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EDITORS: STAFFAN VIOTTI, KERSTIN MITLID
AND THE COMMUNICATIONS SECRETARIAT
Sveriges Riksbank, SE-103 37 Stockholm, Sweden.
Telephone +46 8 787 00 00

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www.riksbank.se/Published/Publications/Economic Review,
E-mail kontorsservicecenter@riksbank.se,
Fax +46 8 787 05 26
Communications Secretariat
Sveriges Riksbank
SE-103 37 Stockholm.

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Contents

Monetary policy when the interest rate is zero

BY ULF SÖDERSTRÖM AND ANDREAS WESTERMARK[1]
The authors work in the Research Division of the Monetary Policy Department. Both of the authors have PhD's in economics and have worked at the Riksbank since 2008.

Most central banks use a short-term nominal interest rate as their primary monetary policy instrument. In Sweden the Riksbank uses the repo rate to influence the overnight rate on the interbank market and ultimately other interest rates and economic activity.[2] However, nominal interest rates cannot be negative. In a deep recession the central bank may wish to make substantial cuts in the policy rate to stimulate aggregate demand. But when the policy rate reaches zero the central bank cannot cut it any further. This does not mean, however, that monetary policy is powerless when the interest rate is zero. In this article we discuss the different instruments at the central bank's disposal to stimulate the economy when the interest rate is zero. The central bank can try to influence individuals' expectations of future inflation or interest rates. The central bank can also use different types of measures to influence other interest rates in the economy and facilitate credit flow. Moreover, the central bank can use the exchange rate to stimulate the economy.

We shall begin by discussing why the nominal interest rate cannot be negative. Then we discuss a number of different ways to conduct monetary policy when the interest rate is zero. After this we provide some examples of how different central banks have conducted monetary policy with a zero interest rate. We conclude with a brief summary of our most important conclusions.

Why can't the interest rate be negative?

Firms and households choose between holding their wealth as cash (banknotes and coins) and holding it in bank accounts, in various real assets or in financial assets, such as bonds or equity. Cash has the advantage that it can be used directly to buy various goods and services. However, cash

[1] We are grateful for useful comments from Mikael Apel, Jesper Hansson, Ylva Hedén, Kerstin Mitlid, Lars E.O. Svensson, Staffan Viotti and Anders Vredin.

[2] The publication *The Riksbank's management of interest rates – monetary policy in practice*, Sveriges Riksbank, 2005, discusses how the Riksbank affects the overnight rate. The article "The monetary transmission mechanism" by Hopkins, Lindé and Söderström in this issue discusses in greater detail how changes in the interest rate affect the economy.

does not provide any direct return; one hundred kronor in cash today will still be worth one hundred kronor in a year's time. Bonds and other assets cannot be readily used to buy goods and services, but on the other hand they provide a return. One hundred kronor that is invested in a government bond or deposited in a bank account today will be worth more in one year's time, as the bond and the bank account pay interest.[3]

The amount of cash that firms and households choose to hold is therefore affected by the return, that is, the interest they can receive on their alternative investments. If the interest rate is high, there will be a high profit in depositing the money in the bank or in buying bonds, and firms and households then choose to hold less of their assets in cash and more in other forms. On the other hand, when the interest rate is low, firms and households choose to hold more liquid assets and less of other assets. The interest rate is "the opportunity cost" of holding cash. When the interest rate on financial assets becomes zero, there is no longer any reason to own such assets, as the return is the same as for cash (that is, zero), while cash has the advantage that it can be used to buy goods and services.

In simple, stylised theoretical models, firms and households will hold as much cash as they wish to use when the interest rate is zero.[4] An even lower interest rate will therefore no longer directly affect the demand for cash, and therefore neither firm investment nor household demand. However, investors could earn money by borrowing at a negative interest rate and investing in cash, putting an upward pressure on the interest rate. Therefore, a nominal interest rate cannot be negative.[5] An increase in the money supply would in this situation not be used for increased consumption but instead be saved as cash. One then says that the economy is stuck in a liquidity trap, as individuals are holding as much cash as they need, and a further increase in the money supply would have no effect on the economy.[6]

In practice, of course, a change in the money supply will not reach firms and households directly, but would instead go through the banking system. A lower repo rate increases the demand for loans, and thereby

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[3] By bank account we here mean accounts that pay interest and cannot be linked to charge cards, such as savings accounts. Money paid into a checking account is more similar to cash, as it accrues a very low interest rate and can be used as a means of payment through charge cards.

[4] Thus, money demand has reached the satiation level.

[5] In practice, one can imagine that a nominal interest rate may be negative without the demand for cash being entirely satiated. For example, it may be costly or risky to store cash. In this case, firms and households would still demand financial assets when the interest rate is negative. However, such costs should be small, at least for households; see Yates (2004). One could also consider introducing a negative return on cash, a form of Gesell tax. This could be achieved by banknotes and coins needing to be stamped for a certain fee in order to remain valid, or that banknotes and coins would have a limited period of validity and need to be redeemed at a cost at the end of the period, see Goodfriend (2000) and Yates (2004).

[6] The concept of a liquidity trap was originally coined by Keynes (1936) to describe the situation during the Great Depression in the early 1930s.

the demand for money. Some of the banks' lending returns to the banks as individuals deposit funds in their bank accounts. In this way an increase in the supply of credit leads to an increase in the supply of money. Furthermore, the financial markets also contribute to mediating credit to firms and households.

However, even in this more complicated system there will be a lower limit for the nominal interest rate. When interest rates are very low the supply of loans declines, and bank customers are less willing to deposit their money in bank accounts. With a negative interest rate, investors could again earn money by borrowing at a negative interest rate and investing in cash. In a liquidity trap households and firms are as happy to hold their money as cash as to hold it in bank accounts. Then an increase in the money supply will have little or no effect.[7]

Interest rates, consumption and business cycles

It is not normally nominal interest rates, but real interest rates that affect economic decisions. While a nominal interest rate measures the return on an investment in terms of money, a real interest rate measures the return in terms of how much extra consumption the household will have from holding the asset. In order to calculate the real interest rate the nominal interest rate must be adjusted by changes in the prices of the goods and services the household buys. The real interest rate is then the difference between the nominal interest rate and the expected inflation rate. Even if a nominal interest rate cannot be negative, a real interest rate could very well be negative if the nominal interest rate is low and inflation expectations are sufficiently high.[8]

The real interest rate in an economy is determined by the individuals' choice between consumption and saving. As savings are normally used for consumption in the future, individuals decide how much they want to consume and to save by balancing the benefits of a change in consumption today against the benefits of a change in consumption in the future. One factor that is very important in savings decisions is that individuals usually want to avoid large fluctuations in consumption to achieve a relatively smooth development in consumption over time.

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7 In advanced financial markets one might imagine that the interest rate can be negative, as the interest rate only measures the return on one asset compared with another. However, technical limitations may still prevent interest rates from becoming negative. For example, computer systems might not be able to process negative interest rates. It is more difficult to imagine negative interest rates in the normal bank market, as households and firms may then not wish to hold money in their accounts. The banks also appear unwilling to set negative interest rates on, for instance, their checking accounts, despite other interest rates in the economy having fallen heavily in recent months.

8 The real interest rate is determined as $r_t = i_t - E_t[\pi_{t+1}]$ where is the nominal interest rate and $E_t[\pi_{t+1}]$ is the expected inflation rate. The real interest rate falls if the nominal interest rate falls, given inflation expectations. Lagervall (2008) discusses the difference between nominal and real interest rates in greater detail.

If the economy is in a recession and consumption falls over time, individuals will increase their saving to smooth out their consumption. The increased saving will in turn push down real interest rates. If the recession is deep, the real interest rate may become negative. The central bank can then try to cut the real interest rate further to stimulate the economy. If the central bank cuts the nominal policy rate but inflation expectations are not affected (in the short term), the real interest rate will also fall. Individuals then reduce their saving and increase their consumption today. A sufficiently negative real interest rate may in this way stimulate aggregate demand and help the economy out of the recession. But as the nominal interest rate cannot be negative, the central bank might not be able to cut the real interest rate sufficiently.[9] In a deep recession where inflation expectations are low (or if the general public even expects deflation), the real interest rate may consequently be too high.[10] Even if the central bank wants to cut the real interest rate, this is not possible with traditional monetary policy.

What can the central bank do when the nominal interest rate is zero?

In terms of the traditional monetary policy instrument, the opportunities for conducting more expansionary monetary policy are thus limited if the economy has fallen into a deep recession where negative real interest rates might be desirable, and where the zero bound on interest rates prevents the central bank from cutting the real interest rate as low as it might wish. Nominal and real interest rates are then too high, compared with an ideally-balanced monetary policy, and in an open economy like the Swedish one the exchange rate would also be stronger than desirable. However, the central bank is not entirely powerless in such a situation. On the contrary, there are several instruments that can be used to influence the real interest rate, even when the short nominal rate has come down to zero. For one thing, the central bank can in various ways try to influence individuals' expectations of future inflation or interest rates. For another thing, the central bank can use different types of measures to influence other interest rates in the economy and facilitate credit flow. Moreover, the central bank can use the exchange rate to stimulate the economy.

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[9] As the nominal interest rate cannot be below zero, the real interest rate cannot be lower than the expected deflation rate: $r_t \geq -E_t[\pi_{t+1}]$.

[10] There is extensive academic research, initiated by Milton Friedman (1969), which argues in favour of the optimal nominal interest rate being zero, so that the average inflation rate is negative. This result depends on prices being flexible, however. If prices are instead sticky, or if deflation may have other negative effects on the economy, the optimal nominal interest rate should be positive. We discuss this in more detail in an appendix.

Before we go through the various alternatives in more detail we want to emphasise that all of these measures are aimed at the same thing; making monetary policy more expansionary. Although monetary policy is usually discussed in terms of the current level of the short-term nominal rate (in Sweden's case the repo rate), how expansionary or contractionary monetary policy is can be described also in terms of other instruments. An expansionary monetary policy is characterised by a *low short-term real interest rate*, which in turn leads to low *long-term real interest rates* in the various credit markets and to a weak real exchange rate. When monetary policy is contractionary, on the other hand, short and long-term real interest rates are high and the real exchange rate is strong. When the short-term nominal interest rate is zero, the central bank can therefore try to influence real interest rates or the exchange rate in other ways to stimulate the economy.

The simple model used for the individual's consumption and saving decision that we described above can be used to understand the various measures the Riksbank has at its disposal. The decision of individuals whether to consume now or later is affected by the current real interest rate, that is, the difference between the nominal interest rate and the expected inflation rate. The interest rates that households and firms meet in the market (for instance, interest rates on mortgages or company loans) differ from the interest rate the central bank decides on and are also affected by different types of interest rate differentials that reflect the risk in lending.[11]

There are then several ways to stimulate aggregate demand in the economy; the central bank can cut the nominal interest rate, try to reduce interest rate differentials or try to raise inflation expectations. All of these measures will reduce the real interest rate that firms and households meet, which should stimulate consumption, and thereby increase aggregate demand and output.

Consumers want to smooth their consumption over time. If, for instance, consumers are expecting the interest rate to fall three years ahead, they know that they will want to save less and consume more then. But as individuals want to smooth their consumption over time, consumption increases during all of the first three years. Current demand

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[11] An expectations-based version of this simple model means that the aggregate demand in the economy, measured in terms of an output gap x_t (the difference between actual output (GDP) and the potential output level), can be written as

$$x_t = E_t[x_{t+1}] - \sigma[i_t + \delta_t - E_t[\pi_{t+1}] - \bar{r}_t],$$

where i_t is a short-term risk-free nominal interest rate, δ_t is an interest rate differential (or risk premium) between the risk-free interest rate and the interest rate that households and firms face, $E_t[\pi_{t+1}]$ is the expected inflation rate and $\bar{r}_t$ is the neutral real interest rate. The parameter σ measures consumers' willingness to change their consumption between different periods. If agents have a motive for precautionary saving, then also uncertainty regarding future consumption will affect the decision to save.

will therefore not depend only on the current real interest rate, but also on the expected real interest rate far into the future.[12]

Current demand can thus be raised either by cutting today's real interest rate or by decreasing expectations of future real interest rates. If the central bank can also affect the differences between market rates and risk-free interest rates, lower interest rate differences may lead to higher demand. Finally, increased inflation expectations lead to an increase in demand through lower real interest rates. There are thus many ways in which the central bank can stimulate the economy, and some of these measures can be used even when the policy rate is zero. We shall begin by discussing measures aimed at influencing individuals' expectations of future inflation and interest rates.

Measures to influence inflation expectations

Normally in a recession, inflation expectations fall. If individuals expect low inflation (or even deflation) and the nominal interest rate is approaching zero, the real interest rate may become too high, which could lead to a further tightening of the economy and an even deeper recession. One way for the central bank to stimulate the economy is then to try to raise individuals' expectations of future inflation, which pushes down real interest rates.

AN INFLATION TARGET MANAGES EXPECTATIONS

Many central banks base their monetary policy on an explicit inflation target. One reason is to try to anchor individuals' long-term inflation expectations so that they do not vary so much over time. A credible inflation target should lead to inflation expectations not rising so much in economic booms and not falling so much in recessions. A monetary policy aimed at attaining a low but positive inflation rate can then help the economy to avoid a situation where low inflation expectations lead to excessively high real interest rates.

