There are few papers in academic literature which, in a structured manner, study the introduction of different types of liabilities eligible for conversion or write-down on a

60 The value of a bond is determined by the expected value of future cash flows. If there are no coupon payments and the nominal amount is repaid in one period, the value of the bond is the discounted value of the bond's nominal amount:

$$Value\ of\ bond = \frac{Nominal\ amount\ (1-E(loss))}{(1+r_f+risk\ premium)} \equiv \frac{Nominal\ amount}{(1+R)}$$

where r_f is the risk-free rate, $E(loss)$ is expected loss as a share of the bond's nominal amount, and R is the bond's promised return (yield).

61 This conclusion is based on the regular rollover of debt; otherwise the lower loss given default will only benefit existing investors.

bank's balance sheet. In a recent paper, Chen et al. (2013) develop a theoretical model with liabilities eligible for bail-in beside covered deposits and senior and subordinated debt. One purpose of their study is to gain deeper insight into how the incentives of a bank's shareholders and the value of equity are changed by the introduction of a bail-in tool.

They show that, under a number of strict assumptions, a bank's cost of funds is reduced through the introduction of a bail-in tool. Chen et al. hence conclude that existing shareholders may benefit from replacing conventional debt with debt eligible for bail-in.

First and foremost, they assume that all bankruptcy costs are avoided in bail-in (or at least that the loss given default in bail-in is lower than that in ordinary liquidation). Furthermore, they make the following assumptions:

1. There are no implicit or explicit government guarantees
2. A certain percentage of liabilities is renegotiated each period (i.e. debt rollover)[62]
3. There is no regulatory uncertainty, i.e. bail-in only occurs when the original shareholders declare bankruptcy[63]
4. The size of the investor base for debt eligible for bail-in is sufficiently large[64]

If not all of the above assumptions are met, there is a risk that the reduction in the bank's funding cost will be small, or that costs will actually increase. An essential aspect in the introduction of a bail-in tool is, for example, that the resolution authority, not the shareholders, decides when liabilities are to be written down or converted to equity. Another important issue is the presence of government guarantees. Next, we analyse how a reduction in these guarantees affects a bank's cost of funds.

THE EFFECT OF REDUCED GOVERNMENT GUARANTEES

As mentioned earlier, the government has strong incentives to rescue a bank from bankruptcy if its failure would come at a major economic cost. Chen et al. (2013) assume, however, that there are no implicit or explicit government guarantees. This makes it difficult to draw any firm conclusions about the impact on a bank's cost of funds from the introduction of a bail-in tool when significant guarantees of this kind are present.

In the absence of a more structured model that includes government guarantees, we can however analyse the effects of introducing a bail-in tool in a simple static model. We know that investors will demand a lower interest rate if expected losses for them are reduced as a consequence of a lower probability of default and/or of a lower loss given default from

62 Debt rollover each period reduces shareholders' incentives to increase the bank's debt ratio and risk level because in that case the new investors will demand a higher return in exchange for the heightened risk.

63 If bail-in is triggered prior to the point in time at which shareholders should have declared bankruptcy, this involves a loss for shareholders because keeping the bank going would potentially imply an increase in the value of equity from a value of zero (or close to zero).

64 Chen et al. take into account however that if debt instruments are converted to equity, some investors may be forced to sell their new shares at a discount following conversion. That is their way of modelling that some investors are not legally or contractually permitted to hold equities, as pointed out by Coffee (2010) and others.

the introduction of a bail-in tool. The cost of funds for the bank will thus decrease, all else equal.

If we denote the change in loss given default when a bail-in tool is implemented by ΔLGD, it can be expressed as follows (for derivation, see Appendix B):

$$\Delta LGD = \left(1\text{-}p(bail\text{-}out)_{gg}\right) \times \left((LGD|bail\text{-}in) - (LGD|liquidation)\right) + \Delta p(bail\text{-}out)\left((LGD|bail\text{-}out) - (LGD|bail\text{-}in)\right), \tag{3}$$

where $p(bail\text{-}out)$ is the probability of a government bail-out given default before the bail-in tool is introduced, $(LGD|bail\text{-}in)$ is loss given default in a bail-in, $(LGD|liquidation)$ is loss given default at failure when the bank is not rescued by the government, $(LGD|bail\text{-}out)$ is the loss given default in a government bail-out and $\left(\Delta p(bail\text{-}out) \equiv \left(p(bail\text{-}out)_{bail\text{-}in,gg} - p(bail\text{-}out)_{gg}\right)\right)$ denotes the changed probability of bail-out.

The intuition underlying equation (3) is straightforward. On the one hand, due to lower bankruptcy costs, loss given default should be lower in a bail-in than in liquidation. This fact is captured by the fact that the term $\left((LGD|bail\text{-}in) - (LGD|liquidation)\right)$ ought to be negative. However, the reduced loss given default is only relevant if the bank is not bailed out by the government. The reduction in loss given default must therefore be multiplied by $\left(1-p(bail\text{-}out)_{gg}\right)$. The first part of equation (3) should thus be negative, implying that loss given default at failure for investors should *decrease*, all else equal.

On the other hand, the probability of bail-out would probably decrease when the bail-in tool has been introduced, i.e. $\Delta p(bail\text{-}out) < 0$. In addition, the loss given default in bail-out ought to be lower than that in bail-in, i.e. the term $\left((LGD|bail\text{-}out) - (LGD|bail\text{-}in\right)$ ought to be negative. The second part of equation (3) should thus be positive, implying that loss given default at failure for investors should *increase*, all else equal.

Appendix B. A technical note

Expected losses for investors in the presence of government guarantees but no bail-in tool, $E(loss)_{gg}$, is a function of the probability of default and loss given default:

$$(4) \qquad E(loss)_{gg} = E\left(p(D)_{gg} \times LGD_{gg}\right),$$

where subscript $_{gg}$ denotes *"in presence of government guarantees"*. In this case, loss given default can be expressed as:

$$(5) \qquad LGD_{gg} = \left(1 - p(bail\text{-}out)_{gg}\right) \times (LGD|liquidation) + p(bail\text{-}out)_{gg} \times (LGD|bail\text{-}out) = (LGD|liquidation) - p(bail\text{-}out)_{gg} \times \left((LGD|liquidation) - (LGD|bail\text{-}out)\right),$$

where $p(bail\text{-}out)_{gg}$ is the probability of a government bail-out given default, $(LGD|liquidation)$ is loss given default for investors at failure when the bank is not bailed out (i.e liquidation), and $(LGD|bail\text{-}out)$ is loss given default for investors in a government bail-out.

Expected losses for investors in presence of both government guarantees and a bail-in tool, $E(loss)_{bail\text{-}in,gg}$, is a function of the probability of default and loss given default:

$$(6) \qquad E(loss)_{bail\text{-}in,gg} = E\left(p(D)_{bail\text{-}in,gg} \times LGD_{bail\text{-}in,gg}\right),$$

where subscript $_{bail\text{-}in,\,gg}$ denotes *"in presence of government guarantees and a bail-in tool"*. In this case, loss given default can be expressed as:

$$(7) \qquad LGD_{bail\text{-}in,gg} = \left(1 - p(bail\text{-}out)_{bail\text{-}in,gg}\right) \times (LGD|bail\text{-}in) + p(bail\text{-}out)_{bail\text{-}in,gg} \times (LGD|bail\text{-}out) = (LGD|bail\text{-}in) - p(bail\text{-}out)_{bail\text{-}in,gg} \times \left((LGD|bail\text{-}in) - (LGD|bail\text{-}out)\right),$$

where $p(bail\text{-}out)_{bail\text{-}in,gg}$ denotes the probability of a government bail-out given default when a bail-in tool is available.

The change in loss given default after a bail-in tool is introduced, ΔLGD, is hence expressed as follows:

$$(8) \qquad \Delta LGD = LGD_{bail\text{-}in,gg} - LGD_{gg} = \left((LGD|bail\text{-}in) - p(bail\text{-}out)_{bail\text{-}in,gg} \times \left((LGD|bail\text{-}in) - (LGD|bail\text{-}out)\right)\right) - \left((LGD|liquidation) - p(bail\text{-}out)_{gg} \times \left((LGD|liquidation) - (LGD|bail\text{-}out)\right)\right),$$

This expression can be simplified as:

(9) $$\Delta LGD = \left(1\text{-}p(bail\text{-}out)_{gg}\right) \times \left((LGD|bail\text{-}in) - (LGD|liquidation)\right) + \Delta p(bail\text{-}out)\left((LGD|bail\text{-}out) - (LGD|bail\text{-}in)\right).$$

Appendix C. Greater subordination for certain liability classes

Given the large volumes of deposits that will be given priority with the implementation of the BRRD, unsecured debt (primarily unsecured bonds and certificates) will have to carry much heavier losses given default (see Figure 3). This is because the losses that would previously have been borne by the deposit guarantee system, private individuals and SMEs, will now be applied to senior unsecured bonds, certificates and large corporate deposits.

Below follows an analysis of how much interest expense for unsecured debt would potentially rise if LGD increased to 100 per cent; that is, if investors in unsecured debt fully priced in the shift in risk.

To derive the impact on unsecured senior debt, we take a look at the components of the premium to the risk-free rate[65]. From Hull's approximation[66] it follows that:

(10) $$Premium_{Senior\ unsecured} = p(D) \times LGD_{senior\ unsecured},$$

where $p(D)$ denotes the probability of default, that is, i.e. the riskiness of the bank, and LGD denotes loss given default.

We then assume that loss given default for subordinated debt is 100 per cent (otherwise LGD for senior debt would be zero). By using the CDS spread on subordinated debt as a proxy, we can now derive the probability of default, because it will be equal to the spread on subordinated debt.

(11) $$Premium_{Subordinated} = p(D) \times 100\% = p(D)$$

Equation (12), which also follows from Hull's approximation, then gives us the LGD for senior unsecured debt.

(12) $$LGD_{Senior\ unsecured} = \frac{Premium_{Senior\ unsecured}}{p(D)}$$

It follows from equations (10) to (12) that if $LGD_{Senior\ unsecured}$ increases to 100 per cent, the spread on senior unsecured debt would be equal to the spread on subordinated debt.

(13) $$Premium_{subordinated} = Premium_{Senior\ unsecured,\ when\ LGD=100\%}$$

65 CDS spreads are used as proxies for the spread to the risk-free rate.
66 *Options, futures and other derivatives* by John C. Hull.

The spread between senior and subordinated CDS spreads for the major Swedish banks is between 30 and 60 basis points. Hence, the spread between senior debt and the risk-free rate would be expected to increase by 30-60 points if investors in this debt category fully discount their new, lower seniority.

A divided labour market – on matching on the Swedish labour market after the economic crisis

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In the wake of the financial crisis, many countries noted that matching between employees and employers seemed to have deteriorated. In previous analyses, the Riksbank has shown the existence of signs that matching on the Swedish labour market has also deteriorated following the crisis.[1]

The aim of this article is to follow up the Riksbank's previous analyses of matching and shed light on developments in recent years, and also to contribute a deepened analysis, in which matching is described from several perspectives linked to current research discussing factors that may be potential explanations to the development of the labour market after the crisis.

The results of the analysis indicate that problems remain in matching. It also shows that a large part of the impaired matching after the crisis can be explained by changes in the composition of the category unemployed, an increasing proportion of which at present are persons with a weaker attachment to the labour market.

However, the picture varies depending on the data sources used. It is less positive when data from the Swedish Public Employment Agency (Arbetsförmedlingen) is analysed, whereas Statistics Sweden's Labour Force Survey gives a brighter view. Even if that data also reveals signs that matching deteriorated after the crisis, recent development is in line with historical patterns. One explanation for the varying results is that the sources, even if they give a coherent view of the extent of unemployment, to some degree cover different individuals.