In a liquidity trap it may then be useful if the central bank has established credibility in its inflation target. Central banks that do not have an inflation target could raise inflation expectation by introducing such a target. When Japan experienced a situation with a zero interest rate and

[12] By repeatedly using the equation in the previous footnote to eliminate future output gaps, one can write the current output gap as

$$x_t = -\sigma \sum_{j=0}^{\infty} E_t [\, i_{t+j} + \delta_{t+j} - \pi_{t+j+1} - \bar{r}_{t+j}].$$

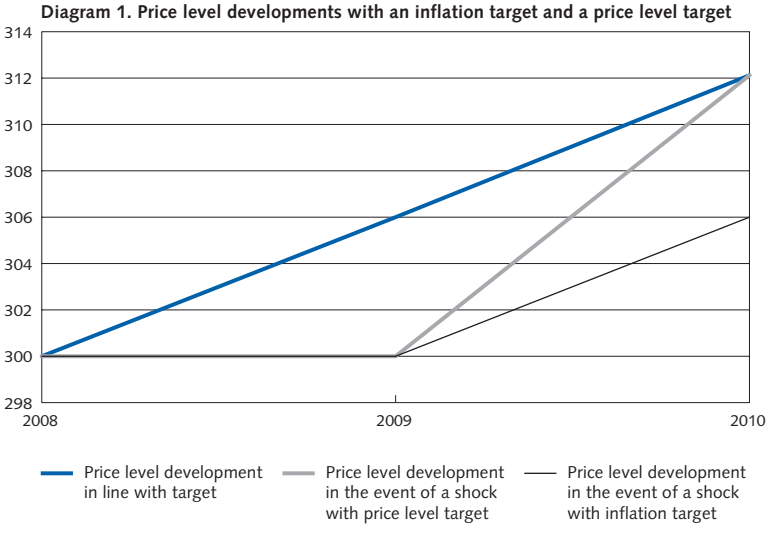
low inflation in the 1990s the Japanese central bank was given the recommendation to introduce an inflation target.[13]

A PRICE LEVEL TARGET ALSO WORKS

One alternative that may be more effective in raising inflation expectations is a target for the price level.[14] A price level target does not mean that the central bank holds prices constant over time; it can allow prices to rise. A price level target that generates 2 per cent inflation over time can specify, for example, a level for the consumer price index (CPI) that rises by 2 per cent every year. For example, if the CPI is 300 in the year 2008, the target for 2009 will be a CPI value of 306 and for 2010 the target will be 312.12; see figure 1. As long as the price level develops in line with the target, such a price level target is equivalent to an inflation target of 2 per cent a year.

Neither an inflation target nor a price level target is adjusted in the case of a shock, but with a price level target the central bank will in the future compensate for shocks. If an unexpected shock to the economy means that the CPI for 2009 is 300 instead of 306, the inflation target, if it is credible, will generate inflation expectations of 2 per cent between 2009 and 2010, that is, the expected CPI in 2010 will be 306 instead of just over 312. A price level target, on the other hand, still requires that the CPI in 2010 should be just over 312, which means that inflation expecta-

Diagram 1. Price level developments with an inflation target and a price level target



[13] See Krugman (1998).

[14] See, for instance, Svensson (2001, 2003, 2004), Vestin (2006) and Billi (2008). Nessén and Vestin (2005) show that an average inflation target running over a longer period of time than one year will have similar effects to a price level target.

tions will be a good 4 per cent between 2009 and 2010. If a negative shock occurs, a price level target therefore generates higher inflation expectations than an inflation target. The opposite of course applies for a positive shock. The reason for this is that old shocks are not forgotten with a price level target – they must be compensated for later on by a change in the inflation rate in the opposite direction.

One way to reduce the real interest rate when the nominal interest rate is zero is to announce that inflation will be allowed to overshoot the inflation target when the crisis is over. This is roughly equivalent to a price level target. The longer the crisis lasts and inflation is low, the higher inflation expectations will be in the future, at least as long as the central bank's announcements are considered credible.

CREDIBILITY IS IMPORTANT

One potential problem with announcing inflation or price level targets is that the effects depend on how credible the commitment to the target is. Economic research analysing the effects of the announcements distinguishes between two extreme cases. In one case, the central bank can credibly *commit* itself to future policy, while in the other case it is assumed that the central bank is not capable of committing itself, but that on each occasion it will revise its earlier plans in a *discretionary* manner. In the first case the central bank has perfect credibility, while in the second case there is no credibility at all. With a commitment policy, the central bank will take into account how the private sector's expectations are affected by the policy when formulating its optimal policy. This is not the case under discretion, as the central bank is then unable to credibly promise to conduct a particular policy in the future.[15]

The central bank must therefore convince private agents that it will conduct a more expansionary policy in the future than it usually does, to influence expectations. If it is unable to do so, there is a risk that the policy will be ineffective. For a central bank that has announced that inflation will be allowed to exceed the target in the future it may be tempting to only stabilise inflation around the target when demand accelerates, and not to allow higher inflation. If individuals realise this, then perhaps inflation expectations and the real interest rate will not be affected as much as the central bank wishes.

The argument above that a price level target has larger effects on inflation expectations than an inflation target holds if both targets have

[15] The difference between optimal policy under discretion and commitment is discussed in e.g., Clarida, Gali and Gertler (1999).

similar credibility. However, to replace a well established target that has a high level of credibility with a new target might not lead to larger effects on inflation expectations if the credibility of the new target is low.

Measures to influence expectations of the nominal interest rate

As aggregate demand depends on expectations of future real interest rates, the central bank can try to affect demand by influencing these expectations. If the ideal nominal interest rate is negative, the central bank can stimulate demand by cutting the interest rate to zero and by announcing that the interest rate will remain zero over a longer period of time.[16] If individuals' expectations are affected when the central bank announces the interest rate path, then consumption will increase today. Moreover, if the central bank believes that the ideal interest rate will be negative in the future it should cut the nominal interest rate to zero before the ideal interest rate becomes negative. One should thus not keep the powder in the keg, but cut the interest rate quickly if one believes that the interest rate has to be cut to zero in the future.

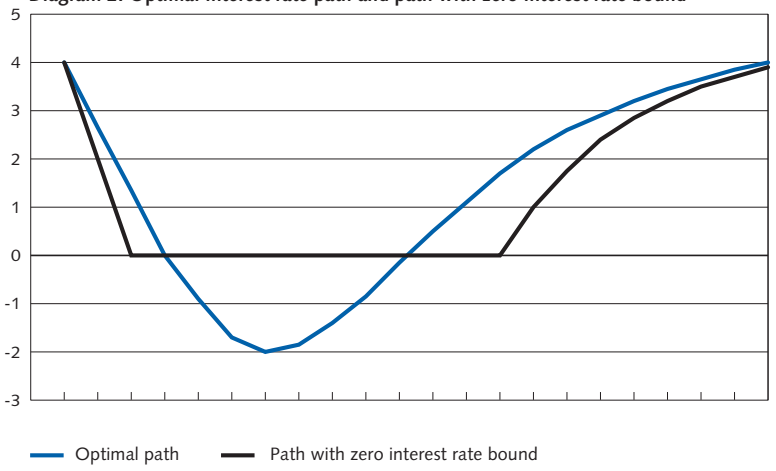
ZERO INTEREST RATE TOMORROW SUPPORTS DEMAND TODAY

By cutting the interest rate to zero at an early stage and then holding it at zero for a long time, a too high interest rate during the period when the nominal interest rate should have been negative will be counteracted by a low interest rate when the nominal interest rate should be positive. As demand depends on both current and future real interest rates, demand can thus be held up even when the nominal interest rate is zero. Figure 2 shows an example where the optimal interest rate is negative. The interest rate path bounded by zero is set so that the aggregate effect (the sum of expected short-term rates) is the same under the two interest rate paths. If this policy is announced in advance and is credible, it should have roughly the same effect on demand as the optimal policy with a negative interest rate.

But just as in the case of an announced inflation and price level target, the central bank may have an incentive to deviate from the stated policy in the future when the economy emerges from the liquidity trap. If the central bank has announced a low interest rate, the central bank could have an incentive to raise the interest rate and tighten monetary policy, despite the optimal commitment policy stating that the interest rate

[16] See Eggertsson and Woodford (2003, 2004) and Adam and Billi (2006, 2007).

Diagram 2. Optimal interest rate path and path with zero interest rate bound



should be zero. The optimal policy under commitment will once again face a credibility problem, and the central bank's credibility will determine the size of the effects of the announcements. If the central bank's announcements of a low interest rate or high inflation in the future lack credibility, the effects may be small, or even negligible. One way of strengthening the credibility of the central bank's announcements could be to back them up with quantitative measures. We will discuss these next.

Quantitative measures

When central banks determine the level of the short-term nominal interest rate, money demand is affected in that households and firms change their demand for cash and financial assets. If the interest rate is raised it becomes more profitable to invest in financial assets, so the amount of money in circulation falls. If the interest rate is cut, money demand increases correspondingly. Since money demand will equal money supply, monetary policy can be regarded as central banks changing the money supply, as well as changing the interest rate (which is the price of money). A policy which is aimed more directly at increasing the money supply – that is, the quantity of money in circulation – is often referred to as "quantitative monetary policy".[17]

[17] Sometimes changes in the money supply are discussed in terms of the central bank's balance sheet, where the asset side of the Riksbank's balance sheet consists of the gold and foreign exchange reserves, lending to the banks and other assets, while the liabilities side consists of banknotes and coins in circulation, deposits from the banks, other liabilities and own capital. The reason is that an increased money supply leads to an increase in both the asset side of the balance sheet (in terms of an increased holding of, for instance, bonds) and the liabilities side (in terms of an increase in banknotes and coins in circulation). But quantitative measures can also be taken without increasing the size of the balance sheet, by the central bank changing the composition of its balance sheet. This can be achieved by buying assets with one maturity and at the same time selling assets with another maturity.

MONEY SUPPLY AND DEMAND

One way of understanding the effects of changes in the money supply is to consider the quantity theory of money. According to the quantity theory, nominal GDP is closely related to the money supply; nominal GDP is equal to the money supply multiplied by its velocity.[18] If the price level and velocity are more or less unchanged in the short term, an increase in the money supply will in a normal economic situation lead to an increase in real GDP. However, in the long run, real GDP is determined by the real structure of the economy. Then an increase in the money supply will only lead to an increase in the price level.

Although the policy rate is zero, the central bank can still try to affect aggregate demand by increasing the money supply, albeit somewhat differently than under normal circumstances. One way for the central bank to increase the money supply is by buying and selling short-term government securities.[19] The liquidity created in the bank system by these purchases will end up as reserves in the central bank. If the banks are sufficiently capitalised they will instead choose to lend the money that is deposited with the central bank to households and firms, if this increases their earnings. This means that the money supply increases further.

But when the short-term interest rate has reached the lower limit, private sector consumption and investment will not be affected by increases in the money supply, as the interest rate cannot fall below zero. Attempts by the central bank to increase the money supply by buying short-term government securities will then have no effect. The increase in the money supply does not lead to any large increase in the supply of credit in the economy. When regarded in terms of the quantitative theory, the velocity of money decreases, so that the increase in the money supply does not affect either real GDP or the price level.

CREDIBILITY IS IMPORTANT

The above reasoning implies that temporary increases in the money supply do not have any effect. However, an increase that is perceived as permanent may have an effect, as it may affect expectations of the future price level and inflation. If the economy is eventually expected to come out of the liquidity trap, the increase in the money supply will affect the price level in the long run. Even when the economy is still in the liquid-

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[18] If P_t is the price level, Y_t is real GDP, M_t is the nominal money supply, and v is the velocity of the money supply, then the quantity equation states that $vM_t = P_tY_t$. The model can be justified in that households need to hold banknotes and coins to be able to buy goods and services, see for instance Auerbach and Obstfeld (2005).

[19] In practice, the Riksbank influences the short-term interest rate in different ways, see the publication *The Riksbank's management of interest rates – monetary policy in practice*, Sveriges Riksbank, 2005.

ity trap a permanent increase in the money supply may thus have effects on expectations of the future price level and inflation.[20] When inflation expectations rise, the real interest rate falls and demand increases.

Also here credibility is central when announcing a permanent increase in the money supply. Once again the central bank may have an incentive to deviate from its announced policy by withdrawing the increase in the money supply once the economy has emerged from the liquidity trap. The quantitative monetary policy conducted in Japan at the beginning of the 2000s does not appear to have had any major effects, possibly because it was interpreted as being temporary.[21]

QUANTITATIVE MEASURES AND MARKET INTEREST RATES

An alternative way of viewing quantitative monetary policy is that the central bank, by buying securities, affects their price. If the central bank increases the money supply by buying other types of securities than short-term government securities, for instance, government bonds with a longer maturity than treasury bills, then individuals (or institutions) selling their securities to the central bank will hold more liquid funds and fewer bonds than they find desirable. They may then wish to rebalance their asset portfolios, which will mean that bond prices rise and the interest rate thus falls. These "portfolio balance effects" may lead to that the effects of the central bank's purchase of certain securities also spread to other financial assets and affect the price of these, too.[22] Similar effects can arise if the central bank by buying long-term government bonds can lower long-term interest rates by decreasing the term premium. For example, investors may have had doubts about investing in certain maturities because they are uncertain whether they will be able to sell them when they wish. If the central bank begins to buy the bonds, then this kind of "liquidity premium" will decrease, so that the long-term interest rate falls.

QUANTITATIVE MEASURES SUPPORT THE ANNOUNCED INTEREST RATE PATH

Quantitative measures may also be used to credibly support the announced repo rate path. If the central bank announces that it will hold a low interest rate over a long period of time so that the expected interest rate path falls, long-term interest rates should also fall. This is because the interest rate on government bonds is closely linked to the interest rate

[20] See Auerbach and Obstfeld (2004, 2005) and Eggertsson and Woodford (2004).
[21] See Svensson (2006).
[22] See Andrés, López-Salido and Nelson (2004).

on shorter securities, as investors choose between investing in government securities with a short or long maturity. One can describe the interest rate on a bond with a long maturity as an average of the expected interest rates on a series of treasury bills with short maturities held during the period to maturity of the long-term bond plus a term premium that reflects that risk of holding a long-term bond instead of a series of short-term treasury bills.[23]

But if the announcement of the interest rate path is not credible, expectations might not be adjusted downwards so much. Then the central bank can affect long-term interest rates by buying long-term government bonds, so that the long-term interest rates are in line with the announced interest rate path. This could be interpreted as a signal that the short-term interest rate will be low for a long period of time. In this way, quantitative monetary policy can be used to support an announcement of a low path for the future policy rate.