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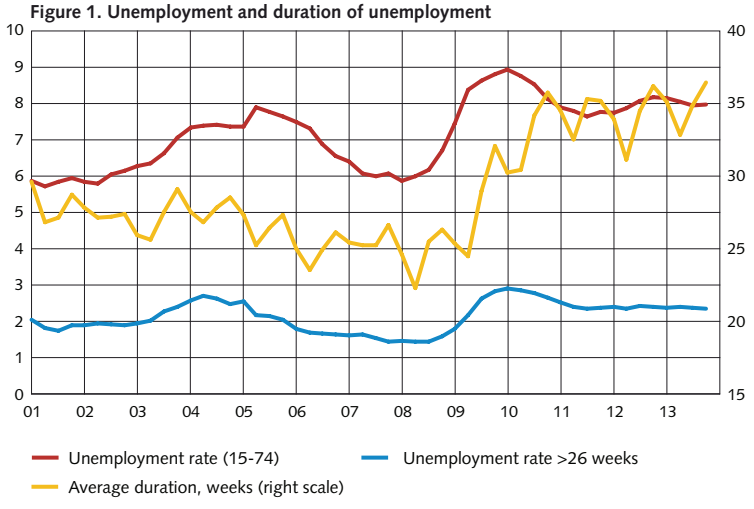
1 See the article on the functioning of the labour market in the Monetary Policy Report published in October 2012. Similar results for Sweden can also be found in analyses from the National Institute of Economic Research (2011, 2012), the Swedish Fiscal Policy Council 2012, the Organisation for Economic Cooperation and Development (OECD) 2012 and elsewhere.

Introduction

The labour market changes constantly. New jobs are created and old ones disappear. Individuals move between employment and unemployment, but also in and out of the labour force. As it takes time for employers and potential employees to come into contact, both unemployment and vacant jobs exist simultaneously. In economic theory this process is commonly called matching. A situation in which it is easier for employers and potential employees to find each other and form a match, i.e. in which matching efficiency is higher, contributes to shorter duration of unemployment, lower levels of unemployment and a higher employment rate. And, in a reversal of the situation, unemployment becomes higher and unemployment duration increases when matching is impaired. The number of matches between jobseekers and employers normally varies with the business cycle. When demand for labour is higher, it is easier for jobseekers to find work, while the opposite is true in downturns.

Both the percentage of long-term unemployed and the average duration of unemployment spells rose in Sweden in conjunction with the prolonged downturn following the financial crisis (see Figure 1). Long-term unemployment has fallen back from the highest levels and is now in line with the historical average, but it is still considerably higher than it was prior to the crisis. At the same time, the average duration of unemployment spells remains at a higher level than it was in the period 2001-2009 (see Figure 1).[2]

Figure 1. Unemployment and duration of unemployment



Sources: Statistics Sweden and the Riksbank

2 Long-term unemployment is measured here as the number of individuals who have been unemployed for at more than six months as a percentage of the labour force.

A LONG PERIOD OF UNEMPLOYMENT CAN AFFECT CHANCES OF FINDING WORK

Longer unemployment spells can affect the functioning of the labour market for several reasons. If being unemployed is interpreted as a signal that an individual has low productivity, longer periods of unemployment will strengthen this signal.[3] This can lead to a vicious circle arising in which the individual becomes trapped in unemployment.[4] This hypothesis is supported, for example, by experiments demonstrating that the probability of being called to an interview declines according to the length of unemployment for unemployed people with otherwise identical qualifications.[5]

Longer duration of unemployment can also affect individuals' behaviour. Empirical results indicate that individuals reduce their search effort as time passes. One reason for this could be that individuals lose motivation and confidence the longer they are unemployed.[6] Another aspect is that knowledge and competence can depreciate when an individual is out of work for a longer period of time. All in all, this can contribute to lower matching efficiency and that the job finding rate declines further in certain groups.

The duration of unemployment is related both to demand in the economy and to how well the matching process between employers and jobseekers works. At the same time, the average duration of unemployment and matching efficiency are also affected by the composition of the category unemployed. If groups with a weaker average attachment to the labour market, which are thereby harder to match, increase in size, both the average matching efficiency and duration of unemployment will increase.

The outline of the article is as follows: First, a theoretical framework and its empirical application are presented. This analysis is mainly based on simple matching functions estimated from data provided by the Swedish Public Employment Agency (SPEA) and Statistics Sweden's Labour Force Surveys. The data is described in the following section. Following this, the results of the empirical analysis are presented, together with a discussion of factors that may contribute towards explaining the development of the labour market after the crisis. Figures are presented at relevant points in the text, while tables with regression results are placed at the end of the article.

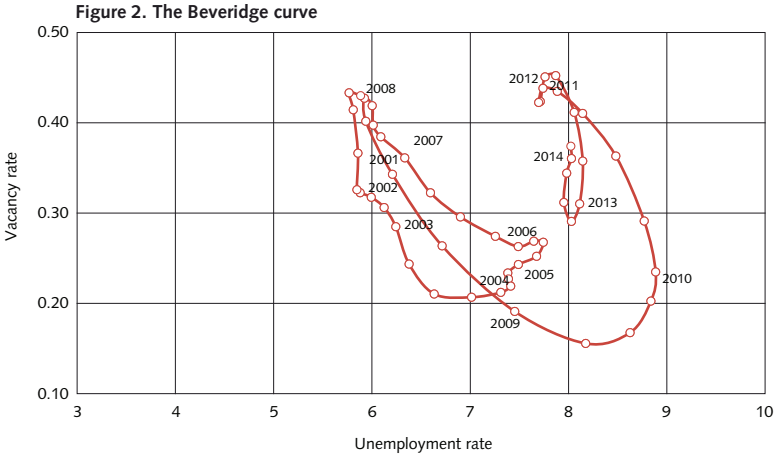
Matching – a simple theoretical framework

A common way of describing the functioning of the labour market and the efficiency of matching is to use the Beveridge curve, which relates the unemployment rate to the vacancy rate (see Figure 2). Normally, there is a negative correlation between vacancies and unemployment. In a period of high economic activity, the proportion of vacant jobs increases while unemployment decreases, while the reverse applies in a downturn. A

3 As it is more likely that individuals with lower productivity will become unemployed, an employer comparing two candidates, one in work and the other not, will quite rationally interpret unemployment as a signal of lower productivity, given that it is not possible to observe productivity perfectly.
4 See Blanchard and Diamond (1994).
5 See Kroft, Lange and Notowidigdo (2013).
6 See Krueger and Mueller (2011).

movement up or down the same curve is usually interpreted as cyclical variations, while a shift outwards (or inwards) *may* indicate a deterioration (or improvement) of matching efficiency. However, such a shift may also be part of a cyclical development, in which case the Beveridge curve forms a loop and eventually returns to the old relationship.[7] In Sweden, the curve showed a clear outward shift in 2009 (see Figure 2). For each given level of the vacancy rate, unemployment became higher than it had been previously. In 2012 and early 2013, the curve then moved inwards again, but this movement has halted over the last year.

Figure 2. The Beveridge curve



Note. The vacancy rate is defined as the number of vacancies as a proportion of the labour force. Seasonally-adjusted and smoothed data. The markings indicate the first quarter of each year.
Sources: Statistics Sweden and the Riksbank

A more direct way of studying matching efficiency is to estimate matching functions. A matching function relates the number of matches, which is to say individuals finding work, to the number of vacancies and jobseekers in the economy. In its simplest form, it assumes that matching between employer and jobseeker occurs randomly. The number of matches (M) is determined by the number of jobseekers (U) and the number of vacancies (V).

$$M=f(U,V)$$

Assuming that the matching function is Cobb-Douglas type with constant return to scale, the function can be written so that the aggregate job finding rate, i.e. the number of matches as a percentage of the number of jobseekers, depends on the tightness of the

7 See also National Institute of Economic Research (2013).

labour market, defined as the number of vacancies as a percentage of the number of jobseekers according to [8]

$$(1) \qquad ln\left(\frac{M_t}{U_{t-1}}\right)=\mu+(1-\sigma)*ln(\frac{V_{t-1}}{U_{t-1}})+\varepsilon_t.$$

In equation (1), the matching function is constant, with all variation in the job finding rate being driven by fluctuations in vacancies and unemployment. The matching efficiency on the labour market is then given by the parameter μ and $(1-\sigma)$ is the elasticity with respect to the tightness of the labour market. The Riksbank estimated such a relationship using SPEA monthly data in the article "Has the functioning of the labour market changed?".[9] The results indicated that matching had deteriorated considerably since the crisis. For a given labour market tightness in terms of jobseekers and vacancies, fewer persons found work than the historical relationship would suggest.

However, there are several reasons why the matching function does not have to be constant. For example, Barnicon and Figura (2013) discuss how the composition of the unemployment pool affects matching efficiency. If groups with a weaker average attatchment to the labour market, and which are thereby harder to match, increase in proportion, the average matching efficiency will decrease mechanically. They demonstrate that the simplest matching function, such as in equation (1), works well in normal circumstances, but struggles to capture major fluctuations on the labour market, and that a functional form that takes composition into account could better capture the relationship.

Another possibility is that changes in productivity and companies' recruitment behaviour may affect matching efficiency.[10] In downturns, matches that had previously been favourable cease to be so, as a result of lower productivity in the economy. For the unemployed, this is expressed as increased demands on jobseekers, with companies only being willing to employ relatively more productive individuals. With a given number of unemployed and vacancies, this implies a decrease in the number of recruitments and thus matching efficiency varies with economic activity.

Random matching is also a strong simplification of reality. Unemployed persons examine many vacancies before deciding which job to apply for. Once a vacancy has been rejected, there is little chance that the unemployed person will change his or her mind and apply for that particular job as opposed to instead screening new vacancies. Gregg and Petrolongo (2005) capture this notion in a stock-flow matching approach and show that this better describes how matching on the labour market is created.[11] Using such an approach, the inflow of jobseekers will search among all vacancies. Those not finding a job (being

8 The Cobb-Douglas function is written $M_t=\mu_0 U_{t-1}{}^{\sigma} V_{t-1}^{\gamma}$ in which μ_0 is a scale parameter (matching efficiency) and σ and γ are elasticities. With constant return to scale, $\sigma+\gamma=1$, i.e. $M=\mu_0 U^{\sigma} V^{(1-\sigma)}$. In equation (1), both sides are logarithmised. $\mu=ln(\mu_0)$ and ε_t is an error term.

9 See the Riksbank's Monetary Policy Report, October 2012.

10 See Sedlacek (2014).

11 Forslund et al. (2007) test random matching and stock-flow matching according to the same specifications as Gregg and Petrolongo for Sweden using SPEA data and find support for stock-flow matching more correctly describing the Swedish labour market.

matched) in the first period will only look among newly posted vacancies in following periods. This means that the probability of going from unemployment to employment is greater for those who have recently become unemployed and it then decreases when the next inflow of new vacancies must be awaited. Similarly, vacancies not filled straight away will have a lower probability of being filled, as only newly unemployed people will search among them. The analysis in this article is based on the simpler approach, with random matching, but similar results have been achieved using a stock-flow approach.

Data – many sources shed light on the labour market

The labour market is multi-faceted and there are a number of statistical sources that describe various aspects of it. This article uses data from the SPEA register together with Labour Force Surveys and vacancy statistics from Statistics Sweden.[12] These sources differ in several ways. They have different purposes, different definitions and different structures. This means that a somewhat different picture emerges depending on which statistics are being used. Statistics from the Labour Force Surveys probably provide a fairer view of the labour market as a whole, as the survey is a representative sample of the population of working age, while the basis of SPEA statistics is formed of those people registered as unemployed. However, SPEA statistics are constructed in such a way as to shed light on important groups facing particular difficulties on the labour market. There are thus good reasons to use both sources. The appendix describes the differences between the Labour Force Surveys and SPEA statistics in greater depth.