One complication if central banks begin to buy government bonds is that this can be interpreted as monetary financing of the government debt, that is, the central bank is printing money that is then lent to the government. As many episodes of hyperinflation have begun in this way, monetary financing is banned by law in many countries. The central banks in many countries are therefore not allowed to buy government bonds in the primary market (directly from the government), and there are often restrictions on purchases of government bonds in the secondary market (from other investors). This is also the case in Sweden. However, in a liquidity trap the situation is different. Then the central bank buys government bonds to avoid too low inflation, and the risk of hyperinflation is almost non-existent.

Credit easing

The measures described above can be interpreted as the central bank trying to affect demand by increasing the money supply. Such policy is often called "quantitative easing", as the central bank focuses on increasing the quantity of money in circulation and the liabilities side of the central bank's balance sheet increases. It is then of secondary importance exactly what type of securities that are bought and how the asset side changes, as the main purpose is to increase the money supply. As mentioned above, the policy can also be regarded as a way for the central bank of lowering interest rates in the economy by buying securities.

[23] The interest rate on a bond with a maturity of n can be written as , where $i_t^n = \frac{1}{n}\sum_{j=0}^{n-1} E_t\,[i_{t+j}] + \delta_t^n$, where δ_t^n is the term premium for maturity n.

TARGETED PURCHASES OF SECURITIES IMPROVES CREDIT MARKET FUNCTIONING

Sometimes there may be a reason to focus on certain sub-markets and to try to influence the interest rates on these. Bernanke (2009) defines this policy as "credit easing", as the objective of the policy is to buy a certain type of security to lower interest rates in specific credit markets, while the effects on the money supply are less important.

If certain credit markets are not functioning satisfactorily, for instance because the turnover in the market is unusually low, the liquidity premiums are inefficiently high, or because various investors dare not take the risk of investing in certain markets, the central bank can choose to support these markets directly. The central bank can thus directly purchase securities in different markets to facilitate the flow of credit in the economy. This could reduce the differentials between interest rates on various assets (for instance, commercial paper, corporate bonds or mortgage bonds) and government bonds. When interest rate differentials decline, the real interest path falls and demand increases, as some households and firms can now borrow at lower interest rates.

During the financial crisis many credit markets have not functioned normally. Many banks around the world have suffered large capital losses and experienced problems with their balance sheets, which has led them to become more cautious in their lending. The banks' losses, together with the deep recession, have also increased the risk of lending between banks, other financial institutions and firms. Higher risk premiums have led to higher interest rates on many markets, which has in turn had a restrictive effect and further aggravated the economic downturn. High interest rate differentials relative to the policy rate of the central banks have also meant that the general interest rate levels in many economies have remained high despite policy rates have hit the zero bound.[24] Many central banks have therefore intervened to improve the functioning of the credit markets. We discuss some of these measures in a later section.

Measures to influence the exchange rate

The various measures we have discussed above essentially have the same effects on the economy. As all of the measures aim to make monetary policy more expansionary, they will lead to a lower path for the real interest rate and higher inflation expectations. In an open economy the exchange rate will also be affected. A more expansionary monetary policy

[24] See the article "The transmission mechanism and the financial crisis" in this issue.

means that the exchange rate weakens, which also stimulates the economy.[25] If the nominal interest rate reaches zero and cannot be cut further, but the central bank nevertheless wishes to stimulate the economy more, the exchange rate will be stronger than would otherwise have been the case with ideally-balanced monetary policy. One way of stimulating the economy and making monetary policy more expansionary is then to try to directly affect the exchange rate. Instead of buying domestic securities, the central bank would buy foreign securities, and thereby also foreign currency.[26] Such a policy could attain the same effect as the other measures.

DEPRECIATING THE EXCHANGE RATE INCREASES INFLATION EXPECTATIONS

Svensson (2001, 2003, 2004) has in a series of essays proposed a method for stimulating the economy in a liquidity trap. An important element of Svensson's proposal is that the price of a foreign basket of goods in relation to a domestic basket of the same goods (the real exchange rate) can be expected to remain constant in the long term, as a deviation from the long-term level due to, for instance, higher prices abroad means that Swedish firms improve their competitiveness and can thereby raise their prices, which pushes the real exchange rate back towards its long-term level.[27]

Svensson advocates a measures package in three stages; (1) announce an increasing price level target, (2) announce a new exchange rate policy with an initial depreciation to an undervalued real exchange rate, and (3) when the price level target has been attained, switch to a price level or inflation target and a floating exchange rate. The central element of such a policy is that the real exchange rate is depreciated to a rate that is weaker than the long-term equilibrium level.

One potential problem might be that the new exchange rate is not credible. But the credibility problem is not so serious in this case. As the real exchange rate is weaker than the long-term equilibrium level, the credibility problems lead to a pressure on the exchange rate to appreciate. Unlike defending a currency that is expected to weaken, it is easy to defend a currency that is in the process of strengthening. To do so, the

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[25] The article "The monetary transmission mechanism" in this issue describes in greater detail how changes in monetary policy affect the economy through the exchange rate.

[26] See McCallum (2000), Svensson (2001, 2003, 2004) and Jeanne and Svensson (2007).

[27] The real exchange rate is defined as $Q_t = \frac{P_t^F S_t}{P_t}$, where Q_t is the real exchange rate (the price of a foreign basket of goods in relation to a domestic basket of goods), P_t^F is the price level abroad, S_t is the nominal exchange rate (the price of foreign currency in relation to domestic currency) and P_t is the price level in the home country.

central bank buys foreign currency. As the central bank has unlimited access to its own currency, it can buy foreign currency as long as the credibility problem remains.[28]

This policy will lead to higher inflation expectations. If the currency depreciates to a rate where the real exchange rate is too weak, the real exchange rate will appreciate over time. In a small open economy like Sweden's, it is reasonable to believe that the international price level will not be affected by Swedish monetary policy to any great degree, so prices in the country must increase for the real exchange rate to strengthen. An expected strengthening of the real exchange rate will then imply that the price level in Sweden is expected to rise, so that inflation expectations rise. Higher inflation expectations will then lead to lower real interest rates and higher demand.

Despite the fact that this policy is formulated in terms of exchange rates and price level targets, it will also entail a permanent increase in the money supply.[29] One can thus see this method as a permanent increase in the money supply, the consequences of which will be the change in the exchange rate and price level described above. This policy thus has the same effects as other measures aimed at lowering the expected path for the repo rate or raising inflation expectations.

EXCHANGE RATE POLICY AND THE BEGGAR-THY-NEIGHBOUR PROBLEM

One possible problem with the central bank intentionally weakening the exchange rate is that such a policy can be interpreted as a beggar-thy-neighbour policy. A weakening of the real exchange rate leads to domestic export firms gaining a competitive advantage over foreign competitors. In this way a policy that entails a weakening of the exchange rate can lead to international criticism and similar actions from other countries.[30] The recurrent devaluations that took place in Europe during the 1970s and 1980s, when the main purpose was to stimulate the economy through an increased demand for exports can be seen in this light. This devaluation policy is now regarded as a failure.

However, there are important differences between a policy that aims to weaken the exchange rate when the interest rate is zero and a

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[28] If the currency is subject to pressure to weaken the central bank instead intervenes by buying its own currency and paying with foreign currency. As access to foreign currency is limited by the size of the central bank's foreign exchange reserve, there is always the risk that the resources for the intervention may run out.

[29] This follows from the quantity theory, as the real output level is in the long term determined by the real structure of the economy. The increase in prices that occurs must then be reflected in an increased supply of money.

[30] See The Economist (2009a).

traditional devaluation policy. The zero interest rate policy aims to stimulate the economy first and foremost by increasing inflation expectations and lowering real interest rates, not by increasing the demand for export goods. The idea is to achieve the same effects as with a traditional cut in the short-term policy rate in a situation where the policy rate cannot be cut further. Other unconventional measures should (if they work) have the same effect on the exchange rate, and thereby on the demand for exports and on other countries. It is merely a question of the central bank choosing the exchange rate to stimulate the economy instead of another instrument.

Nor is it entirely obvious that other economies will be negatively affected by a weakening in the domestic currency if this leads to lower real interest rates. The expansionary policy leads to an increase in total demand, which in turn increases the demand for import goods at the same time as the weakening of the exchange rate increases the demand for exports. It is not self-evident that other countries' trade balances necessarily will worsen. The exchange rate weakening may therefore have positive effects on other countries. Countries from which the domestic country imports a lot should benefit, while countries whose industries compete with the country's firms risk being affected negatively. However, it should be in the interests of all countries that one country manages to come out of a deep recession and a liquidity trap.

If other economies also are in a liquidity trap with a zero interest rate and use unconventional measures to conduct an expansionary monetary policy to increase inflation expectations, then the exchange rate may not be affected very much. However, inflation expectations should rise and the real interest rate should fall in all economies, which will stimulate demand and lift the world economy out of a global liquidity trap.

What have various central banks done when the interest rate approaches zero?

Until the mid-1990s liquidity traps were considered to be a thing of the past. After the Great Depression of the 1930s it was believed that central banks had learnt to avoid recessions leading to falling prices and a zero interest rate. It was rather the central banks' primary task to avoid situations where supply shocks at the same time led to recession and high inflation, as in the 1970s.

However, developments in Japan in the 1990s made economists and central banks rethink; after a bubble in the property market burst in the beginning of the 1990s, Japan suffered a deep recession with falling prices, and in 1999 the central bank cut its policy rate to zero. When the

economy still did not show any sign of a recovery the Japanese central bank began to apply quantitative easing. The central bank increased the money supply by buying long-term government bonds and it announced that the expansionary monetary policy would persist until inflation was positive again.[31] Other measures were also proposed. For instance, the Japanese central bank was encouraged to introduce a high positive inflation target or to depreciate its currency.[32] This was how research on monetary policy when the interest rate hits the zero lower bound began to develop.

When the United States suffered a recession with falling inflation after the collapse of the IT bubble at the beginning of the 2000s, the US central bank cut its policy rate to 1 per cent in June 2003 and later announced that it would hold the rate at this level for a long period of time. The purpose was to lower individuals' expectations of future interest rate levels to further stimulate the economy.

These episodes are two early examples of how unconventional methods were used in monetary policy when the interest rate approached zero. Since the financial unrest began in mid-2007 many central banks have resorted to unconventional measures. To begin with, the central banks confined themselves to cutting their policy rates and at the same time changing the composition of their balance sheets. However, the interest rate cuts were unusually fast and interest rates fell in large increments. This forceful reaction was a clear departure from earlier interest rate adjustments that used to be made in many small stages. The new policy can be interpreted as that there was little uncertainty over what the central banks should do; it was clear that interest rates needed to be cut. The interest rate cuts and the other measures were primarily aimed at improving the situation in various credit markets. But, as we have discussed above, it may also be optimal to cut the interest rate quickly if one fears that the interest rate will be zero in the future.

THE ZERO LOWER BOUND AND UNCONVENTIONAL MONETARY POLICY

Since the crisis worsened in autumn 2008, however, many central banks have almost reached the zero lower bound and have therefore resorted

[31] See Ito and Mishkin (2006).
[32] See Krugman (1998), McCallum (2000) and Svensson (2001).

to unconventional measures.[33] In December 2008 the US central bank cut its policy rate to an interval between 0 and 0.25 per cent, while the British central bank cut its interest rate to 0.5 per cent in March 2009 and announced that it did not intend to cut it further. In Canada the policy rate was cut to 0.25 per cent in April 2009 and the central bank announced that the interest rate would be held at a low level for a longer period of time. The Riksbank cut the repo rate in the same month to 0.5 per cent and announced that this low interest rate would apply to the end of 2010.

Many central banks have also expanded their balance sheets. When the US central bank began implementing its measures to support the credit markets by extending lending to financial institutions at the end of 2007, they did not allow the balance sheet total to expand. Instead, they sold off large parts of their assets in government bonds at the same time to avoid the balance sheet total from being affected. However, since September 2008 the US central bank (and many other central banks) have allowed their balance sheets to expand. The Riksbank has, for instance, extended the number of eligible counterparties for its monetary policy transactions, and has lent out large sums to banks and financial institutions both in Swedish kronor and US dollars. Other central banks have carried out similar measures.[34]

Until March 2009 the US central bank concentrated on credit easing in specific markets. That same month the British central bank announced that it would not cut the interest rate lower than to 0.5 per cent but would instead begin buying large quantities of government bonds and corporate bonds as a means of increasing the money supply and stimulating the economy. A few weeks' later the US central bank announced that it would extend its purchase of mortgage-backed securities and also begin buying government bonds. However, while the British central bank calls its policy "quantitative easing", the US central bank continues to use the term "credit easing". The difference is that the British central bank sees its measures as an increase in the liabilities side of the balance sheet, while the US central bank talks about an increase in the asset side.

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[33] For various reasons the central banks have not cut their policy rates right down to zero, but have chosen to stop at a low positive rate. Some interest rates in the financial markets are slightly lower than the policy rate, for instance, the banks' deposit rates and various interest rates in private repo markets. If the central bank were to set the policy rate at zero, such interest rates could be negative, which could lead to disruptions in the financial markets. Moreover, it is possible that banks that do not want to have negative deposit rates might choose not to cut their lending rates when the deposit rate is zero to avoid the margins between the lending and deposit rates shrinking. This would mean that a further cut in the policy rate would not have as great an effect on the economy as normally.

[34] The Federal Reserve Bank of Cleveland (www.clevelandfed.org) makes a detailed analysis of the various unconventional measures carried out in the United States and their effects on the central bank's balance sheet. A similar analysis of the Riksbank's measures can be found at www.riksbank.se (see also www.slopedcurve.com). See The Economist (2009b) for a discussion of various central banks' unconventional measures.

The Swiss central bank decided in March 2009 to cut its target for the short-term interest rate and announced that it intended to buy Swiss government bonds and foreign currency. Since the financial unrest began in 2007 the Swiss franc has strengthened against other currencies, probably as the Swiss currency is regarded as a safe haven in uncertain times. However, the strengthening of the currency leads to a tightening of the economy. The central bank therefore decided to begin buying foreign currency to weaken its own currency and to conduct a more expansionary monetary policy.

Various central banks have thus chosen different measures to stimulate demand. Exactly which measures are appropriate will of course depend on domestic factors. In the United States the central bank has seen how important credit markets have dried up and has therefore chosen to support specific markets. In Britain the central bank has focused on supporting banks that have suffered problems and then on stimulating demand by buying government bonds. Switzerland, which is a small, open economy, have also focused on weakening their currency to conduct a more expansionary monetary policy. In Sweden the Riksbank has so far focused on supporting liquidity in the interbank market by increasing lending to the banks and extending the number of eligible counterparties. But the Riksbank has also said it is prepared to resort to more unconventional measures in the future if this should prove to be necessary, for instance, purchasing government bonds or mortgage bonds.[35]

Concluding remarks – monetary policy at the zero lower bound

In this article we have discussed how monetary policy can be conducted when the policy rate approaches the zero lower bound. We have described how the central bank, if it thinks that the economy needs to be stimulated further, has many different instruments at its disposal.

To begin with, the central bank can announce that inflation will be allowed to exceed the target for a period of time once the crisis is over, or that the interest rate will be low for a long period to come. In connection with the publication of the Monetary Policy Update in April 2009 the Riksbank cut the repo rate by 0.5 percentage points to 0.5 per cent, and at the same time published a path for the repo rate that remained at this level until the end of 2010. As lower expected short-term interest rates and higher inflation expectations lead to lower real interest rates, both of these measures stimulate demand in the economy.

[35] See Monetary Policy Update, April 2009.

Other ways to stimulate the economy are also discussed in the theoretical literature. One alternative is for the central bank to buy securities, for instance government bonds, mortgage bonds, commercial paper or corporate bonds. Such measures can lead to lower interest rates, as the expectations of individuals can be affected so that they believe that the central bank will hold its policy rate low for a long period of time. Moreover, they can affect liquidity and term premiums and thereby lower interest rates on long maturities. Directed purchases of mortgage bonds or corporate bonds can also lower interest rate differentials between these and government bonds. All of these effects can lead to higher demand. The US central bank has over a long period purchased mortgage-backed securities to support these markets, and has recently also begun to buy government bonds. The British central bank has begun purchasing government and corporate bonds. The Riksbank announced in April that it might buy government bonds and possibly also mortgage bonds to further expand monetary policy if this were necessary.

Another alternative mentioned in the literature is that the central bank can stimulate the economy by buying foreign currency and thereby weakening the exchange rate or preventing it from strengthening. As the exchange rate and inflation expectations are closely linked, a weaker exchange rate will mean higher inflation expectations and thereby lower real interest rates. The Swiss central bank has recently bought government bonds, but also foreign currency to prevent the Swiss franc from strengthening, with the aim of conducting a more expansionary monetary policy.

As shown in our discussion here, all of these measures can be regarded as different sides of the same coin. All of the measures lead to a more expansionary monetary policy, that is, lower real interest rates, higher inflation expectations and a weaker exchange rate. The fact that monetary policy focuses on one instrument rather than another does not necessarily mean that the final outcome will differ. However, some instruments may be more effective than others for achieving the desired monetary policy. Exactly which measures a central bank chooses to use to stimulate the economy will therefore depend on a number of different factors.

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APPENDIX

Is a zero interest rate necessarily a problem?

The zero interest rate bound need not be a problem for the economy. Many theoretical models point to the contrary, that optimal monetary policy should set the nominal interest rate to zero. This reason is that the social cost of manufacturing money is close to zero, while the private cost of holding money is equal to the interest rate (the opportunity cost). In optimum, the social cost should be equal to the private cost; otherwise individuals will hold too little or too much money. The interest rate should therefore be set at zero. This reasoning was developed by Milton Friedman (1969) and is therefore called the "Friedman rule".

In the long term consumption has a constant growth rate, and the real interest rate r_t is given by this growth rate and by individuals' preferences and is usually positive. If the nominal interest rate is zero, the average inflation rate will be negative and equal to $-r_t$. Thus, the economy will experience deflation on average over time. Deflation is thus optimal in Friedman's model and its successors. However, other mechanisms may counteract Friedman's deflation result. Friedman's model assumes that prices and wages can be adjusted freely in each period. In this case, monetary policy have no effect on real variables such as employment and output, as prices and wages are adjusted directly in the same way as the change in the money supply. There is then no role for monetary policy in stabilising the economy. Other models, on the other hand, assume that prices and wages are sticky and that they cannot be adjusted freely, and also that individuals do not need money to make transactions. This provides a scope for a stabilising monetary policy. Then it is a problem if monetary policy cannot cut the interest rate sufficiently to stimulate the economy in a recession.

Unless all prices change at the same time, or if there are direct costs associated with changing prices, welfare losses arise if inflation deviates from zero. For example, a negative inflation rate could mean that certain prices are cut while other prices remain unchanged. Then changes in relative prices will arise that are not efficient, as they only arise because of the stickiness of prices. Corresponding problems arise of course with a positive inflation rate. If wages are sticky, then similar costs arise in terms of inefficient changes in relative wages. Thus, if prices or wages are sticky, the optimal inflation rate should be zero, not negative. In this case the optimal nominal interest rate will be positive and equal to the real interest rate. If one takes into account that prices and wages are sticky and if individuals have a transaction demand for money, as in Friedman's model,

the optimal inflation rate will be negative, although not as low as in Friedman's model.[36]

A further reason why the optimal inflation rate can be positive is that a period of deflation can be self-reinforcing. If demand is low and inflationary pressures are weak so that prices begin to fall, individuals who believe that prices will fall even more in the future may choose to postpone their consumption. This will mean that demand weakens further and prices fall more quickly. In addition, most debt contracts are written in nominal terms, so borrowers have to pay back a particular nominal amount in the future. Falling prices then lead to nominal debts being worth more in real terms, which may further subdue demand. In this way the economy may be caught in a vicious circle (what is known as a "debt-deflation trap") as described by Irving Fisher (1933) in connection with the Great Depression of the 1930s.[37]

For these reasons most central banks wish to avoid deflation. One of the reasons why most central banks aim for an inflation rate that is low, but positive, is to reduce the probability of being caught in a debt-deflation trap. For example, the Riksbank's inflation target is set at two per cent a year. Nominal interest rates will as a result usually be positive.

[36] See, for intance, Khan, King and Wolman (2003) and Aruoba and Schorfheide (2009).
[37] See also King (1994).

The monetary transmission mechanism

BY ELISABETH HOPKINS, JESPER LINDÉ AND ULF SÖDERSTRÖM[1]

Elisabeth Hopkins works at the Modelling Division of the Monetary Policy Department. She has a licentiate degree in economics and has worked at the Riksbank since 1997.

Jesper Lindé is Head of the Trade and Financial Studies Section in the Division of International Finance at the US Federal Reserve. He has a PhD in economics and was until October 2008 Head of the Modelling Division at the Monetary Policy Department.

Ulf Söderström works in the Research Division of the Monetary Policy Department. He has a PhD in economics and has worked at the Riksbank since 2008.

The monetary transmission mechanism describes how monetary policy affects the economy. In the short run monetary policy affects both the real economy – such as consumption, investment, production and employment – and inflation. In the long run, however, monetary policy has no or a very limited effect on the real economy. Monetary policy is then "neutral" and only determines the rate of inflation.

In this article we discuss how monetary policy, through changes in the repo rate, affects first market interest rates in the economy and then aggregate demand, production and inflation. Thereafter we illustrate these effects in different models used at the Riksbank. In a separate article in this issue we further discuss the financial crisis and how it can have affected the economy and the monetary policy transmission mechanism.

A general description of the transmission mechanism

Monetary policy affects the economy by changing the level of market interest rates. We start this section by briefly describing how changes in monetary policy, i.e. in the Riksbank repo rate, affect market interest rates and banks' and mortgage institutions' deposit and lending rates.[2] We then describe how changes in these interest rates affect the economy as a whole. Public expectations as to future developments consistently play a major role in determining the effects of monetary policy on the economy.

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[2] A more detailed description of how the repo rate affects the shortest rates in the money market can be found in the publication *The Riksbank's management of interest rates – monetary policy in practice*, Sveriges Riksbank, 2005.

At the end of the section we therefore discuss the role of expectations for monetary policy.

HOW DOES MONETARY POLICY AFFECT MARKET INTEREST RATES?

Changes in the repo rate primarily affect rates in the interbank market, i.e. the rates paid by banks when they borrow from each other for shorter periods. The interbank rates with the shortest maturities are affected directly by monetary policy. When the Riksbank raises the repo rate the Riksbank's deposit and lending rates to banks also rise. Banks with money in their accounts with the Riksbank then receive a higher interest rate and banks borrowing from the Riksbank must pay a higher rate. This also affects the interest rate paid by banks to each other on the interbank market.

Interbank rates with slightly longer maturities are also affected by expectations of future changes in the repo rate and some compensation for risk. Market participants can choose between borrowing or lending money for a long period or in a series of short loans and investments. If market participants expect the interest rate on short-term investments to rise in the future, the expected return on a series of short-term investments will be higher. To achieve equilibrium in the fixed income market interest rates on investments with longer maturities must then rise. But a series of short-term investments and a long-term investment carry different degrees of risk. Consequently, interest rates with longer maturities also include a compensation for risk, i.e. a risk premium.

In a similar way, changes in the repo rate also impact rates for treasury bills and government bonds, which have an even longer maturity. Market participants choose between lending to banks or to the state. Higher interbank rates will therefore typically be reflected in higher interest rates on treasury bills and government bonds. Here too, interest rates with longer maturities are partly determined by expectations of future monetary policy and partly by risk premiums.

Since a change in the repo rate normally persists for a long period, an increase in the repo rate tends also to lead to a rise in expectations concerning the future repo rate level. Accordingly, longer market rates are adjusted in the same direction as the repo rate.[3] But market rates can change even if the Riksbank does not change the repo rate if market participants adjust their expectations of future monetary policy decisions.

[3] In some cases long-term market rates can fall when the repo rate rises, for example if an unexpected repo rate increase is interpreted to mean that in future the Riksbank will act more vigorously to bring inflation back to the inflation target. See Ellingsen and Söderström (2001).

Changes in rates on the interbank market, treasury bills and government bonds then impact other borrowing rates for the banks, such as interest rates on bank accounts and mortgage institutions' bonds. Changes in banks' borrowing rates in turn affect their lending rates, for example on bank loans, mortgages and corporate loans as well as interest rates for commercial paper and corporate bonds. In that way monetary policy affects many different interest rates in the economy, including deposit and lending rates to households and firms.

However, there is considerable uncertainty as to how great these ultimate effects are and if market interest rates are is also determined by other factors. Recently many market rates have changed in a way that does not seem to depend on monetary policy. In this article we describe how monetary policy affects the economy via market rates in normal circumstances. In our other article in this issue of Economic Review we discuss instead the recent financial crisis. There we attempt to determine why different market rates in 2008 seemed to rise faster than could be explained by the Riksbank's monetary policy.

HOW DO MARKET RATES AFFECT THE ECONOMY?

A change in market interest rates affects the economy in a number of different ways. A tightening of monetary policy that raises market rates will lead to a reduction in the aggregate demand for goods and services, resulting in a slower increase in output and a fall in inflation. Higher interest rates can also impact inflation directly without first affecting demand in the economy. We can describe these different mechanisms by identifying four "channels" through which monetary policy works: the interest rate channel, the credit channel, the exchange rate channel and the cost channel. However, it is not always easy in practice to separate these channels from each other since the mechanisms are tightly entwined. Households' and firms' expectations about the future also play an important role for how great the effects of monetary policy will be. This further complicates the analysis.

The interest rate channel

When the Riksbank changes the interest rate it affects other nominal interest rates in the economy. But most economic decisions are not based on the nominal interest rate but on the real interest rate, which is the

nominal rate adjusted for expected inflation.[4] Studies show that most firms do not adjust their prices immediately when for example their cost of production or the demand for their products change. Prices are said to be sticky.[5] If prices and thus inflationary expectations are sticky, a change in the nominal interest rates will lead to a change in different real interest rates. Real interest rates in turn affect household consumption and savings and firms' investments. The interest rate channel implies that when the Riksbank raises the repo rate so that market interest rates in the economy rise, it becomes more profitable to save and less profitable to borrow money. Households then decide to postpone consumption by saving more, borrowing less and consuming less today. In the same way firms decide to postpone investments, since they are more expensive to finance by loans. Firms and households thus demand fewer goods and services and aggregate demand falls. Lower demand for goods and services in due course leads to a decrease in both output and in the demand for labour and capital. When demand for these factors of production falls, their price falls too, i.e. wages and the cost of capital, and firms' costs are reduced. Reduced costs mean that domestic firms gradually reduce their prices, which leads to lower inflation.

The credit channel

Interest rate changes also affect the economy through the credit market. Higher interest rates generally reduce the present value of financial assets' future payoffs, for example share dividends.[6] Higher interest rates also reduce demand for real assets such as real estate. Thus prices of both real and financial assets fall. Since these assets are used as collateral for loans, banks and other financial institutions become more restrictive in their lending when asset prices fall. This results in lending rates rising more than other interest rates, which reduces lending. Alternatively, banks can choose to reduce lending directly by setting stricter conditions for new credit.