One advantage of SPEA data is that a relatively long period, from 1992 onward, can be studied and that the frequency is high (monthly data). Statistics Sweden's current flow statistics within the Labour Force Surveys only go back to the third quarter of 2005. However, it is possible extend data to 1997 by linking data from older flow statistics, although the results should be interpreted with caution as the definitions and methods differ between the two vintages.

Job opportunities vary along with labour market tightness

To shed light on recent years' development, equation (1) is first estimated for the period January 1992-June 2008 (see Table 1 for results).[13] The estimated elasticity with respect to the labour market is 0.41 and is in line with previous empirical results.[14] Figure 3 shows fitted values from the estimated equation together with a projection of how job opportunities should have developed given the historical relationship and the actual

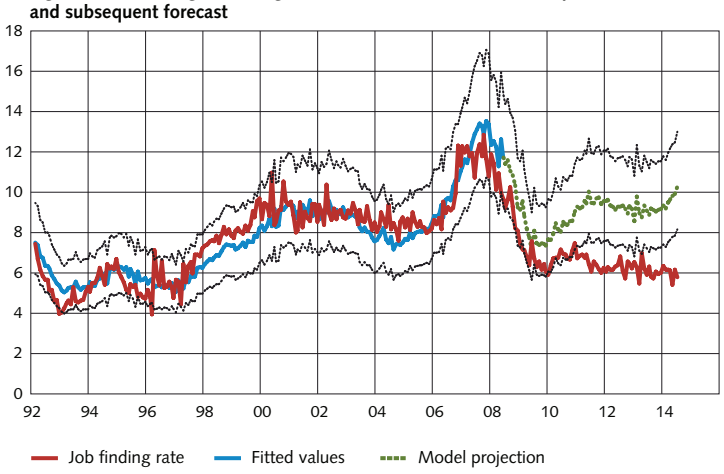
12 Statistics Sweden's vacancy statistics go back to 2001. For this analysis, vacancies prior to 2001 have been extrapolated with the use of SPEA data for remaining vacant positions.

13 Corresponding estimates have also been made in which the matching function is instead assumed to follow a stock-flow relationship. The results resemble those obtained from random matches in the sense that matching efficiency shows the same deterioration after the financial crisis.

14 From a review of literature, Petrolongo and Pissarides (2001) reach a span of 0.3-0.5 for elasticity ($1-\sigma$). Barnicon and Figura (2013) estimate elasticity at 0.33 and Sedlacek (2014) at 0.35.

development of vacancies and unemployment (the green line in Figure 3).[15] As Figure 3 shows, the actual job finding rate (the red line) is significantly lower than suggested by the model projection and is below the 95 per cent forecast interval from 2010 and on.[16]

Figure 3. Job finding rate using SPEA data – estimated relationships until June 2008 and subsequent forecast



Note. The relationship is estimated until the end of June 2008. After this, the equation is projected given the actual development of vacant positions and unemployment according to the Swedish Public Employment Agency. Job finding rate as a percentage. The broken lines indicate a 95 per cent forecast interval. See Table 1, column 1 for the regression results.
Sources: Swedish Public Employment Agency and the Riksbank

If the model is instead estimated for the entire period January 1992 to July 2014, which is to say also including the years after the crisis, the estimate changes considerably (see Table 1, column 2). Elasticity falls to 0.32. The estimate also becomes less precise, with the coefficient of determination decreasing from 0.81 to 0.52. One reason for this may be that the assumption of a constant matching efficiency places too heavy a restriction on the model. For example, changes in the composition of the unemployment pool may affect the aggregate matching efficiency (Barnicon and Figura, 2013). It may also vary cyclically as in Sedlacek (2014). This means that the unemployed find it harder to find work during a downturn for two reasons. Firstly because there are fewer jobs in relation to the number of unemployed people and secondly because matching efficiency declines.

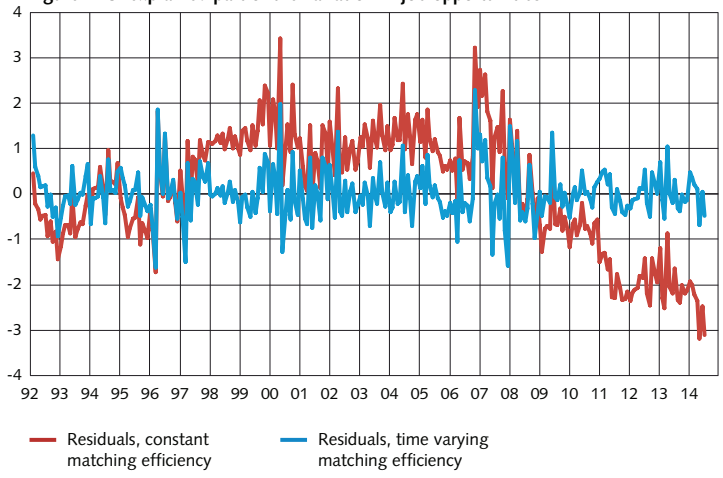
To reflect that matching efficiency may change over time, the model is thus re-estimated with annual time effects (see Table 1, column 3). This does not significantly change elasticity with respect to the tightness of the labour market, but the coefficient of determination rises to 0.91. One way of illustrating this is by studying the residuals, the unexplained part,

15 The same approach is taken in Employment Outlook (OECD, 2012). The matching function is estimated for data predating the crisis and the model is adjusted using the actual development of the labour market situation. The OECD also notes that there are signs that matching deteriorated after the financial crisis in a number of countries, including Sweden.

16 The choice of cut-off point for how long the model is estimated is arbitrary and chosen to exclude the financial crisis. The results are not affected notably if the date is instead moved forwards or backwards by six months.

from the estimates with both constant and time-varying matching efficiency (see Figure 4). When matching efficiency is forced to be constant, the residuals are positive from the end of the 1990s until the crisis and then become large and negative after the crisis. In contrast, when matching efficiency is instead allowed to vary, there is no clear pattern in the residuals.

Figure 4. Unexplained part of the variation in job opportunities

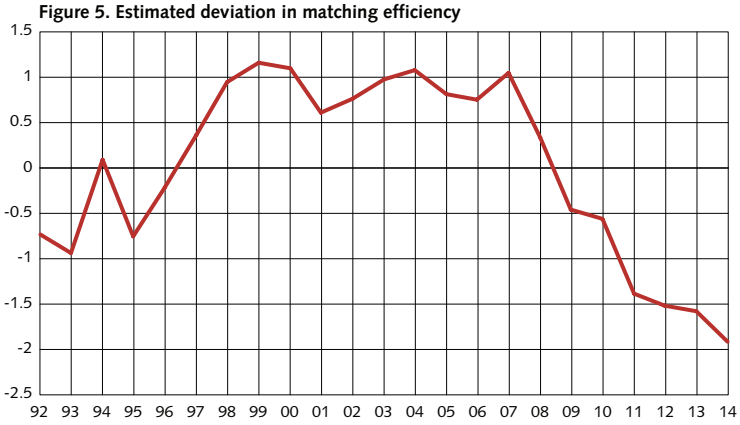


Note. Unexplained part in the variation in aggregate job opportunities. Residuals from regressions January 1992-July 2014. See Table 1, columns 2 and 3 for the regression results.
Sources: Swedish Public Employment Agency and the Riksbank

To illustrate how the estimated matching efficiency changes over time, Figure 5 shows how the time dummies deviate from their mean value. From 2010 on, matching efficiency is more than one standard deviation lower than its mean value and shows no sign of recovering.[17] From the end of the 1990s until the crisis, the deviations are instead positive, which indicates that matching efficiency was then above average.

17 The pattern largely follows the development of productivity growth as discussed in Sedlacek (2014). In the period 1993-2008, average productivity growth was 2.6 per cent, while the average for 2009-2013 was significantly lower at 0.5 per cent.

Figure 5. Estimated deviation in matching efficiency



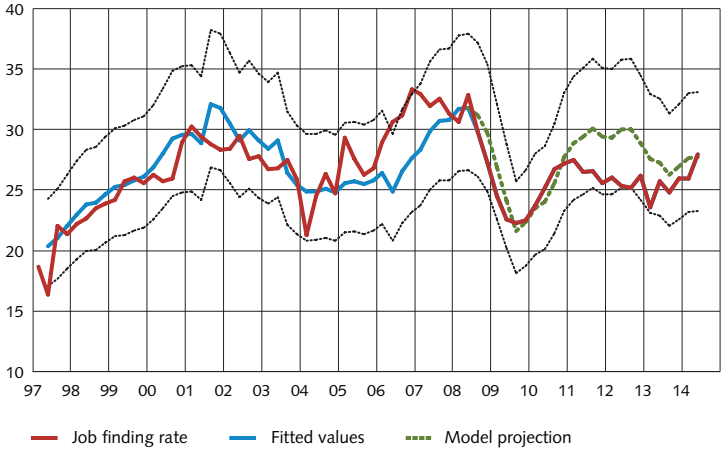
Note. Standardised deviation from mean value. See Table 1, column 3 for the regression results.
Sources: Swedish Public Employment Agency and the Riksbank

LABOUR FORCE SURVEY STATISTICS GIVE A BRIGHTER VIEW

Table 1, columns 4 and 5, present the results of corresponding analyses using flow data from the Labour Force Surveys. Interestingly, these results do not indicate the same deterioration of matching, regardless of whether the relationship is estimated for the entire period or the shorter one. The coefficient of determination is certainly higher when the crisis period and following years are excluded, but the difference is not as clear as in the estimates from SPEA data. It can also be seen in Figure 6, in which the fitted values 1997-2008:2 are shown together with a projection of the model given the actual development of vacancies and unemployment according to Statistics Sweden. Following the crisis, the actual development of the job finding rate was weaker than indicated by the historical relationship, but the deviation is significantly smaller than in SPEA data and falls within a 95 per cent forecast interval. Unlike the analysis of SPEA data, it also shows that the job finding rate over the recent period again is in line with historical relationships. However, the estimate is subject to significant uncertainty as historical data has been linked.[18]

18 For more information, see the section describing the data.

Figure 6. Job finding rate in the Labour Force Survey – estimated relationships until the end of 2008:2



Note. Linked quarterly data, Labour Force Survey. The relationship is estimated until the end of the second quarter. 2008. After this, the equation is projected given the actual development of vacancies and unemployment according to Statistics Sweden. Job opportunities as a percentage. See Table 1, column 4 for the regression results. The broken black lines indicate a 95 per cent forecast interval around the green line.
Sources: Statistics Sweden and the Riksbank

One possible explanation for the difference in results from data from SPEA and the Labour Force Surveys may be that the different sources partly capture different persons.[19] For example, the Labour Force Surveys include more full-time students than SPEA data. At the same time, some individuals who are unemployed according to SPEA are outside the labour force according to the Labour Force Surveys, which indicates that they have a weaker connection to the labour market. It is also likely that unemployed persons with high employability, such as individuals with good educations, for example, may be less inclined to register at SPEA, while weaker groups register to a greater extent, which may be reflected in the results.

What possible explanations are there for the deteriorated matching?

The pattern shown in Figure 3 is not unique to Sweden.[20] Barnichon and Figura (2013) study data for the United States and find support for the view that the common matching function (random matching), that has shown itself to be a fairly good approximation of the labour market in normal times, works significantly less well in times of major fluctuations on the labour market. One reason is that the matching function finds it difficult to capture the effects of the changing composition of the unemployment pool. Another is that different occupations, industries and geographical areas are affected in different ways. If groups with poorer employability (i.e. below average matching efficiency) increase as a share of the unemployed, matching efficiency will decrease mechanically.

19 See Statistics Sweden 2013 and the appendix.
20 See, for example, Employment Outlook 2012.

THE CHANGED COMPOSITION OF THE LABOUR FORCE HAS AN EFFECT

In recent years, changes have taken place on the Swedish labour market, leading to changes in the composition of the labour force. Firstly, demographic developments have contributed towards groups with a weaker attachment to the labour market increasing as a percentage of the working age population, for example younger people, older people and immigrants. Secondly, a series of economic policy reforms aimed at increasing the labour supply and incentives to work have been carried out, for example the earned income tax credit and changes to unemployment and sickness insurance.[21] As an illustration, these measures have led to over 70,000 people previously on sick leave being transferred from the Swedish Social Insurance Agency to the Public Employment Agency since 2010, thus being included in the labour force. In October 2013, 32,000 of these individuals remained registered with SPEA[22]. In recent years, labour force participation has developed strongly even though demographic developments suggest it should instead have decreased. The labour market reforms implemented over the past decade have probably contributed to this.

In the long term, an increased supply of labour will form the basis for a long-term higher employment rate, but in the short term it may entail major challenges, particularly if there is an imbalance between the qualifications of the labour force and employers' demands. This, in turn, is expressed as impaired matching. An adjustment, which may involve everything from training and education to mobility and changes in production, may take a long time.[23]

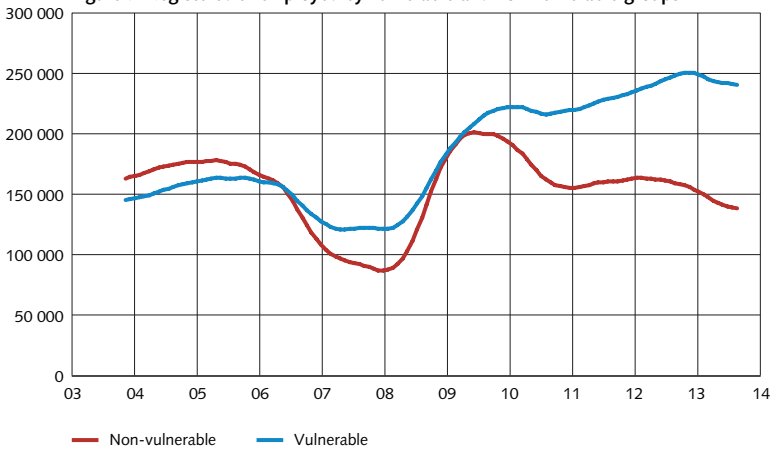
The SPEA usually speaks of four groups that are more vulnerable on the labour market. These are people who

- have at most compulsary school,
- were born outside Europe,
- are older (55-64 years), or
- have a disability entailing a reduction of working capacity.

In these groups, job finding rates are generally lower and/or unemployment higher than in other groups.[24] Figure 7 shows how the number of people registered by SPEA in vulnerable and non-vulnerable groups has changed over time. While members of vulnerable groups were fewer than those of non-vulnerable groups in the early years of the last decade, over 60 per cent of registered unemployed are now in the vulnerable groups. Moreover, while the size of the non-vulnerable group is now almost back on the same level as before the financial crisis, the vulnerable group has increased by about 100,000 persons.

21 See also Sveriges Riksbank (2011) and National Institute of Economic Research (2012).
22 See Arbetsförmedlingen, 2013.
23 One method of studying how imbalances between job-seeking and vacant positions affect unemployment has been developed by A. Sahin, et al. (2012). The same method has been applied to Swedish data by Marthin (2013). This concludes that mismatches between professions are important as regards total unemployment. In a comparison between 2002 and 2011, he also finds indications that mismatches between professions have increased over time.
24 It is possible to follow several of these groups in SPEA's register from 1992 onwards. Those without upper-secondary educations are reported separately from November 2000 and those born outside of Europe from November 2003.

Figure 7. Registered unemployed by vulnerable and non-vulnerable groups



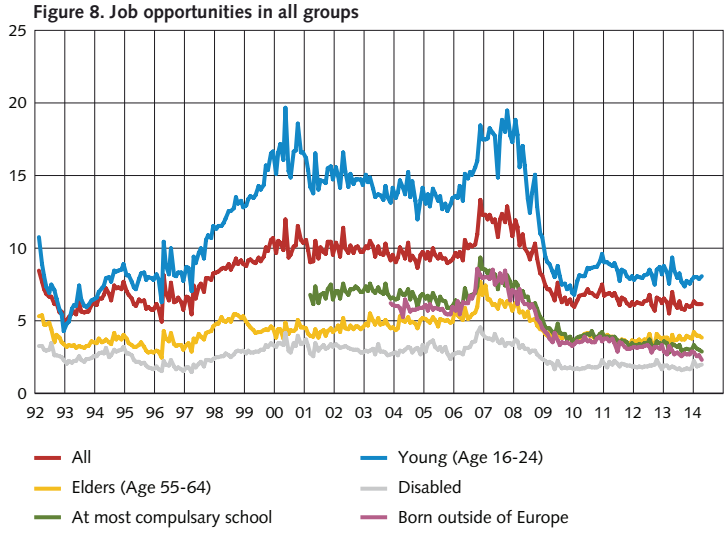
Note. Vulnerable groups means older people between 55 and 64, those without upper-secondary educations, those born outside Europe and persons with disabilities. Number of persons, trend values.
Source: Swedish Public Employment Service

JOB FINDING RATES VARY OVER TIME AND BETWEEN DIFFERENT GROUPS

Job finding rates, defined here as the percentage of jobseekers finding unsubsidised work, have developed differently for different groups (see Figure 8). The average job finding rate decreased from 10 per cent in 2004 to about 6.5 per cent in 2013 (red line). Part of the decline can be explained by a change in the definition of unsubsidised work.[25] According to SPEA, this change in definition implies a decrease of the average job finding rate by about one percentage point. This means that the reduction in the job finding rate for all jobseekers is less in reality, about 2.5 percentage points.

25 The statistics from 2007 on exclude jobs lasting for less than six months for jobseekers covered by the job and development guarantee scheme and the job guarantee for young people. The data has been corrected for this in all estimates.

Figure 8. Job opportunities in all groups



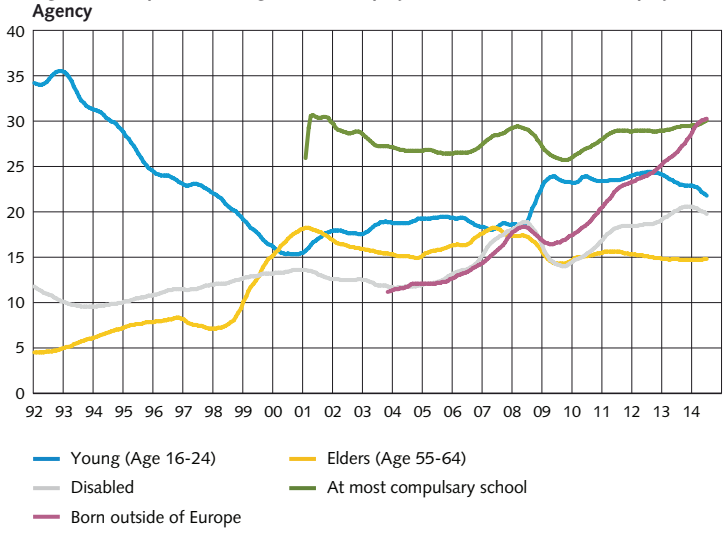
Note. Unemployed persons gaining unsubsidised work in various groups. Per cent.
Source: Swedish Public Employment Service

At the same time, major changes have taken place in the composition of unemployed individuals registered with SPEA. Figure 9 shows how the proportion of unemployed people who are young, older, without upper-secondary educations, born outside Europe or disabled has changed over time. Note that these percentages do not add up to 100 per cent as an individual may be included in more than one group.

The percentage of young people has varied widely. From having formed almost 35 per cent of the unemployed at the start of the 1990s, this group decreased to form just below 20 per cent for the greater part of the present century. The great expansion of higher education has probably been a major contributory factor to this. However, the percentage increased again in conjunction with the crisis before declining again over the last year to just over 20 per cent (see Figure 9). Although young people are not included among the vulnerable groups, this group saw a major deterioration of its job finding rate in conjunction with the crisis (see Figure 8). Another major change is that the percentage of older people (55-64 years) increased, particularly in the 1990s, from about 5 per cent to almost 15 per cent at present. The percentage born outside Europe has been reported separately since the end of 2003. At this point, they formed about 10 per cent of the unemployed but have since increased to about 30 per cent. At the same time, this group has a low job finding rate compared to the other groups.

All in all, groups with lower job finding rates have thus increased significantly in size, which affects the development of the overall job finding rate. With regard to the division between vulnerable and non-vulnerable, a simple decomposition shows that about two-thirds of the decline in the total job finding rate can be explained by changes in the composition of the unemployment pool and the remaining part by a reduced job finding rate given that composition.

Figure 9. Composition of registered unemployed at the Swedish Public Employment Agency



Note. Unemployed in different groups. Per cent.
Source: Swedish Public Employment Agency

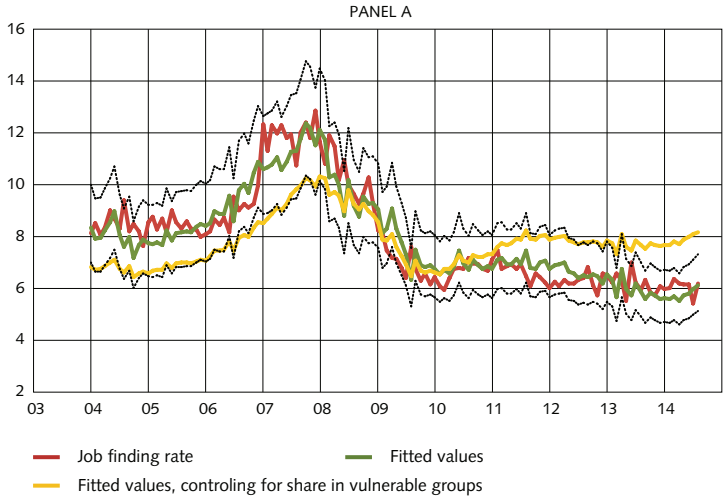
WHAT PART DOES THE CHANGED COMPOSITION PLAY IN ESTIMATES OF THE MATCHING FUNCTION?

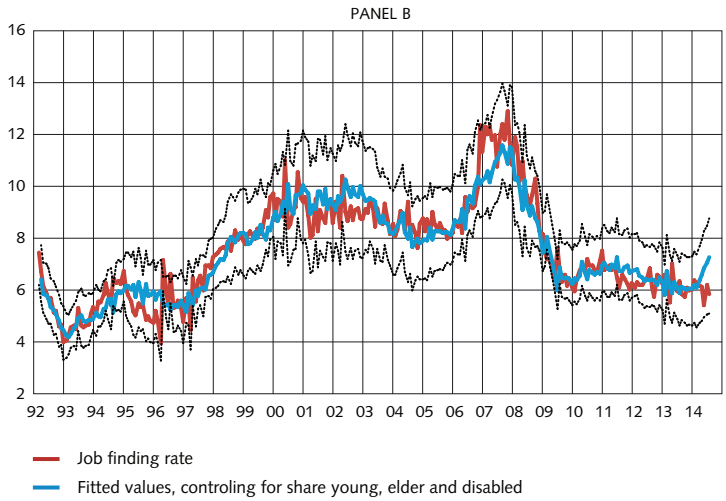
Figure 10, panel A shows the fitted values when equation 1 (random matching) is re-estimated for the shorter sample from November 2003 to 2013 (yellow line), i.e. from the point in time at which the vulnerable group as a whole can be identified in the data. This fit is poor and the simple function cannot capture the large decline in the job finding rate after the crisis. The model underestimates the job finding rate before 2008 and overestimates it afterwards. The green line shows fitted values where the estimated equation is expanded to include the proportion of unemployed belonging to one of the vulnerable groups. The idea is to thereby take the changed composition of the unemployment pool into consideration. The results indicate that the increase in the share belonging to vulnerable groups can explain a large part of the decline in the job finding rate (see Table 3, column 2 and Figure 10, panel A). Given the composition of unemployment and the tightness of the labour market, the estimated job finding rate is then in line with actual developments.