Banks' lending also decreases for other reasons. When asset prices fall it is more profitable for banks to buy shares and bonds instead of

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4 The nominal interest rate measures the return on an investment (or the cost of a loan) expressed in currency, e.g. kronor. The real interest rate measures the return in terms of a basket of goods. Lagervall (2008) gives a more detailed description of the short-term real interest rate in Sweden.

5 There may be different reasons for sticky prices. In the first place prices are sometimes determined by long-term contracts between firms and customers to reduce uncertainty and the costs that arise as a result of frequent negotiations. In the second place firms can keep prices fixed so as not to upset their relations with regular customers by adjusting prices too often. In the third place some prices are sticky due to the market structure. When a company has printed and distributed a catalogue or price list it is expensive to change the prices.

6 A present value is the current value of a payment to be made in the future. Since a payment today can be invested, thereby giving a return, it is worth more than if the same payment is made in the future. The future payment is thus discounted. The value of many financial assets, such as bonds or shares, depends on their giving the right to future payments.

lending money. Households' future wages and firms' future profits also fall when the demand for labour, goods and services weakens. This also makes banks more restrictive in their lending. All in all, lending to households and firms decreases when interest rates rise, leading to lower consumption and investment.

These mechanisms, together called the credit channel, also contribute to reducing aggregate demand and inflation after a tightening of monetary policy.

Changes in asset prices can also affect demand directly through changes in household and corporate wealth. Lower asset prices mean that wealth decreases, which may make households and firms feel they have smaller margins for their spending. They may therefore decide to reduce consumption and investment, which also reduces aggregate demand. But for individuals this effect depends on the assets owned and their plans for the future. For example, people who own their home feel poorer when house prices fall, while those who have saved and plan to buy a home get more for their money.

The exchange rate channel

In an open economy monetary policy also affects the real economy through exchange rates. An increase in the repo rate normally strengthens the exchange rate. A higher interest rate level in Sweden compared with the rest of the world makes it more profitable for Swedish and foreign investors to buy Swedish financial assets compared with foreign assets. In equilibrium, however, the expected return on Swedish and foreign investments must be the same. Consequently, the higher Swedish interest rates must be compensated by an expected weakening of the Swedish krona. Therefore, in theory an interest rate increase in Sweden leads to a stronger krona, which is followed by a gradual weakening of the Swedish currency at the same rate as interest rates return to their long-run equilibrium.

A strengthening of the exchange rate has two different effects on the economy. If prices are sticky, a stronger nominal exchange rate will lead to a stronger real exchange rate.[7] Measured in the same currency foreign goods will then become cheaper and Swedish goods more expensive. This will lead to a drop in demand for domestic goods and a rise in demand for foreign goods, thus reducing the aggregate demand for Swedish goods.

[7] The nominal exchange rate measures the price of foreign currency in terms of Swedish kronor. The real exchange rate measures the price of a basket of goods abroad, converted into Swedish kronor, relative to what is paid in Sweden for the equivalent basket of goods. If the Swedish nominal exchange rate is strengthened and prices are sticky the real exchange rate will also be strengthened, since it then becomes cheaper to buy goods abroad in relation to what they cost to buy in Sweden.

In addition, a stronger exchange rate has a more direct effect on inflation by reducing the prices of imported goods, thus lowering inflation.

The cost channel

Monetary policy can also affect inflation without first affecting aggregate demand. Since firms finance their operations to some extent with borrowed funds a change in the interest rate can directly affect firms' costs. A repo rate increase which raises lending rates can then raise financing costs for firms, which in turn will be forced to increase their prices to compensate. Thus this cost channel affects inflation in the opposite direction with the traditional channels. As we will see later, when we discuss the transmission mechanism in different models, this effect is typically dominated by the other channels so that an interest rate increase typically leads to lower inflation.

THE ROLE OF EXPECTATIONS FOR MONETARY POLICY

Modern macroeconomic theory assigns great importance to firms' and households' expectations about the future. Many of the channels discussed above are based on these expectations. For example, both the interest rate and the exchange rate channels are based on the fact that firms' prices are sticky and not immediately adjusted when disturbances occur. In this case firms' prices depend to a great extent on expectations of future demand, since firms know that their prices will remain unchanged for some time. Similarly, households' decisions to save or consume and firms' decisions to invest not only depend on the current interest rate but also on the expected future interest rate. And the exchange rate is to a great extent determined by expectations of future exchange rates and consequently future interest rates.

As a consequence, monetary policy not only affects the economy through the current interest rate level but also through expectations of the future interest rate level. Today's demand for consumer or investment goods depends on expectations of future consumption and investment, and current inflation depends on expectations of future inflation. The central bank can help firms and households to form expectations for the future by publishing forecasts for important variables. The Riksbank primarily publishes forecasts of CPI inflation, GDP growth and the repo rate, but also of other variables that may be of importance to firms and households.

The effects of monetary policy in different models

Exactly how the economy is affected by an interest rate change depends on how quickly the different mechanisms operate and how powerful they are. To gain an idea of these effects and estimate their size one must rely on economic models. However, models always give a simplifed and stylised picture of reality. A given model can therefore never identify all the mechanisms in the economy, and different models give different answers depending on how they are constructed. For this reason the Riksbank uses several different models to make forecasts and to examine how monetary policy affects the economy. In the forefront is Ramses, which is a general equilibrium model, but in addition vector autoregressive models (VAR models) and partial models are used.

In the following we first illustrate the monetary transmission mechanism using Ramses. Ramses is based on certain assumptions of how the economy is constructed, and does not include all the mechanisms discussed above. We therefore also compare Ramses with various VAR models. These are based to a greater extent on statistical relationships between different variables and are therefore more general than Ramses.[8] We will show how the aggregate effect of an interest rate change appears in these models, but in Ramses we will also decompose the effects on GDP and inflation into those that operate via the interest rate channel and those that mainly arise through the exchange rate channel.

THE TRANSMISSION MECHANISM IN RAMSES

In Ramses it is assumed that the Riksbank sets the level of the repo rate depending on how inflation and GDP develop. If inflation is higher than the Riksbank target or if GDP is unusually high, the Riksbank will tighten monetary policy and increase the repo rate to get inflation to return to the target and avoid overheating the economy. This is a common way of describing monetary policy in economic models, but is naturally a highly simplified view of reality. The monetary policy rule in Ramses, however, is chosen so as to provide a relatively good description of interest rate movements in Sweden over the years. Deviations between the interest rate decisions actually made and the decisions which would have been

[8] A VAR model is a statistical model in which a number of variables are interdependent with different time lags. The VAR models used here include Swedish and foreign GDP growth, inflation, short-term interest rate and the real exchange rate. Since Sweden is a small economy the Swedish variables are assumed not to affect the foreign variables. Ramses, on the other hand, is a general equilibrium model estimated on Swedish data. An outline of Ramses is given by Adolfson et al. (2007) and a more detailed description can be found in Adolfson et al. (2008).

made had the model's interest rate rule been exactly followed can be viewed as a measure of monetary policy "surprises".

To describe how the transmission mechanism works in Ramses we study how the economy is affected by an unexpected increase in the repo rate of 0.25 percentage points. Hence this increase is not caused by a change in inflation or in economic activity, which monetary policy normally reacts to, but constitutes a deviation from the Riksbank's normal behaviour. In Figures 1–8 we show how such a tightening of monetary policy affects different variables in the economy if there are no other disturbances. The figures have been drawn in terms of deviations from the long-run equilibrium of the model. In this equilibrium inflation is equal to the Riksbank's target of 2 per cent and the repo rate is 4.25 per cent. Most real variables, such as GDP, consumption and investment, are assumed in equilibrium to grow at the economy's long-run growth rate of 2.25 per cent per year.

The figures can also be interpreted as describing what would happen to the different variables when the forecast for the repo rate is unexpectedly adjusted upwards. In the model all households and firms are assumed to know and understand exactly how the economy works and is affected by an interest rate change. Since the agents in the model know exactly what will happen they also adjust their expectations of the future just as the forecasts are adjusted.

In Figure 1 we see first that the unexpected interest rate rise is followed by a period with a higher repo rate than normal. Since the interest rate rise is not justified by changes in the economy the repo rate returns to its original level after about one and a half years. Agents in the model are assumed to understand what is happening and they realise that the repo rate will be unusually high for a long period. Their expectations concerning the future repo rate level therefore increase, and interest rates with long maturities consequently also rise.[9] As an example, Figure 1 shows that a five-year interest rate would rise by about 3 basis points and return to its original level after about one year.

Since a higher interest rate leads to lower inflation, inflation expectations will fall after the tightening of monetary policy. Therefore in Figure 2 the real repo rate, which is the repo rate adjusted for inflation expectations, rises more than the nominal repo rate in Figure 1.[10] In our case inflation is expected to fall by about 0.13 percentage points. Thus the real repo rate rises by 0.38 percentage points when the nominal rate goes up

[9] In practice long-term market rates are also determined by risk premiums, which could be affected by changes in monetary policy. However, in the example these are assumed to be unchanged.

[10] One period in Ramses is equivalent to one quarter. The nominal repo rate in the diagrams should therefore be interpreted as an average over one quarter. The real interest rate has been calculated as the nominal rate for one quarter minus the expected inflation rate for the following quarter.

Figure 1. How an unexpected increase in the repo rate of 0.25 percentage points affects the repo rate and the five-year interest rate in Ramses
Deviation from long-run level in percentage points

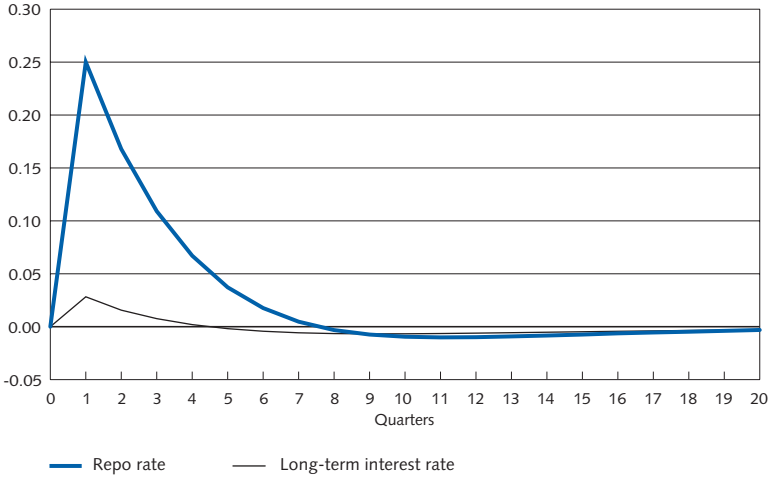
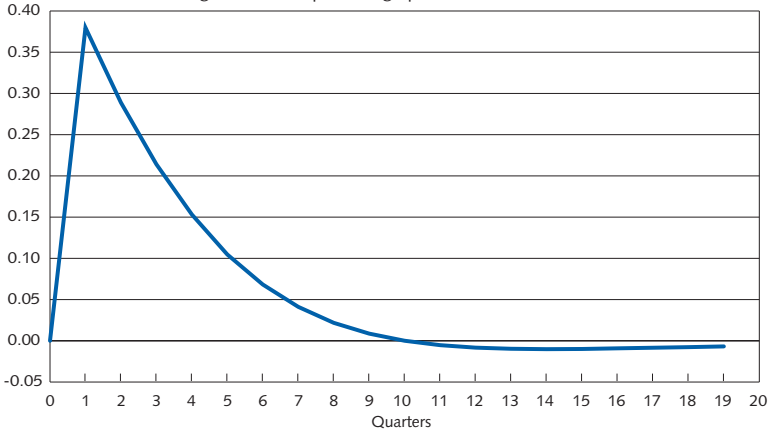


Figure 2. How an unexpected increase in the repo rate of 0.25 percentage points affects the real repo rate in Ramses
Deviation from long-run level in percentage points

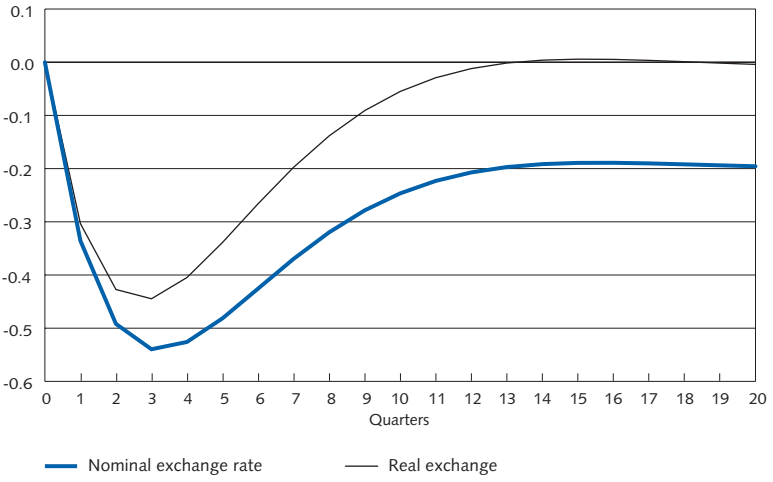


by 0.25 percentage points. The real rate then returns to its original level at about the same pace as the nominal rate.

Figure 3 shows that tightening monetary policy strengthens the nominal and real exchange rates.[11] The nominal exchange rate is strengthened because the Swedish interest rate rises relative to foreign rates. When the interest rate then reverts to its original value the nominal exchange rate is expected to become successively weaker. When the interest rate rises the price level in Sweden falls. The real exchange rate,

[11] The exchange rate is measured as the price of foreign currency in terms of Swedish currency, for example SEK/EUR. A strengthening of the krona which makes Swedish kronor more expensive measured in foreign currency is therefore reflected in a lower exchange rate. The real exchange rate is measured as the nominal exchange rate adjusted for the relative price levels in the foreign and Swedish economies.