One weakness is that the estimation period is relatively short as the vulnerable group as a whole cannot be traced back further than to the end of 2003. However, it is possible to study the part played by composition over a longer perspective by controlling for the percentages of young people, older people and disabled people, all of which are reported separately in SPEA data as far back as January 1992 (see also Figure 9). This is done in the lower panel (B) in Figure 10. Here too, simple checks for composition show that the fitted values are more in line with actual developments. The results thus indicate that the

composition can also explain a large part of the decrease in job opportunities after 2008 over the longer sample period (see also Table 2, column 2 for the regression results).[26]

Figure 10. Job finding rate – estimated relationships with controls for the composition of unemployment





Note. See Table 2 for the regression results.
Sources: Swedish Public Employment Agency and the Riksbank

26 To take consideration of variations in composition and labour market situation on local labour markets, the relationship has also been estimated using data from SPEA by county and over time. The results are in line with those received from aggregated data and are therefore not reported here, although they are available from the author.

Discussion – a divided labour market?

This analysis describes the factors that have contributed to the development of the Swedish labour market: both the economic downturn connected to the financial crisis and the changes in the composition of the labour force due to both demographic developments and various economic policy measures. Since the end of 2009, the number of vacant jobs in relation to the number of persons unemployed has risen without opportunities for the unemployed to find work having recovered to the same extent. A certain decline in matching efficiency is natural in conjunction with a downturn, but other factors have probably also played a role.

Labour force participation has developed strongly in recent years. The labour market reforms implemented over the past decade have probably contributed to the strong development. But this has also meant that groups closer to the periphery of the labour market are participating to a greater degree. For example, this can be seen in SPEA's statistics, in which the number of unemployed persons belonging to vulnerable groups now forms the majority of the registered unemployed. The analysis shows that it is difficult for a simple random matching function to capture the decrease in job finding rates following the crisis and the results indicate that at least a part of the explanation lies in a change in the composition of the unemployment pool.

At the same time, it is important to point out that the picture varies depending on which data is analysed. SPEA's data gives a less positive view, in which matching efficiency deteriorated significantly and has shown no sign of recovering as yet. If the statistics from the Labour Force Surveys are used instead, the deterioration is not as clear and estimated job finding rates in the recent period are again in line with actual developments. This divergence of results depending on the source is probably due to the inclusion, to a greater extent, of individuals on the periphery of the labour market in SPEA's register. At the same time, the estimates in the Labour Force Surveys are associated with great uncertainty.

When estimates of the matching function using SPEA's data take consideration of the composition of the category unemployed, the results are closer to those received when the years following the crisis are excluded. The estimated values of the job finding rate then fall into line with the actual development given the labour market tightness.

So what are the implications of this changed composition for unemployment in the future? In the long term, the increased supply of labour will form the basis for long-term higher employment, but in the short term it may entail major challenges, particularly if jobseekers' qualifications do not match companies' demands. The large supply of labour could then contribute to keeping unemployment at a high level.

The Riksbank's assessment is that labour force participation will decrease somewhat over the coming years.[27] This is mainly explained by the fact that the population of working age (15-74 years) increasingly consists of groups with lower average workforce participation. An expansionary monetary policy is contributing to the strengthening of

27 See the Riksbank, Monetary Policy Report, July (2014).

economic activity, which is also boosting demand for labour and expectations of continued rising employment. Unemployment will thus successively decrease over the years ahead. However, monetary policy cannot affect structural factors on the labour market such as the composition of the labour market or matching efficiency. Other measures than an expansionary monetary policy are needed to significantly bring unemployment down.

Without measures to improve matching efficiency, for example, there is a risk that the labour market will become more divided. Labour shortages in certain industries and professions may arise at the same time as many people with other skills or the wrong skills remain unemployed. In such a situation, the risk may arise that inflationary pressures rise via wage increases at the same time as there is slack in parts of the labour market.

Tables

Table 1. Estimated job opportunities

	AF	AF	AF	LFS	LFS
	(1) 1992:1-2008:6	(2) 1992:1-2013:12	(3) 1992:1-2013:12	(4) 1997q1-2008q2	(5) 1997q1-2014q2
ln (V(-1)/U(-1))	0.41*** (0.02)	0.32*** (0.03)	0.28*** (0.05)	0.27*** (0.04)	0.23*** (0.04)
Constant	-1.58*** (0.06)	-1.88*** (0.08)		-2.92*** (0.06)	-2.95*** (0.05)
Annual effects			X		
N	197	270	270	45	69
Adj R2	0.83	0.52	0.91	0.61	0.53

Newey West corrected standard error in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Note. V represents the number of remaining vacant positions according to Arbetsförmedlingen (columns 1-3) and vacancies according to Statistics Sweden (columns 4-5). U represents the number of jobseekers according to the Swedish Public Employment Agency (columns 1-3) and number of persons unemployed according to Statistics Sweden (columns 4-5)

Table 2. Estimated job opportunities with checks for composition

	(1) 2003:11-2013:12	(2) 2003:11-2013:12	(3) 1992:1-2013:12
ln (V(-1)/U(-1))	0.31** (0.08)	0.56*** (0.03)	0.48*** (0.03)
Proportion aged 16-24			-2.56*** (0.21)
Proportion aged 55-64			-1.64** (0.39)
Proportion disabled			-4.66*** (0.40)
Proportion in vulnerable groups		-3.86*** (0.24)	
Constant	-1.96*** (0.17)	0.64*** (0.217)	-0.07 (0.15)
Number of observations	129	129	263
Adj R2	0.27	0.85	0.86

Newey West corrected standard error in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note. V represents the number of remaining vacant positions and U is the number of jobseekers according to the Swedish Public Employment Agency.

Appendix

DESCRIPTION OF DATA FROM THE LABOUR FORCE SURVEYS AND SPEA

The Labour Force Survey (LFS) is a sample survey based on about 29,500 individuals every month and providing Sweden's official labour market statistics. The survey describes current labour market conditions and also provides a view of developments. The definition of unemployment and employment complies with the guidelines of the International Labour Organization (ILO). SPEA's statistics are instead based on data concerning those individuals registered at SPEA. A review of the correspondence between the statistics from SPEA and the LFS, produced by Statistics Sweden last year, concluded that there is strong correspondence as regards the number of unemployed persons but that there are large differences in composition. There are individuals registered as unemployed at SPEA who are classed as employed or outside the labour force by the LFS. There are also unemployed individuals in the LFS who are not registered as unemployed at SPEA.[28] One reason for these differences is that the LFS and SPEA have different definitions of unemployment.[29] The comparison also revealed large differences in age distribution. The LFS covers young people to a greater degree, for example unemployed full-time students not registered as unemployed by SPEA (Statistics Sweden, 2013). As SPEA's statistics are based on a person actually being registered at SPEA, the willingness to do this also plays a part.

Statistics from both the LFS and SPEA are also used to measure the tightness of the labour market. From Statistics Sweden, economic statistics regarding job vacancies are used. Vacancies refer to unmanned vacant positions in the private sector that can be filled immediately. SPEA instead uses remaining and newly reported vacancies registered at SPEA. SPEA's measure covers all sectors but probably suffers from a number of measurement errors. Firstly, there is a delay in the deregistration of vacancies after they have been filled and, secondly, newly reported vacancies may be duplicated, above all as regards seasonal short-time work (see Arbetsförmedlingen 2012).

28 In the first quarter of 2011, about 60 per cent of those registered as unemployed at SPEA were classified as unemployed according to the LFS. Twenty per cent were classified as employed and the rest were outside the labour force (Statistics Sweden, 2013).

29 To be classed as unemployed by the LFS, a person must be without work, be available for work and have actively looked for work or have been offered and accepted work starting within three months. A person is classed as employed if he or she has worked at least one hour during the week of measurement. However, under certain circumstances, a person registered at SPEA can work up to 8 hours per week and still be classed as unemployed.

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What is Bitcoin?

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Bitcoin is a so-called virtual currency that has been devised for anonymous payments made entirely independently of governments and banks. In recent years, Bitcoin has generated a great deal of attention on several fronts. Bitcoin payments are based on a new interesting technical solution and function differently to traditional payments. In certain payment situations, Bitcoin can bring advantages in the form of lower costs, rapidity, anonymity, etc. over traditional payment methods. However, usage can also be more risky because Bitcoin is not directly covered by the laws that govern other payment mediation. Weak consumer protection is also a reason for why it may be difficult for Bitcoin to become generally accepted and viable as a means of payment. Use of Bitcoin for payments is low today, and although Bitcoin's future is uncertain, it is an interesting innovation worthy of description. This article explains what a virtual currency is, and how Bitcoin works. Bitcoin use in Sweden – which is very limited – is also described. Finally, the future of Bitcoin and other virtual currencies is discussed.

Responding to new needs?

Many areas have undergone rapid technological progress in recent years. Our needs in terms of making payments are also undergoing transformation. For instance, households are shopping online to a growing extent, and the amount of cross-border payments is on the rise. Payment solutions, especially for person-to-person payments, have however not evolved as quickly. Bitcoin can be seen as a response to the lack of such payment solutions and has often been a topic of discussion in the media, at workplaces and among friends in recent years. Various factors have evoked curiosity about how the currency works, such as the supposed anonymity for users, the fact that banks are not involved in the payments and the ability to make payments worldwide. At the same time, it is difficult to understand what Bitcoin really is, and how it works. I attempt to elucidate this in this article.

I start by explaining what a virtual currency is, the different types of virtual currency that exist, and where Bitcoin fits into that categorisation. I then go on to describe how Bitcoin works and what we know about its use in Sweden. Finally, I discuss Bitcoin's benefits and risks, and the difficulties it may face in future.

* I would like to thank those who have contributed their valuable input. While they are too many to mention, I would like to extend particular thanks to Malin Alpen, Susanna Grufman, Marianne Sterner, Claes Berg and Kristian Jönsson.

Virtual currency

Bitcoin is what is known as a virtual currency.[1] A virtual currency is a means of payment; that is, units of the virtual currency represent a value. It is intended for use in payments within a specific virtual community, such as a particular website, or in a network of users with special software for managing the virtual currency and making payments. This type of virtual community can thus be said to resemble a voluntary agreement to use a specific item as a means of payment. This is an important difference to national currencies, such as the Swedish krona. For the latter, it has been established in law that the monetary unit in Sweden shall be called the Swedish krona. The virtual currency thus has a different unit of account than national currencies. For Bitcoin, the unit of account is the Bitcoin itself.

The issuer of the virtual currency can be a non-financial company or even a private individual, but such an issuer is not under the supervision of a government authority. The issuance of virtual currency is thus not a government-regulated activity.[2] However, each virtual currency has some type of rules of its own governing where and how it may be used, and some form of technical infrastructure in which the payments are carried out. The virtual currency, the own set of rules and the technical infrastructure combined form a small payment system, hereinafter referred to as a virtual currency scheme.

There are a large number of virtual currency schemes that have been built up, and function, in different ways. They can be broken down into different categories depending on the extent to which it is possible to buy and sell the virtual currency. Here, we divide them into virtual currency schemes that are closed, with unidirectional flow and bidirectional flows. In closed virtual currency schemes, the virtual currency can be neither bought nor sold, but only earned and used on certain websites (such as World-of-Warcraft Gold). If the virtual currency can be bought for national currency but not exchanged back, the scheme has a unidirectional flow (such as Amazon coins). When the virtual currency can both be bought and sold and used outside of a certain website, the scheme has bidirectional flows. As explained below, Bitcoin is an example of a scheme with bidirectional flows. However, these categories can overlap.[3]

A further distinction that can be made is whether the virtual currency is centralised or decentralised. As with banknotes and coins, payments with virtual currency units are made by means of them changing ownership. The ownership structure must therefore be registered somewhere, otherwise it might be tempting for a virtual currency unit holder to duplicate it and use it multiple times. A centralised virtual currency scheme has a centralised

1 The term "virtual currency" is used by the ECB (2012) and we use their terminology. Other terms are sometimes used in other articles, such as digital currency. However, it is doubtful as to whether Bitcoin is a currency in the proper sense, see Yermack (2014).

2 The issuance of virtual currency must be distinguished from offering different forms of payment service in virtual currency. The providers of financial services, such as exchanges, in virtual currency are subject to anti-money laundering regulation. Regarding payment services, the main regulation in Sweden is the Payment Services Act (2010:751) which sets out the rights and obligations of both mediators of payments and users of payment services. It applies to payment services in Euro or other EES-currencies but could in principle be extended to other currencies, including virtual currencies.

3 See Segendorf (2014) for a more detailed description of the various categories.

system for verifying and executing transactions, often with the issuer. In practice, the latter administrates all of the accounts through which the payments are made. In a decentralised virtual currency scheme, like Bitcoin, the transactions are instead verified and executed via the network of users that carry out some form of activity to this end. The right to register events is thus delegated to the network's participants.[4] The decentralised virtual currency schemes are not uncommonly based on an exchange of encrypted messages and are therefore usually called cryptocurrencies. The anonymity and security that this provides are the fundamental concepts on which Bitcoin rests.

How Bitcoin works

Bitcoin is a decentralised virtual currency scheme with bidirectional flow, and a cryptocurrency.[5] It was devised to be independent of governments, banks and other institutions. At an overarching level, Bitcoin works rather like a type of electronic cash. Bitcoins can be purchased on special websites, both abroad and in Sweden, where they are exchanged for national currency.[6] [7] The exchange rate for Bitcoin is determined by the market as a function of supply and demand.

Bitcoin payments can be made between anybody with the requisite software on their computer, smartphone or tablet. This software is called a *wallet*. Yet, Bitcoin should not be considered to be a type of digital cash. The reason is that Bitcoins are not digital units of value stored on e.g. a computer. A Bitcoin is thus not a digital note or coin and should not be compared to regular notes and coins. Rather, Bitcoin should be viewed as funds in an account. When a payment is made, the payer thus does not send digital notes and coins to the recipient; rather, the payment occurs by means of debiting the sender's account and crediting the recipient's account. Payments are made by means of exchanging encrypted messages and are verified within the user network. I describe this process below.

4 Also, traditional retail payments can be divided up into centralised and decentralised systems. Cash is a decentralised system. It suffices for the paying and receiving parties to agree on the validity of the payment for its acceptance. Other retail payments such as credit transfers, direct debits, cards and cheques are centralised in that they are centrally cleared and the payments are settled at a settlement institution, commonly the central bank. See Sveriges Riksbank (2013) for an account of clearing and settlement of retail payments.

5 Bitcoin was launched in 2009 by Satoshi Nakamoto, which is possibly a pseudonym. Until 6 March 2014, when Newsweek claimed that it had found the real Satoshi Nakamoto, there was a general conviction that the true founder, or group of founders, was unknown. The identified man has denied that he is the true Satoshi Nakamoto. It is currently uncertain whether or not it was the true Satoshi Nakamoto who was found. Source: http://mag.newsweek.com/2014/03/14/bitcoin-satoshi-nakamoto.html and http://www.coindesk.com/one-simply-find-satoshi-nakamoto/

6 Different exchange sites offer slightly different services. Some only exchange, while others can offer accounts. There are also websites that match buyers and sellers geographically. In Sweden and most other countries, companies that offer exchange services are regulated and come under supervision.

7 The largest international exchange site by far has long been Mt.Gox. At the end of February 2014, a major theft/fraud was uncovered, whereupon Mt.Gox became insolvent and was declared bankrupt.

ASYMMETRICAL ENCRYPTION GIVES SAFE PAYMENTS

I start by explaining the concept "asymmetrical encryption" and how the sender (person A) and the recipient (person B) of encrypted messages can be securely identified. Asymmetrical encryption is based on A and B having two encryption keys each. The encryption keys are unique and nobody can have the same keys as anybody else. One of the keys is public; in other words it is or could be made publicly known. The other is private, or secret in other words. When A wishes to send an encrypted message to B, he uses B's public key to encrypt the message which can then only be de-encrypted using B's private key. So, B is the only person who can read the message.

Asymmetrical encryption can also be used for signing. If A uses his private key to encrypt a message, this can only be de-encrypted using A's public key. The person de-encrypting the message can then be sure that it was sent by A – nobody else has access to A's private key. This is comparable with A having signed the message.

Assume that A is to pay 1 Bitcoin (BTC) to B. A and B both have their wallets on their computers, and each such wallet has a private and a public encryption key. A wallet is associated with its public encryption key, which serves as an address or an account number. A and B communicate through their wallets.

THE TRANSACTION IS VERIFIED BY THE NETWORK

The transaction commences by B sending his public encryption key (account number) to A. A, or more precisely A's wallet, now writes a payment order for 1 BTC to B and signs it with A's private key. The payment order is issued to the network of Bitcoin users. One could say that the transaction between A's and B's wallets is proposed to the network, which now has to confirm/verify the transaction for it to become valid. The method used to send the message to the network is based on technology similar to file sharing (BitTorrent), which is common for spreading/sharing films, music, etc. online.

The verification process is as follows: Every tenth minute, a certain type of participant in the Bitcoin network gathers the transactions proposed in the last ten-minute period. This occurs automatically, and the round of gathered transactions is called a "block" and the special participants are called "miners".[8] They have the task of verifying the transaction by adding the new block (the transactions) to what is known as the blockchain, which is the official list or register of verified Bitcoin transactions. Because the blockchain contains information about sending wallets, receiving wallets and amounts, it can be used to verify how many BTC belong to a specific wallet. It is the same as being able to calculate the balance of a normal bank account if one has access to all the incoming and outgoing transactions of that account. A wallet can therefore be viewed as an account, for which the public key serves as an account number for the wallet. A Bitcoin transaction is not

8 Anybody can become a miner; it's the choice of the individual. They are called miners because their activity has been likened to gold digging, because they are rewarded with new Bitcoins. It is an ill-fitting comparison, however, because Bitcoin, unlike gold, has no intrinsic value. For gold, this value comes from the ability to use it for jewellery, in industrial processes, etc.

completely anonymous. Because it is added to the blockchain, it is registered and readily available online. It is thus fairly simple to identify the wallets between which a transaction has been made. However, it is very difficult to link wallets to individual users, which means that the transaction is in practice anonymous.

The payments are verified by means of miners solving a mathematical problem for which the solution is difficult to calculate, but easy to verify once calculated. In order to better understand the verification, the concept "hash function" must be explained. A hash function is a function that converts an arbitrary-length number or text into a given-length number.[9] For example, the individual figures in a number can be added together and if the sum exceeds a one-digit number, the components of the sum are added together, and so on. The number 678910 is thus 6+7+8+9+1+0=31, and 31 is 3+1=4. Hence, the multi-digit number has been converted into a single-digit number. Let x denote the original blockchain, y the transactions to be verified and z a different number. The mathematical problem to be resolved can be formulated as $f(x,y,z)\leq v$ where f is a hash function and it is a case of finding a number z so that the hash function assumes a lower value than v where v can in this case be interpreted as the degree of difficulty of the hash function.

Miners compete with each other over who can find a solution fastest. When a miner has found a solution, the proposed solution is sent out in the network, in which other miners can simply verify whether or not the solution is correct. A decision to accept a solution is taken by majority decision, in which the voting strength of a miner depends on the extent of calculation capacity, or computing power, he brings to the network. When a solution is supported by miners who represent a majority of the network's computing power, the solution is considered to be accepted. The proposed transactions are now added to the blockchain, which becomes one block longer. Now that the transaction between A and B has been accepted, B is the owner of the transferred 1 BTC with which his wallet was credited. At the same time, 1 BTC has been debited from A's wallet.

MINERS GET NEW BITCOINS FOR THEIR EFFORTS

The incentive for miners to invest computing power in the verification process is that, as compensation, they may create new Bitcoins. The process is as follows: the miner that resolved the hash function quickest, in other words who first computed z, as a reward also adds an extra "transaction" to the block to be verified (y). This transaction credits the miner's wallet with N amount of BTC without anybody else's wallet being debited. In order words, N amount of new Bitcoins is created with the winning miner as the owner. Every other week, the set of rules (the protocol)[10] governing Bitcoin adjusts the degree of difficulty v of the hash function and the amount of Bitcoins (N) created in each verification. The adjustment is to ensure that the network can verify transactions once every ten

9 The specific hash function used in the Bitcoin protocol is SHA-256. For more information about this function, see http://en.wikipedia.org/wiki/Sha-256.

10 A protocol is a set of rules that helps the computers concerned to communicate online. Nobody owns a protocol; rather, it is created to be a usable standard.

minutes. If computing power in the network increases, so will the degree of difficulty, and vice versa. The amount of Bitcoins created decreases over time through N being halved after 210,000 blocks, which equates to around 4 years. The initial amount was $N=50$ and now it is $N=25$. Because N decreases over time, there is an upper limit of 21 million on the number of Bitcoins that can exist. This limit can be seen as a mathematical threshold that is never reached, even if the amount of BTC can get arbitrarily close. At 30 June 2014, there were around 13 million BTC.

Because of this way of creating new Bitcoins, there is, unlike for national currencies issued by central banks, no central Bitcoin issuer – the creation of new Bitcoins being governed by its protocol. Hence, neither is Bitcoin a monetary claim on another party. Swedish notes and coins are formally a claim on the Riksbank and bank balances are a claim on the bank, backed by its balance sheet. The value of a Bitcoin is thus not based on any type of claim or underlying asset. Rather, its market value depends entirely on an expectation that it can be used in future transactions.

PAYMENTS ARE NOT IN REAL TIME

A Bitcoin payment is not a real-time payment. It can take up to ten minutes for a payment to be verified, and the general rule is that one should wait six verification rounds to be sure that the payment was actually added to the blockchain.[11] Obtaining verification for a Bitcoin payment can thus take up to around an hour. Depending on the situation, this can be perceived as a long or short space of time. It is also worth noting that, due to the file sharing technology and the verification process, there is no central storage location for the blockchain. Each network participant has information about all or parts of the blockchain.

11 The recommendation comes from Bitcoin.se. The underlying reason for why waiting a couple of verification rounds is recommended is a consequence of the decentralised verification process. Expressed simply, different versions of the blockchain can occur. In such cases, the longest blockchain is considered to be the proper one. The transaction that was just verified is registered in the final block of the blockchain. Should duplicate versions occur, there is hence a risk of the other version of the blockchain being selected as the proper one by the network, and hence of the final block being different. If the transaction is no longer included in the blockchain, it is not verified either. It is therefore wise to wait a couple of verification rounds to eliminate the risk of the blockchain changing.

Box 1. Electronic money is not virtual currency

The concept "electronic money" should not be confused with virtual currency. Electronic money is an electronically stored money value that represents a claim on the issuer, has a value that equals no more than the amount for which it was purchased, and which is accepted by parties other than the issuer.[12] By the latter, it is meant that the e-money must be accepted by a sufficiently broad circle of companies. Bitcoins are thus not electronic money, one reason being because they do not represent a claim on the issuer.

In general, a virtual currency can fulfil a couple of the above criteria, but not all. For example, most virtual currencies do not fulfil the requirement of a sufficiently broad circle of recipients. Neither is it always possible to exchange the virtual currency for national currency. Virtual currencies are also specified in other units of account than national ones. This is an important difference to electronic money. Redemption need not take place on a one-to-one basis because the units of value differ. In a potential redemption or exchange for national currency, the value cannot usually be predicted because the exchange rate fluctuates. Control of the regulations governing the virtual currency rests with the issuer. There is no supervision of the currency and the issuer is usually a non-financial company. Payments via virtual currency schemes are hence not covered by the Electronic Money Act (2011:755) or the Payment Services Act (2010:751). In addition, the issuer is not usually located in Sweden.