Figure 3. How an unexpected increase in the repo rate of 0.25 percentage points affects the nominal and real exchange rates in Ramses
Per cent deviation from long-run level



i.e. the nominal exchange rate adjusted for differences in the relative price level between Sweden and abroad, will therefore be strengthened somewhat less than the nominal exchange rate. The real exchange rate will then gradually return to its original equilibrium level. On the other hand, the nominal exchange rate does not have a fixed equilibrium level, but in the long term will reach a new equilibrium depending on how the Swedish price level has moved in comparison with the price level abroad. Since the price level in Sweden falls compared with abroad, the nominal exchange rate will be strengthened in the long term as well.

The higher level of short and long-term market rates leads to lower consumption and investment, see Figure 4. The higher interest rate level means that households and firms save more and postpone consumption and investment. Moreover, the strong exchange rate makes domestic goods more expensive than foreign goods, which also dampens investment due to reduced export demand, so exports decrease, see Figure 5. The stronger exchange rate also tends to increase imports, since imported goods become cheaper in relation to Swedish goods. But at the same time the fall in consumption and investment reduces demand for imported goods. In the model the second effect prevails over the first so that imports fall after the tightening of monetary policy. However, since exports decline more than imports, the trade balance, i.e the difference between exports and imports, deteriorates.

When consumption, investment and exports decline, aggregate demand for Swedish goods decreases and output falls. Figure 6 shows that according to the model Swedish GDP will fall by a maximum of 0.11 per cent below its long-run trend after two to three quarters and not

Figure 4. How an unexpected increase in the repo rate of 0.25 percentage points affects consumption and investment in Ramses
Per cent deviation from long-run trend

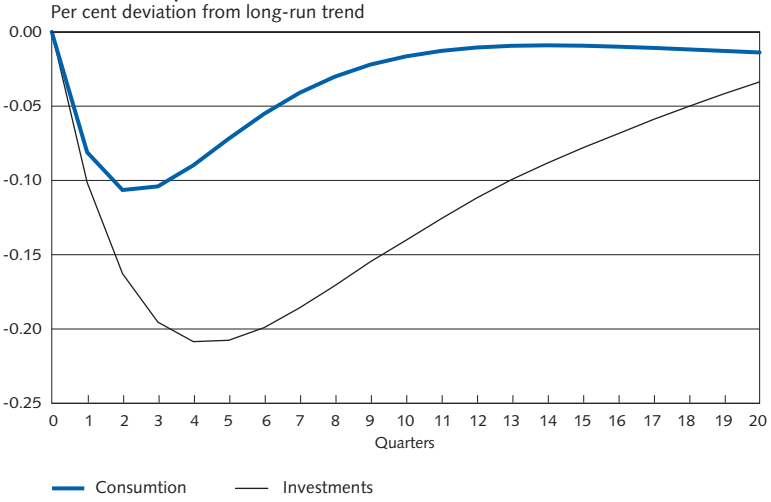
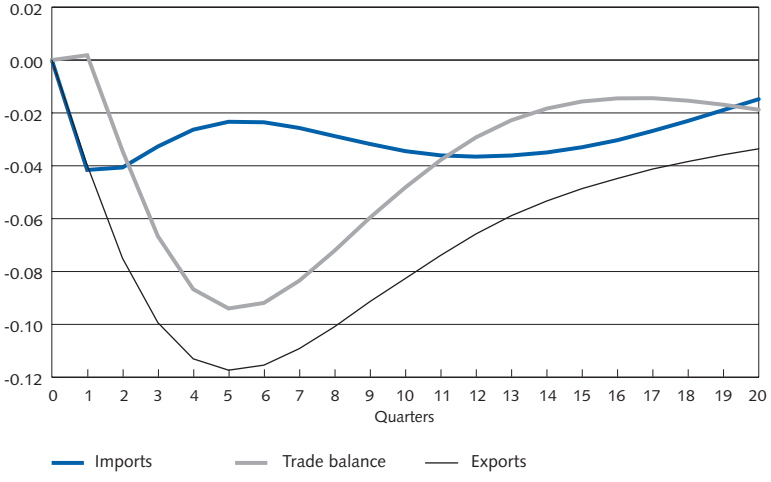


Figure 5. How an unexpected increase in the repo rate of 0.25 percentage points affects exports, imports and the trade balance in Ramses
Per cent deviation from long-run trend



return to the trend until after more than five years. Apart from showing the total effect of an interest rate rise, Figure 6 also shows the effect that is solely due to the interest rate channel.[12] We see that GDP is mainly affected through the interest rate channel, but the remaining effect, due to the exchange rate channel, is not insignificant.

[12] We isolate the effect via the interest rate channel by analysing a version of the model for a closed economy where all links to the rest of the world are removed. The effects that arise in a closed economy are mainly via the interest rate channel, but also via the cost channel. (Ramses does not include any credit channel.) The additional effects in an open economy are mainly via the exchange rate channel. However, both channels are augmented by effects via expectations.

Lower output means that firms need less labour and so employment decreases and wages fall. Figure 7 shows a fall in employment of 0.12 per cent while real wages fall by only 0.02 per cent below their long-run trend. Note that employment falls by about the same as GDP, which means that labour productivity – the ratio between GDP and employment – is not affected to any great extent.

Finally, Figure 8 shows that inflation, measured as the quarterly change in the price level, immediately falls by 0.13 percentage points and after about three years returns to its long-run level.[13] Inflation falls for

Figure 6. How an unexpected increase in the repo rate of 0.25 percentage points affects GDP in Ramses
Per cent deviation from long-run trend

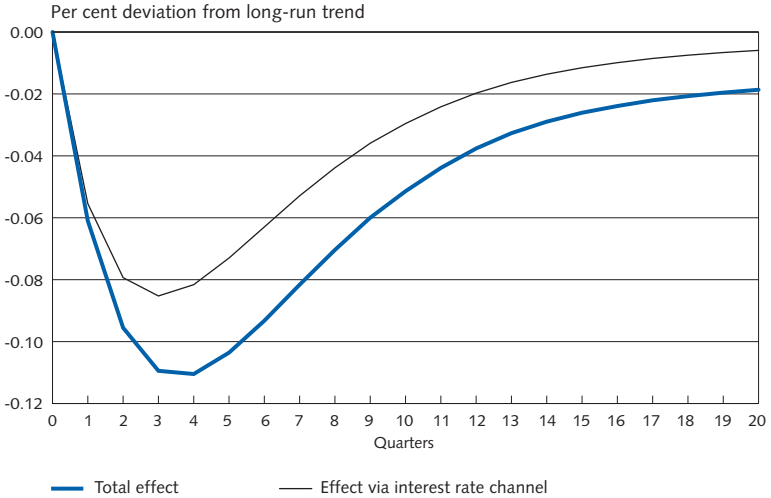
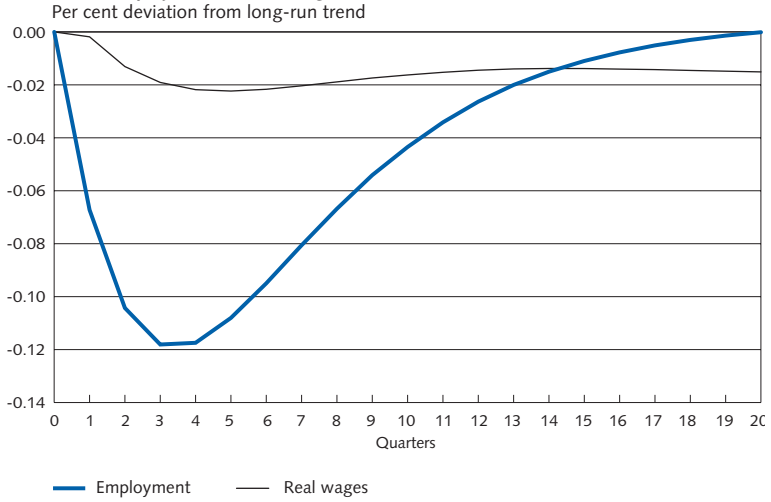
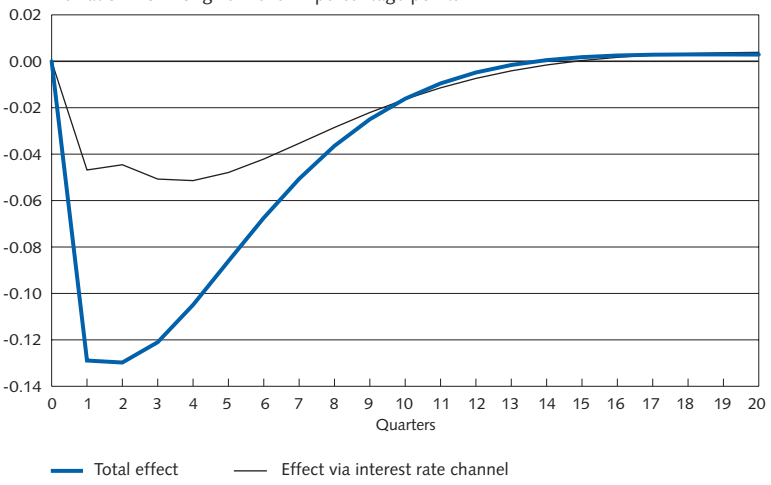


Figure 7. How an unexpected increase in the repo rate of 0.25 percentage points affects employment and real wages in Ramses
Per cent deviation from long-run trend



[13] The price level in the model corresponds in practice to CPIX, i.e. the consumer price index excluding interest costs for owner-occupied housing and direct effects of changed indirect taxes and subsidies.

Figure 8. How an unexpected increase in the repo rate of 0.25 percentage points affects CPIX inflation in Ramses
Deviation from long-run level in percentage points



several reasons. Lower wages lead to lower production costs for firms. The stronger exchange rate also makes imported goods cheaper. This applies both to goods for final consumption and goods used as inputs in production. Firms' costs are also directly affected by the interest rate increase, since to some extent firms need to borrow funds to pay their wages and other costs. This means that costs and prices also tend to rise somewhat when the interest level rises. In this case the latter effect is smaller than the other effects, so inflation decreases. We also see that inflation is substantially affected via the exchange rate channel, while the interest rate channel is somewhat weaker. Consequently, the exchange rate channel is more significant for inflation than for GDP. This is natural, since the exchange rate directly affects prices of imported goods that constitute a large proportion (about one third) of the Swedish consumption basket.

Why are GDP and inflation affected so quickly in Ramses when the interest rate changes?

A common view is that the monetary policy transmission mechanism is very long drawn-out. A change in monetary policy is often assumed to affect GDP and inflation gradually, with a maximum effect on GDP after about a year and on inflation after another year. Many studies using VAR models also support this view. Figures 6 and 8 show, however, that the effects on GDP and inflation in Ramses are faster than that. GDP falls by 0.06 per cent in the same quarter as monetary policy is tightened, and the maximum effect comes two to three quarters later. At the same time, inflation falls steeply, by 0.13 percentage points, and then slowly returns

to its long-run level. There are several reasons for the rapid impact on inflation. Firstly, the exchange rate is immediately strengthened when monetary policy is tightened, leading to lower prices for imported goods. In Ramses import prices are only gradually impacted by changes in the exchange rate, but a large proportion of the effects are direct. Moreover, inflation is affected to a great extent by expectations about the future. When monetary policy is tightened expectations are quickly adjusted, which affects inflation directly. Many VAR models assume instead that GDP and inflation are not affected in the same quarter, not even by expectations, which makes the effects of monetary policy slower. Since Ramses is an estimated model its results are based on the average impact of monetary policy during the estimated period. We discuss below whether there is reason to believe that the impact of monetary policy has changed since a credible inflation target was introduced in Sweden.

THE EFFECTS OF MONETARY POLICY – A COMPARISON BETWEEN RAMSES AND OTHER MODELS

The Riksbank also uses other models than Ramses for its monetary policy analysis. These models are all VAR models in which different variables are modelled as a system and affect each other with different time lags. The various models differ through different assumptions made about how the variables affect each other before the models have been estimated. The first model (VAR) is a classical VAR model in which no such assumptions have been made. The other two models are Bayesian VAR models in which prior assumptions have been made about various correlations. These assumptions are then updated when comparing the implications of the model with statistical relationships in the data used. In the first model of these two (BVAR) prior assumptions have been made that the different variables do not affect each other; each variable is only determined by earlier observations of the same variable. This means that the different variables do not interact to any great extent even after the model has been estimated. In the second Bayesian VAR model (DSGE/VAR) Ramses has been used instead to make the prior assumptions. According to these assumptions the variables follow one another to a greater extent than in the BVAR model, which leads to greater interaction between the variables in the final estimate as well.[14] These models give a similar qualitative picture of the monetary policy transmission mechanism to that of Ramses,

[14] The designation DSGE/VAR is derived from the fact that a Dynamic Stochastic General Equilibrium model such as Ramses is used to make prior assumptions. Villani (2009) and Adolfson et al. (2008) discuss in more detail how the BVAR and DSGE/VAR models are designed.

though the quantitative effects are different. Below we compare how the monetary policy transmission mechanism operates in the various models.

Figures 9–12 compare how an unexpected increase in the repo rate of 0.25 percentage points affects the economy in Ramses and in the three other models. As we see in Figure 9, the effect of the increased repo rate is less long-lasting in the VAR and DSGE/VAR models than in Ramses, but more long-lasting in the BVAR model. It is natural that the interest rate in the BVAR model is more enduring than in the other models, since this model has been estimated using the prior assumption that the interest rate will gradually return to equilibrium and not be affected by the other variables. In the other models the interest rate is pulled down to some extent when GDP growth and inflation fall. Since the short-term interest rate increase is more enduring in the BVAR model the five-year interest rate rises more than in the other models (see Figure 10). In the classical VAR model and the DSGE/VAR model the repo rate falls quickly and then for a time stays at a lower level than the original one. Consequently the five-year interest rate does not rise as much in the VAR model and even falls in the DSGE/VAR model.