THE EXTENT OF BITCOIN USAGE

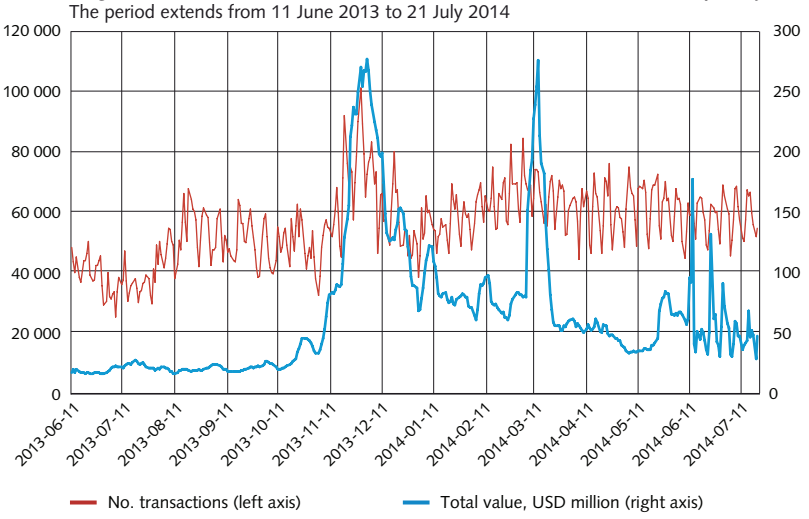
There are statistics about all transactions made using Bitcoin from 2009 onwards. These statistics come from the blockchain and are basically available to everybody. Some analyses are available online and provide an overview of global Bitcoin usage. However, it is not possible to see the extent of usage in a certain country because the wallet holders between which transactions were made can typically not be identified.

Bitcoin usage is low globally

In the past year, almost 60,000 Bitcoin transactions per day have been made. At the lowest, there were 28,000 per day, and just over 100,000 at most. This equates to around 0.1 per thousand of the number of card payments. The total value, measured in USD million, has also varied sharply – partly due to major fluctuations in the exchange rate. On average, the total value was no more than around USD 64 million per day. Diagram 1 shows the number of transactions per day and the total mediated value.

12 See Sveriges Riksbank (2013) for a description of the law.

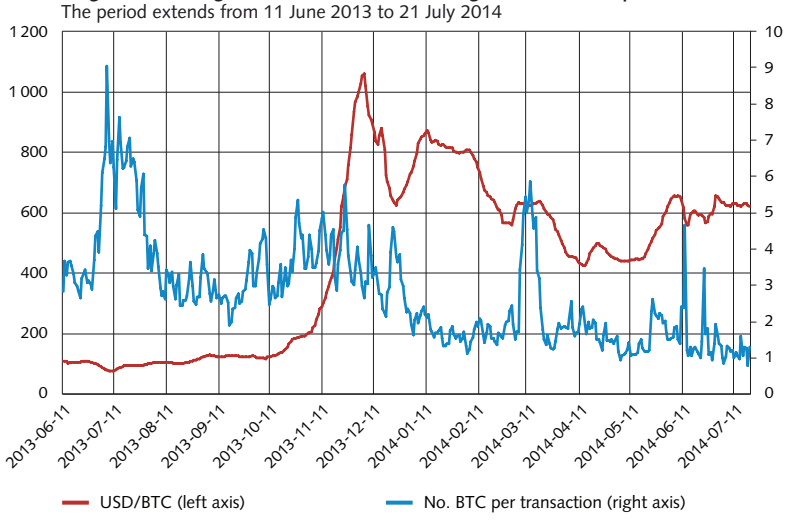
Diagram 1. Number of Bitcoin transactions and mediated value (USD million) per day
The period extends from 11 June 2013 to 21 July 2014



Source: blockchain.info. Revision by the Riksbank.

The average transaction value, measured in BTC, has dropped somewhat over time, probably because the exchange rate appreciated sharply in the autumn of 2013. Diagram 2 shows the exchange rate and the number of Bitcoins per transaction. The increase in the mediated value in the autumn of 2013 is often explained by increased demand for Bitcoin from China.

Diagram 2. Exchange rate USD/BTC and the average number of BTC per transaction
The period extends from 11 June 2013 to 21 July 2014



Source: Blockchain.info. Revision by the Riksbank.

Only 4 per cent of all Bitcoins are traded within a week by their holders. If the time interval is extended to three months, a further 24 per cent is traded. Only after six months have more than half been traded. Around 38 per cent are kept for over a year.[13] Bitcoin holders thus do not apparently trade them particularly often. It should also be mentioned in this context that many miners, especially major participants or those that cooperate in pools, often exchange their earned Bitcoins into national currency immediately to cover their overheads. The fact that only a small proportion of all Bitcoins seems to be used for transactions suggests that most of them are held for more long-term purposes, such as currency exchange speculation or saving.

BITCOIN USAGE IN SWEDEN IS EVEN LOWER

A rough estimate indicates that, in mid-August 2014, there were around thirty companies/websites accepting Bitcoin in Sweden.[14] It is mainly a matter of small companies and Bitcoin does not seem to have any broad acceptance as a commercial means of payment. It is therefore probable that a large proportion of the Bitcoin transactions in which the sender or recipient is located in Sweden takes place between private individuals or to payees abroad.

Bitcoin transactions are anonymous and it is not possible to obtain statistics for payments in which one of the parties is in Sweden. However, there is some data on the amount and value of exchange transactions between BTC and SEK.[15] The table below shows aggregate information regarding exchange traffic for the period 15 December 2012 to 31 May 2014. An average of SEK 266,000 was exchanged daily. The high volatility in the exchange transactions is illustrated in Diagram 3. The total value of the exchange transactions between BTC and SEK appears to amount to a couple of per cent of the corresponding value for exchange between BTC and EUR and less than 1 per cent of the exchange value between BTC and USD. The SEK is thus a minor currency in a Bitcoin context. It is also apparent that exchanging between BTC and SEK is a minor market when comparing it with the SEK 25 billion exchanged on average on the spot market to and from USD.[16]

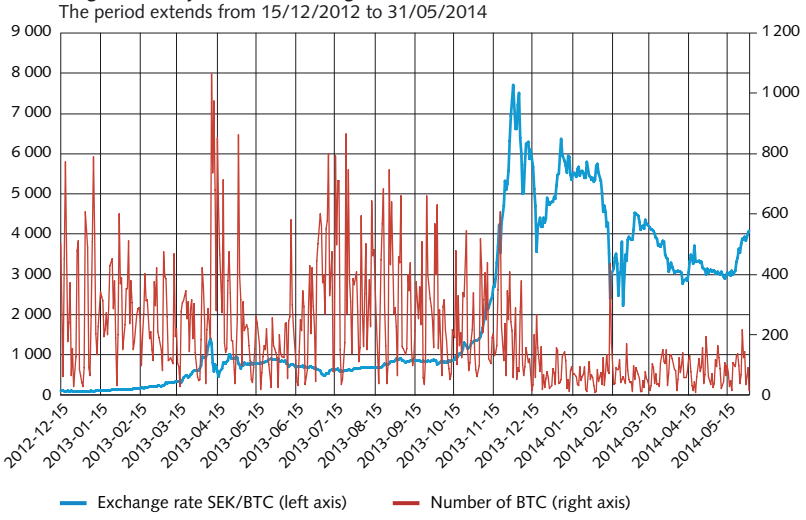
Table 1. Daily values for exchanging between Bitcoin and SEK

	VOLUME (BC)	EX. RATE (SEK)	TURNOVER (SEK)
Mean	212	1 995	265 501
Min	7	89	2 536
Max	1 065	7 720	2 574 066
Std. dev	184	1 916	312 520

Sources: http://bitcoincharts.com, Safello and BTCX. Revision: The Riksbank.

13 Source: Swanson (2014).
14 Source: bitcoin.se
15 These statistics do not capture exchange by private individuals and companies in Sweden to e.g. USD. The extent of exchange by Swedish participants into other currencies is unknown. For example, according to Dagens Industri (2014), KNC Miner earns SEK 3 million per day by mining Bitcoin. But, they always exchange it to USD.
16 Refers to the average for June 2014. Source: http://www.riksbank.se/Documents/Statistik/Turnover/2014/stat_omsFX_1406_sve.xls

Diagram 3. Daily values for exchange between BTC and SEK
The period extends from 15/12/2012 to 31/05/2014



Sources: http://bitcoincharts.com, Safello and BTCX. Revision: The Riksbank.

It is uncertain how well the exchange transactions reflect Bitcoin payment traffic. If Bitcoin is reused for payment without it being converted into SEK in the process, Bitcoin use for payment purposes is underestimated. However, if Bitcoin is bought and held for the purpose of speculation, it is overestimated. If the usage of Swedish holders resembles global use, the lion's share of the holding should be for saving or speculation, and the exchange transactions ought then to overestimate the volume of pure Bitcoin payments. Whichever the case, values are low in relation to the Swedish payment system. In total, household payments amount to around half of GDP for one year. This amounts on average to over SEK 4.5 billion daily. With cards and cash alone, households make more than 8 million payments to a value of over SEK 3 billion per day. Even if use of Bitcoin in Sweden were much greater than the exchanged value, the values are comparatively low.

DOES BITCOIN WORK AS A CURRENCY?

A currency has three functions. First, it serves as a means of payment, in the form of notes and coins. Second, it serves as a unit of account used to express prices, saving, mortgages, etc. in terms of e.g. kronor and öre. Third, it serves to preserve value in savings; in other words, I can refrain from consumption today, stuff my money in my mattress and use it for consumption tomorrow.

In theory, it can be said that Bitcoin fulfils the three roles of a currency, but in practice it doesn't. The role of a means of payment presumes that there is broad acceptance for the currency in society, otherwise it is hard to use it to make payments. In Sweden, there is no such broad acceptance and the possibilities of using Bitcoin as a means of payment are therefore very limited in practice. Similarly, it is uncommon for prices to be expressed

in Bitcoin, although this does occur. It therefore cannot be said that Bitcoin serves as a generally accepted unit of account. Finally, the high volatility in Bitcoin's exchange rate makes it unsuitable for preserving value, because its purchasing power can very quickly diminish and a large part of the value is then lost.

A further difference between Bitcoin and traditional national currencies, such as the SEK, is that the latter enjoy special legal status in their country of issue. In Sweden, the Sveriges Riksbank Act establishes that the monetary unit in Sweden is called the krona, that it is divided into one hundred öre, that only the Riksbank may issue notes and coins and that these are legal tender, i.e. that the recipient of a payment has an obligation to accept cash.[17]

The benefits and risks of Bitcoin for users

For individual users, there are both benefits and drawbacks in Bitcoin, depending on the payment situation. The benefits mainly relate to anonymity/integrity, convenience, rapidity and costs. The drawbacks mainly relate to the lack of any kind of protection for users. In certain situations the benefits can outweigh the drawbacks, and vice versa in other situations. Normally, the benefits should weigh heavier in situations in which there are no simple, cost-efficient traditional payment services.

BITCOIN PROTECTS USER IDENTITY

The stated purpose of Bitcoin is to enable anonymous payments online and make them independent of governments, banks and other institutions. So, for users, the benefit of Bitcoin is that the network in which payments are mediated is global, and that certain payments that were not previously made for integrity reasons can now be made, both locally and globally. If a payment on a website is reduced to the push of a button instead of requiring entering a volume of payment information such as card numbers, etc. the time(cost) of the paying party for a payment is reduced. The risk of fraud can also be perceived as lower unless card numbers or account numbers need to be disclosed to the recipient. Personal integrity can then also be perceived as higher. A virtual currency can also allow users to make payments to new groups of recipients that are otherwise hard to reach, especially for payments for which the sender and recipient are in different countries. For some cross-border payments of this kind, Bitcoin can also prove a much cheaper and/or convenient alternative to more traditional payment services.

BITCOIN IS NOT REGULATED BY ANY NATIONAL LEGISLATION

There is no central Bitcoin issuer because the value units are created automatically in the network. Bitcoin thus does not come under any national legislation, neither is there a body to which any claims can be directed. The payments are also anonymous and as a rule it is not possible to show that a payment was made to a certain recipient. The exception is if the

17 The Sveriges Riksbank Act (1988:1385).

parties involved know each other's identities and it is possible to demonstrate who owns a certain wallet. Individual users thus only have a narrow possibility of asserting their rights in the event of a payment going wrong.

A Bitcoin payment differs from a payment in Swedish kronor from a consumer protection perspective due to this very factor – i.e. that the Bitcoin payment is mediated via a global, decentralised network outside of the financial sector. The regulations governing normal payment mediation, such as the Payment Services Act, are not applicable, so neither do consumers have the same protection as in e.g. credit transfers or card payments. In other words, it might be more risky for the paying party to make payments using Bitcoin than using traditional payment services.

SHARP FLUCTUATIONS IN THE BITCOIN EXCHANGE RATE

Bitcoin does not represent a claim on another party; rather, its value consists entirely of an expectation that it can be used in future transactions. The value is thus highly sensitive to changes in such expectations. Diagrams 2 and 3 clearly show the major volatility in the Bitcoin exchange rate. Depending on the point in time at which somebody buys or receives Bitcoin, major exchange rate gains or losses can be made. Whether this is bad or not depends on the purpose of holding Bitcoins. If it is purely for transaction purposes, the exchange rate risk is considered to be negative because it makes the payment more risky; that is, the sender and recipient of the payment find it more difficult to set prices in BTC. This is perceived as an increased transaction cost.

For the Bitcoin holder, there is also a risk of losing value, either by fraud or accident. This is because the wallet and encryption keys are stored in some type of medium, such as on a hard drive. Should the hard drive be destroyed for some reason, the information would also be lost and hence so too access to the Bitcoin registered in the wallet. Through hacking, an external party can also access the value by initiating a payment to another wallet he controls. Fraud has occurred, the primary example being that which happened to exchange company Mt Gox, in which several hundred thousand Bitcoins were lost.[18] In this way, Bitcoins are more like cash than funds in bank accounts. If one loses or inadvertently destroys cash, its monetary value is lost. It can also be stolen. Funds in banks accounts are more protected. If the bank acts negligibly, it is liable to pay compensation. If the customer acts negligibly there is a statutory limit to his liability to pay compensation, and if the bank

18 Mt Gox was the world's largest exchange company for virtual currency. It was located in Japan and offered its services globally. Mt Gox itself has not been very forthcoming about what happened, but it is thought the following occurred: one/several hacker(s) is/are thought to have manipulated the blockchain so that it appeared as though the outgoing Bitcoin payment did not go through to the buyer. Mt Gox then automatically made a new outgoing payment and in so doing was slowly drained of Bitcoin over a long period of time. Mt Gox started to experience difficulties in making outgoing payments at the end of 2013 and suspended them at the beginning of February 2014. It is thought that a total of around 850,000 Bitcoins disappeared. If so, the market value ought to amount to SEK 2-3 billion. In Canada, Bitcoins equalling USD 600,000 were stolen from Flexcoin, a Bitcoin bank/exchange site. Source: http://www.businessweek.com/articles/2014-02-26/where-did-the-bitcoins-go-the-mt-dot-gox-shutdown-explained#r=read

goes bankrupt there is a state deposit guarantee scheme that protects funds in accounts up to a value equalling EUR 100,000.

Benefits and risks for society

There are three main types of benefit that a virtual currency like Bitcoin brings to society. First, payments in Bitcoin can be more cost-efficient than traditional payments in certain situations. Bitcoin can thus, in some cases, involve savings and hence a more efficient payment system.

Second, a virtual currency like Bitcoin can contribute over time to a more robust payment system by not all payments passing through the traditional financial infrastructure that constitutes hubs around which the payment flow is concentrated.[19] If the functioning of such a hub were disrupted for some reason, the related payment traffic also comes to a halt. The mere fact of there being alternative routes for certain types of payment is positive from a contingency point of view.[20]

Third, there is a potential benefit in the form of innovation of new payment services and financial services that can be built around Bitcoin. Another important aspect is that the Bitcoin protocol is publicly available online, and that it can be modified if a majority of the network's computing power supports such a modification.

There are essentially two types of risk that Bitcoin could pose to the payment system. First, there is a risk that potential distrust of Bitcoin could spread and lead to more extensive distrust of other participants in the retail payment market too. This could lead to consumers and companies also rejecting safe payment services and participants in favour of perhaps more costly and slower payment services. The market would then not function as well.

Second, if key participants in the retail payment market, such as banks and financial infrastructure, were to have major Bitcoin holdings, this could expose them to substantial financial risks. It is they who provide payment services to households and companies, and if a few such participants were to fail at the same time, this could lead to a deterioration in the functioning of the market, at least temporarily. At the same time, risks to financial stability could theoretically arise if important financial institutions are directly exposed to the virtual currency, or if credit losses are sustained because the institution's customers are heavily exposed.

19 See Sveriges Riksbank (2013). Chapter 1 explains how the Swedish payment system works, and Chapter 6 discusses future risks.

20 The Riksbank and the infrastructure concerned are therefore working actively to prevent risks in the core financial infrastructure, see Sveriges Riksbank (2012). In the Riksbank's opinion, the Swedish financial infrastructure is secure and of a high international standard, see Sveriges Riksbank (2014).

LOW USAGE INVOLVES LITTLE BENEFIT AND LOW RISKS

Very small amounts are currently traded in Bitcoin on the Swedish market, and there is nothing to suggest that key participants have Bitcoin holdings. This renders both the potential welfare gain and systemic risks very low, and the conclusion is therefore that, to date, Bitcoin has not had any measurable impact on the Swedish retail payment market or financial stability.

Another type of problem in terms of society is however that certain virtual currency schemes, such as Bitcoin, which enable anonymous payments can be used for money laundering and other criminal ends.[21] While nobody knows the extent of criminal usage of Bitcoin, anecdotal examples (see footnote 21) suggest potentially substantial sums.

Future outlook for Bitcoin and other virtual currencies

It is believed that Bitcoin is only used to a minor extent for payments. Instead, the currency is held for speculation or saving purposes. If Bitcoin is to take market share from traditional payment services, it must thus be used for payments to a much greater extent than currently. What could prevent such a course of events? What could be the role of other virtual currencies in future?

NO CONSUMER PROTECTION OR SUPERVISION

The main factor that will probably make it difficult for Bitcoin to grow as a means of payment is the absence of consumer protection and supervision by public authorities. The reason for this is simple. Broad usage of Bitcoin for payments would also require a high proportion of consumers to be prepared to have Bitcoin holdings. If Bitcoin is perceived as risky, it is not very probable that the general public would be prepared to do this. I have called attention above to this lack of consumer protection in Bitcoin payments. Bitcoin holdings are also more risky than funds held in accounts. It is thus probable that Bitcoin must, in some way, be placed under the same or equivalent regulations that apply for other payment services or funds in accounts in order to gain broad acceptance – for anything other than very small payments.

At the same time, however, rendering the use of Bitcoin more reminiscent of traditional payments would overturn the fundamental concept underlying Bitcoin; that is, of it being independent of governments and the financial sector. Creating the requisite regulations could also prove difficult for the government. For example, how could something that is decentralised and does not have an issuer be regulated?

21 The website Silk Road, on which drugs and criminal services were offered in exchange for Bitcoin, is the most notorious example. It was closed down by the FBI in October 2013. A new website, Silk Road 2.0 was however soon opened under different management to the original website. However, the new website was shut down in mid-February 2014 because Bitcoins worth around USD 2.5 million were missing – probably through embezzlement. Money laundering is another concern. The website Liberty Reserve, which was used for extensive money laundering, was closed down in May 2013. Fraudsters had appropriated regular currency for themselves, exchanged it to Bitcoin then sent it off untraceably.

DOESN'T WORK FOR ALL TYPES OF PAYMENT

Another obstacle is that Bitcoin is not suitable for all payment types, Bitcoin payments not occurring in real time. While payments are verified every ten minutes, it is also recommended that users wait for a couple of more verification rounds to be completed to be sure that the transaction has actually been added to the blockchain. Hence, it can take up to an hour for a user to be sure that the payment really has gone through. This makes Bitcoin unsuitable for many types of common payments, such as at the checkout of a convenience store. In card payments, which do not occur in real time either because the account of the recipient is credited with the funds one or several days later, this problem is resolved by reserving funds in the account of the payer and guaranteeing the payment to the payee. Bitcoin, which does not have a central issuer or verification process, cannot do this. However, individual payment service providers can guarantee Bitcoin payments to their customers. But, finding a guarantee that supports the decentralised usage of Bitcoin, without central participants, is difficult.

CREDIBILITY ISSUES OF A TECHNICAL NATURE ARE ALSO A BARRIER

Bitcoin's functioning is based on miners verifying transactions. Incentives for them to do so mainly consist of new Bitcoins being allotted to miners. However, this incentive could be undermined, which could erode confidence in the virtual currency.

One reason is that the creation of new Bitcoins declines over time.[22] This risks reducing the incentive for miners to continue with their activity. Another is the upper limit to how many Bitcoins there can be (21 million). The fundamental problem is that virtual currency can easily be newly created. If 21 million Bitcoins can suddenly turn into 42 million, each individual Bitcoin would also be worth less. Keeping an upper limit of 21 million Bitcoins is therefore important to preserving credibility in Bitcoin's future value. That credibility is affected by the perceived stability of the protocol governing Bitcoin. In connection with problems or a crisis, the protocol might quickly need modifying. Yet, if it is considered far too easy to modify the protocol, there is also a risk of confidence in the cap on the number of Bitcoins being undermined.

Another reason for why incentives for miners could be undermined is that the exchange rate could decline, which would reduce the value of the reward. On top of that, computing power and electricity might become too expensive. As the hash function becomes more complex, increasing computing power and bespoke computers are needed.

Another potential problem is that the length of the blockchain is constantly increasing. It is currently at over 14 gigabytes. The Bitcoin network presupposes that there is a great number of nodes with the entire blockchain stored on their machines. This makes the network robust. The incentive for managing such a "full" node has diminished, and such

22 As described above in the section on how Bitcoin transactions work, the reward (N) for miners is halved around once every four years.

nodes are apparently decreasing in number.[23] It appears, in other words, as though Bitcoin is becoming increasingly centralised and thus less robust.

If incentives for miners disappear, the decentralised verification of transactions will cease and it will not be possible to use Bitcoin.

OTHER VIRTUAL CURRENCIES COULD REPLACE BITCOIN

There are thus several potential obstacles to Bitcoin's ability to grow as a means of payment. However, it is also important to bear in mind that Bitcoin was the first virtual currency. Although the Bitcoin protocol can be modified and is publicly available, which stimulates further innovation surrounding Bitcoin, it is not certain that Bitcoin will mark the end of the evolution of virtual currencies – better solutions could emerge, putting it out of business. There are currently over 450 other cryptocurrencies and they are constantly on the rise.[24] Some of them have taken Bitcoin's structure as their basis, but enhanced or modified it. Others have seemingly emerged as part of a business model to capitalise on the attention generated by Bitcoin.

The success and future of Bitcoin are thus not clear cut. All we know is that the future will not be as it is today, and how we make payments in 25 or 50 years' time is an open-ended question.

23 See Cawrey, D. (2014a) and (2014b).

24 According to http://coinmarketcap.com/ there were around 460 different cryptocurrencies in mid-August 2014. At the beginning of 2014 there were fewer than half that amount. The five largest in terms of issued value are Bitcoin, Ripples, Litecoin, Peercoin and Mastercoin. More about other virtual currencies can be found in Segendorf (2014).

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