The effects of the unexpected tightening of monetary policy on GDP growth and inflation are shown in Figures 11 and 12. The repo rate increase has the greatest effect on GDP growth and inflation in the DSGE/VAR model, despite the fact that the repo rate path increases least and the long interest rate falls in that model. On the other hand the tightening has little effect on growth and inflation in the BVAR model. The fact that the effects are small in the BVAR model is again a natural consequence of the prior assumption that the variables do not affect each other. The

Figure 9. How an unexpected increase in the repo rate of 0.25 percentage points affects the repo rate in different models
Deviation from long-run level in percentage points

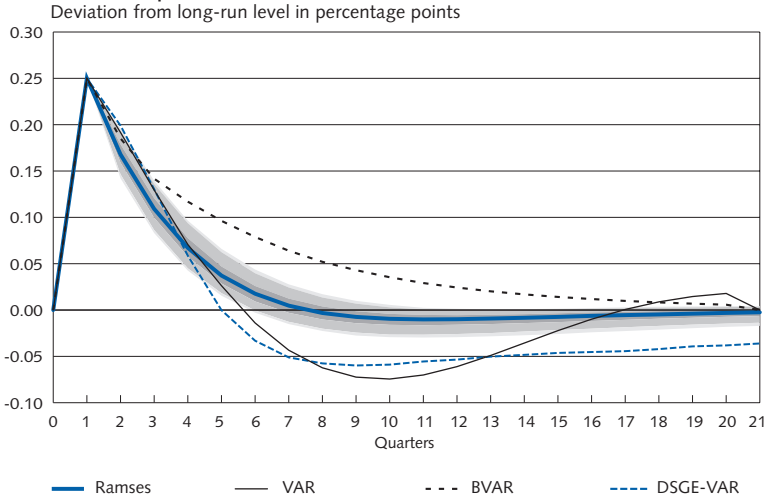


Figure 10. How an unexpected increase in the repo rate of 0.25 percentage points affects the five-year interest rate in different models
Deviation from long-run level in percentage points

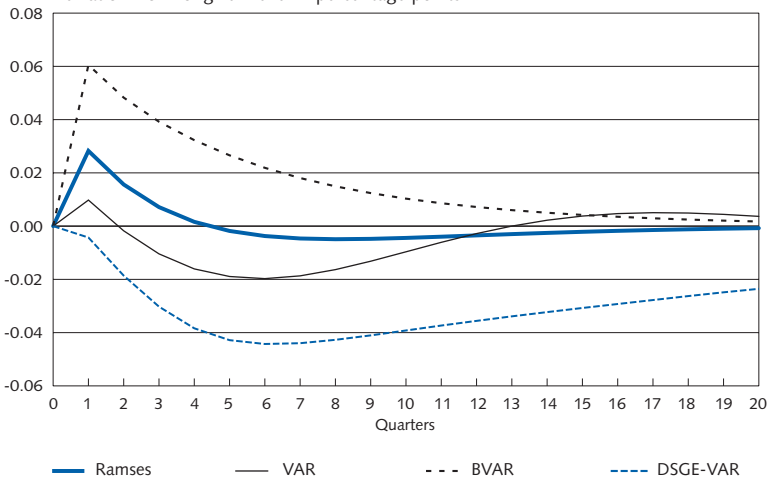
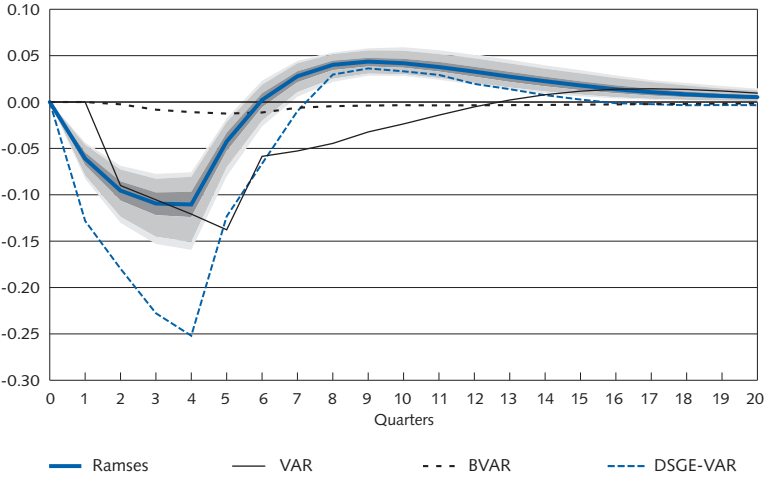


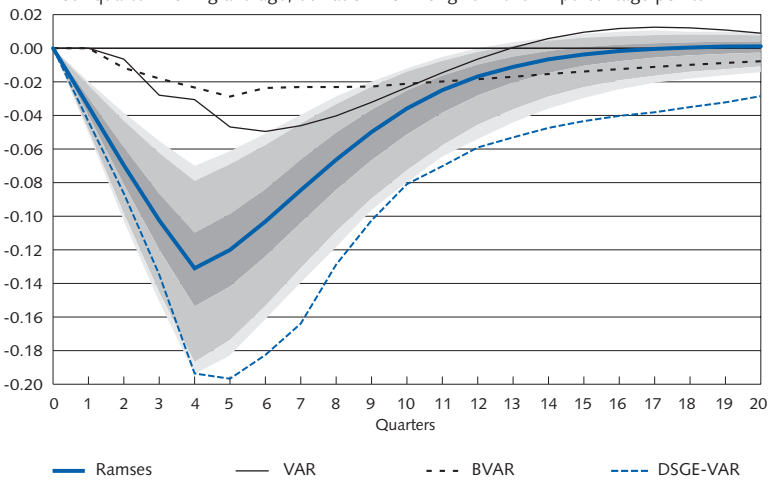
Figure 11. How an unexpected increase in the repo rate of 0.25 percentage points affects GDP growth in different models
Four quarter growth rate, deviation from long-run level in percentage points



effect on growth in Ramses is about as great as in the VAR model, but the VAR model gives smaller effects on inflation than in Ramses.

To sum up, the different models predict similar qualitative effects of an unexpected tightening of monetary policy, though the quantitative effects differ between the models. The effects in Ramses most often lie between the effects in the different VAR models. The shaded areas in the figures represent uncertainty bands around the effects in Ramses. The effects in the other models often lie inside these uncertainty bands. This indicates that the differences between the models are not statistically sig-

Figure 12. How an unexpected increase in the repo rate of 0.25 percentage points affects CPIX inflation in different models
Four quarter moving average, deviation from long-run level in percentage points



nificant, particularly if the uncertainty in the VAR models is also taken into account.[15]

All in all we can see that the effects in the VAR models deviate from Ramses in a way that can be explained by the models' design. This also applies to how fast monetary policy affects GDP and inflation in the different models. The VAR model assumes that an unexpected change in monetary policy will not affect GDP growth and inflation in the same quarter, while in Ramses GDP and inflation are affected without any time lag. This may explain why the effects in the VAR models are somewhat smaller than in Ramses. The BVAR model has been estimated with the prior assumption that monetary policy does not affect the other variables to any great extent, which may explain why the effects in this model are also smaller than in Ramses. On the other hand, the effects on GDP growth and inflation are faster and more powerful in the DSGE/VAR model than in Ramses, which confirms that the effects in Ramses are reasonable. The DSGE/VAR model uses the results from Ramses to formulate prior assumptions that are then updated when the model encounters the actual data. The fact that the ultimate effects are stronger in the DSGE/VAR model than in Ramses indicates that the statistical correlations are even stronger. Hence Ramses gives a balance between theoretical and statistical relationships. We therefore conclude that it is reasonable to use Ramses in the Riksbank's monetary policy analysis.

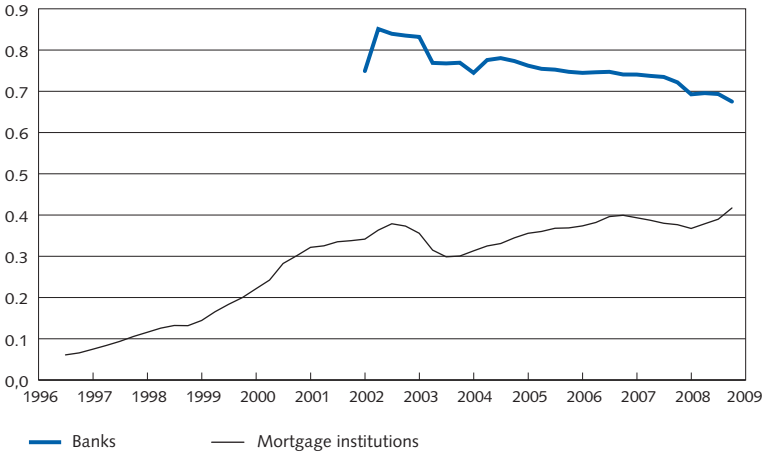
[15] In order to simplify the figures, only uncertainty bands from Ramses are shown.

IS THERE REASON TO BELIEVE THAT THE TRANSMISSION MECHANISM HAS CHANGED?

The different models are estimated for long periods under the assumption that economic relationships have been stable over time. But of course it is not completely certain that this has been the case. For example the maturity structure of lending to households and firms has changed in recent years, with an increase in the percentage of households and firms with variable interest rates on their loans. It is therefore conceivable that the monetary policy transmission mechanism has changed. If a large proportion of lending is at long maturities the borrowing cost is mainly determined by the long-term lending rates, and hence the expectations of future monetary policy. If, on the other hand, lending is mainly at short maturities, firms' and households' borrowing costs are primarily dependent on the short-term interest rates that are more directly connected to the current repo rate level. In that way the effects of monetary policy on aggregate demand could have a faster impact if a greater proportion of today's lending is at short maturities.

Figure 13 illustrates how the percentage of loans at short maturities (up to three months) has developed since 1996. As regards lending by mortgage institutions there has been a substantial change – short-term lending has increased from less than 10 per cent in 1996 to over 40 per cent in 2008. The trend of banks' lending has rather gone in the opposite direction – short-term lending has fallen from around 80 per cent in 2002 to less than 70 per cent in 2008. The tendency since 2001, however, has been relatively weak, while changes from 1996 to 2001 were more pro-

Figure 13. Fraction of loans with variable interest rates
Quarterly average



Source: Statistics Sweden and Sveriges Riksbank.

nounced. This could indicate that changes in monetary policy today have a faster impact on the economy than in the mid-1990s.

However, this argument is based to some extent on an assumption that firms and households are either not completely rational or that their borrowing is rationed in the credit market. If, on the other hand, firms and households are rational and do not encounter extensive restrictions in the credit market they can plan their saving and borrowing exactly so that a series of loans with short maturities is equivalent to a loan with a long maturity, apart from some compensation for the greater risk associated with short maturities. Therefore, it is not certain that the change in the maturity structure of lending has affected the monetary policy transmission mechanism.

Summary and conclusions

Monetary policy mainly affects the economy by changing the general level of market interest rates. A tightening of monetary policy, i.e. an increase in the repo rate, leads to higher market interest rates. This in turn reduces the aggregate demand for goods and services through a number of different channels. Firstly it becomes more profitable to save and less profitable to borrow, secondly the value of real and financial assets declines, so that firms and households find it harder to borrow against collateral. In addition the exchange rate tends to strengthen, so that exported goods are more expensive and imported goods cheaper. All these effects tend to reduce the aggregate demand for goods and services and consequently inflationary pressure. We have illustrated these effects in the Riksbank's theoretical model Ramses and in three different statistical VAR models used at the Riksbank. The different models provide similar answers to the question of how powerful an effect monetary policy has on the economy.

We have also discussed the common argument that monetary policy effects are different today than they were before, since today's households and firms borrow to a greater extent at short maturities. This could mean that the impact of monetary policy on the economy is felt more rapidly today than before. Our objection to this argument is that it assumes that households and firms are either not completely rational or that their borrowing is rationed in the credit market. Whether or not this is the case is an important question for future investigation.

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The transmission mechanism and the financial crisis

BY ELISABETH HOPKINS, JESPER LINDÉ AND ULF SÖDERSTRÖM[1]

Elisabeth Hopkins works at the Modelling Division of the Monetary Policy Department. She has a licentiate degree in economics and has worked at the Riksbank since 1997.

Jesper Lindé is Head of the Trade and Financial Studies Section in the Division of International Finance at the US Federal Reserve. He has a PhD in economics and was until October 2008 Head of the Modelling Division at the Monetary Policy Department.

Ulf Söderström works in the Research Division of the Monetary Policy Department. He has a PhD in economics and has worked at the Riksbank since 2008.

Monetary policy affects inflation and economic activity mainly by having an impact on interest rates in financial markets, for example in the interbank market, the bond market and various loan markets. The financial turbulence that started in summer 2007 and thereafter developed into a financial crisis has affected price setting on many of these markets. In this article we discuss how the financial crisis has affected market interest rates.

Interest rates in the interbank markets rose steeply until the end of 2008. We analyse the factors behind this rise. Interbank rates are important in this context, since to a large extent they form the basis for other interest rates in the economy. We show that the rise in interbank rates was mainly due to international factors.

We then analyse whether the financial crisis has affected the impact of monetary policy on the economy; that is the monetary transmission mechanism.[2] The monetary policy expansion that has taken place since October 2008 has had a great impact on the interest rate level in the markets, even though some interest rate spreads today continue to be greater than before the outbreak of the financial crisis. So monetary policy is not without effect. But since much of the rise in interbank rates is due to foreign factors it may be difficult to reduce the spreads between these rates and other interest rates solely by means of Swedish monetary policy

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[2] In a separate article in this issue of Sveriges Riksbank Economic Review we describe in more detail how the monetary transmission mechanism works and how monetary policy affects the economy in more normal circumstances.

measures. Recent developments indicate that extensive global measures are required before the crisis in the financial markets can be alleviated.

Interest rate developments since 1996

Changes in the repo rate primarily affect rates in the interbank market, i.e. the rates paid by banks when they borrow from each other for shorter periods. Interbank rates with the shortest maturities are directly affected by monetary policy, while slightly longer interbank rates are also affected by expectations of future changes in the repo rate and compensation for risk. In a similar way, changes in the repo rate also impact rates for treasury bills and government bonds, which have even longer maturities. Changes in rates on the interbank market, treasury bills and government bonds then impact borrowing rates for the banks, such as interest rates on bank accounts and mortgage institutions' bonds. Changes in banks' borrowing rates in turn affect lending rates, such as those for bank loans, mortgages and corporate loans as well as interest rates on commercial paper and corporate bonds. In that way monetary policy affects many different interest rates in the economy, including those encountered by households and firms.

Most economic models (including the Riksbank's general equilibrium model Ramses) assume that a change in the repo rate will lead to a proportional change in all market rates. In that case the spreads between different interest rates are constant over time, and various interest rate spreads can be disregarded when analysing the effects of monetary policy on the economy.[3] In normal circumstances this may be a reasonable assumption, since different interest rates tend to move in approximately the same way. However, in the financial turbulence that started in mid-2007 market rates seem to have been changed due to factors not directly dependent on monetary policy. In particular, many market rates rose in relation to interest rates on treasury bills and government bonds with corresponding maturities, increasing interest rate spreads.

In this section we illustrate how different market rates and interest rate spreads have developed in the last twelve years. For example, we show that many interest rate spreads were very low in the years before the start of financial turbulence. Consequently, to some extent financial turbulence has meant that these interest rate spreads have reverted to

[3] However, there are a number of papers that study models with several different interest rates in the economy. Bernanke, Gertler and Gilchrist (2000), for example, develop a model in which firms borrow funds to make investments. Since some firms are expected to fail, the interest on corporate loans is higher than the interest on government bonds. Christiano, Motto and Rostagno (2007) develop this model to contain an explicit banking sector. Goodfriend and McCallum (2007) also analyse a model with several different interest rates. Their model takes into account spreads between interest rates on loans against collateral of varying quality and interest rates on uncollateralised loans.

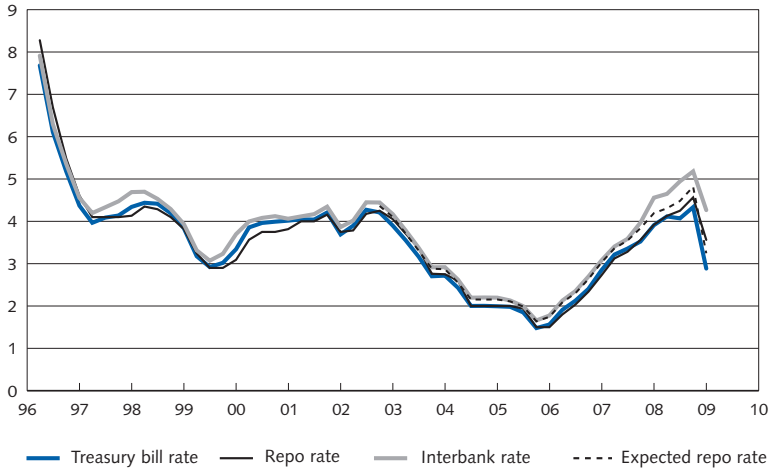
more normal levels. Other interest rate spreads rose in 2008 to levels that from a historical perspective are exceptionally high.

MONEY MARKET RATES

Figure 1 shows the movements of some money market rates from 1996 to the end of 2008. These are the Riksbank repo rate, interest on three-month treasury bills, the interbank rate (Stibor) with three months maturity and the expected repo rate in the coming three months.[4] The four rates have followed each other closely during the period. In general the interbank rate was higher than the repo rate and the treasury bill rate, which reflects the fact that banks find it more risky to lend to another bank than to the Government. The treasury bill rate and repo rate are often very close to each other. This is because the treasury bill rate normally primarily reflects expectations about the repo rate in the next three months. The expected repo rate was slightly higher than the treasury bill rate during the period. This difference is to some extent due to market participants' demand for safe investments in the form of treasury bills.

Periodically the interbank rate rose faster than the repo rate and treasury bill rate, increasing the difference against government bond rates. This was the case in 1997 and 1999, for example, and particularly since mid-2007.

Figure 1. Money market rates, three month maturities
Per cent



Note. Quarterly averages. The interbank rate is Stibor, the expected repo rate is the rate for a Stina swap.

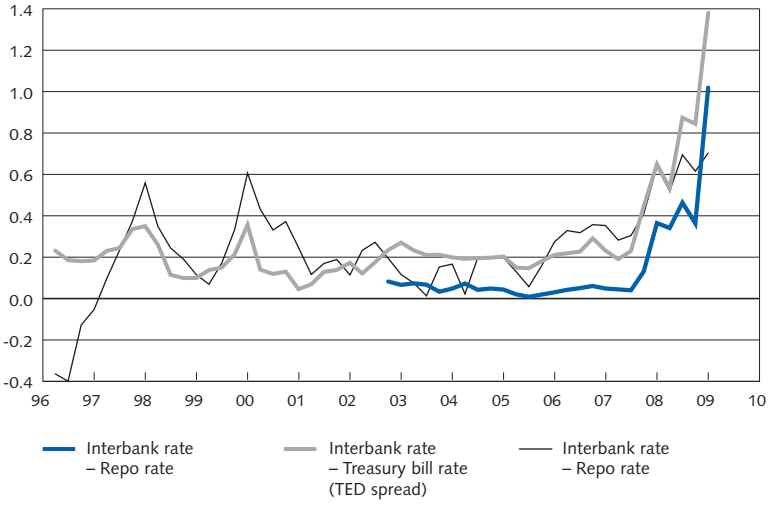
Sources: Reuters Ecowin and Sveriges Riksbank

[4] The terms Stibor and expected repo rate are described in the box "Stibor and Stina swaps".

Figure 2 shows the difference between the interbank rate and the repo rate as well as the TED and basis spreads.[5] Until mid-2007 the average quarterly TED spread was typically between 0.15 and 0.25 percentage points, with peaks in 1997 and 1999 of around 0.35 percentage points. In the latter part of 2007, however, the TED spread rose dramatically. In the fourth quarter of 2008 the average TED spread was about 1.35 percentage points. Since the end of 2008 interbank rates have fallen somewhat as the Riksbank has cut the repo rate (see Figures 9 and 10 later in the article). The spread against the treasury bill rate is, however, still higher than before the start of the financial turbulence. This indicates that the banks find it unusually risky to lend to each other. The development of the TED spread is therefore due in some part to the unusually high interbank rate, but also to the unusually low level of interest on treasury bills in relation to the repo rate.

The difference between the interbank rate and the expected repo rate, known as the basis spread, is probably a more accurate measure of the risk premium in interbank rates in the latest period. This has also risen steeply since 2007. Since mid-2007 the basis spread has risen from about

Figure 2. Interest rate spreads on the money market, three month maturities
Percentage points



Note: Quarterly averages. The interbank rate is Stibor, the expected repo rate is the rate for a Stina swap.

Sources: Reuters Ecowin and Sveriges Riksbank

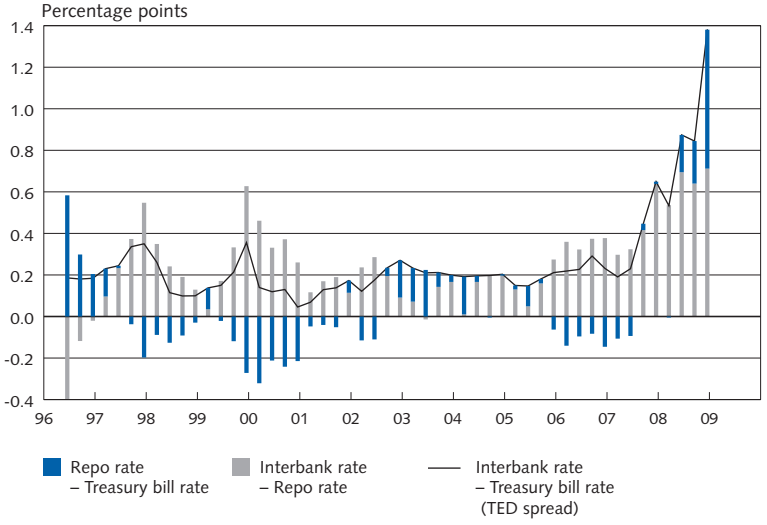
[5] The TED spread specifies the difference between the interbank rate and the expected repo rate. The basis spread specifies the difference between the three-month interbank rate and the expected repo rate. The term TED spread was originally used to describe the spread between the interest on an American three-month treasury bill (T-bill) and a "eurodollar contract" with the same maturity. Nowadays an interbank rate is usually used instead of the eurodollar rate.

0.05 percentage points to just over 1 percentage point. In the same period the difference between the interbank rate and the repo rate increased from about 0.3 to 0.6 percentage points. Since data on the expected repo rate are only available since the end of 2002 we focus on the TED spread in the following. As shown in Figure 2 the two interest rate spreads have exhibited a similar pattern during the financial crisis.

Figure 3 divides the total spread between the interbank rate and treasury bill rate into two components: the spread between the interbank rate and the repo rate and the spread between the repo rate and the treasury bill rate. The figure shows that the increase in the total spread can be explained partly by the fact that since mid-2007 the interbank rate has risen more than the repo rate, and partly by the fact that the treasury bill rate has risen more slowly than the repo rate. This may to some extent be because market participants have expected a transition to more expansionary monetary policy, but also because the risk appetite of market participants has fallen, which has led to increased demand for safe and liquid assets such as treasury bills. We will come back later to a more detailed analysis of the rise in the interest rate spread.

Thus interest rates on the interbank market seem to have risen more than can be directly explained by monetary policy.

Figure 3. Decomposition of interest rate spreads on the money market, three month maturities
Percentage points



Note: Quarterly averages. The interbank rate is Stibor.

Sources: Reuters Ecowin and Sveriges Riksbank

Stibor and Stina swaps

Stibor stands for Stockholm Interbank Offered Rate and measures interbank rates, that is the rates paid by banks when they borrow from each other for shorter periods. Stibor is not a true transaction based interest rate. Instead, the major commercial banks specify the interest rate for which they are prepared to lend money without collateral at short maturities (between one day and twelve months). Stibor is compiled by Nasdaq-OMX as an average of the offered rates (with the exception of the highest and lowest quotes). This is done every day at 11.00, and the Stibor Fixing is published at 11.05 for eight maturities from one day up to twelve months. Despite the fact that Stibor rates are not true market listings, and even if trade on the interbank market is largely concentrated on maturities of one week or less, Stibor is used as a basis for many different financial contracts. The level of the interbank rate is therefore an important indicator of the general interest rate level for short-maturities.

The expected repo rate is measured using the interest on a Stina swap, where Stina stands for Stibor Tomorrow/Next Average. It is based on the tomorrow/next rate, which runs from the next day to the following day. This rate historically lies close to the repo rate. A Stina swap is a contract in which one party pays a fixed interest rate to a counterparty and then receives the average tomorrow/next rate for an agreed maturity. That is to say, if the contract is determined for example for three months, party A undertakes to pay the three-month rate in force today to party B. Party B in turn undertakes to pay the tomorrow/next rate applicable every day for these three months. The interest rate on a Stina swap therefore reflects the market expectations for the tomorrow/next rate for the maturity. And since the tomorrow/next rate is close to the repo rate the interest rate on the Stina swap can be seen as a measurement of the expected repo rate for the period.

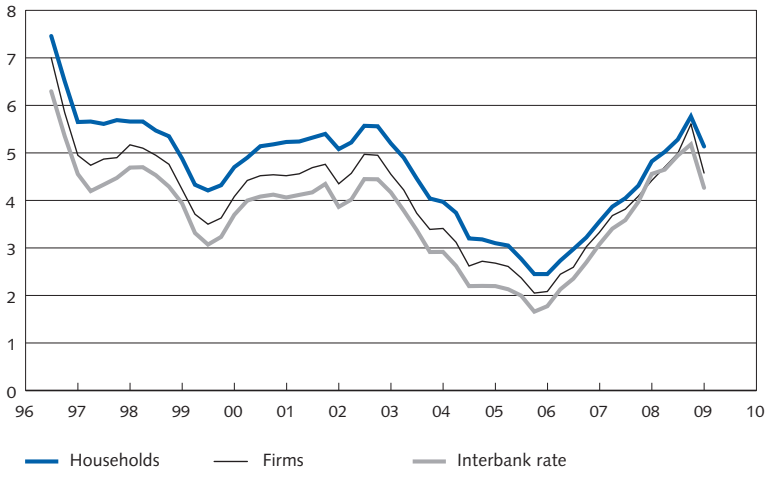
LENDING RATES WITH SHORT MATURITIES

The three-month interbank rate is a measure of the banks' short-term funding costs. It is shown in Figure 4 together with the mortgage institution rates for loans to households and firms with maturities up to three months. How changes in the interbank rate spill over to changes in lend-

ing rates to households and firms is the next step of the transmission mechanism. Figure 5 shows the spread between these lending rates and the interbank rate.

The mortgage institutions' lending rate to households is normally higher than that to firms. The most natural explanation for this is that the credit risk for lending to households is higher than for lending to firms. But it is also conceivable that transaction costs for lending to households

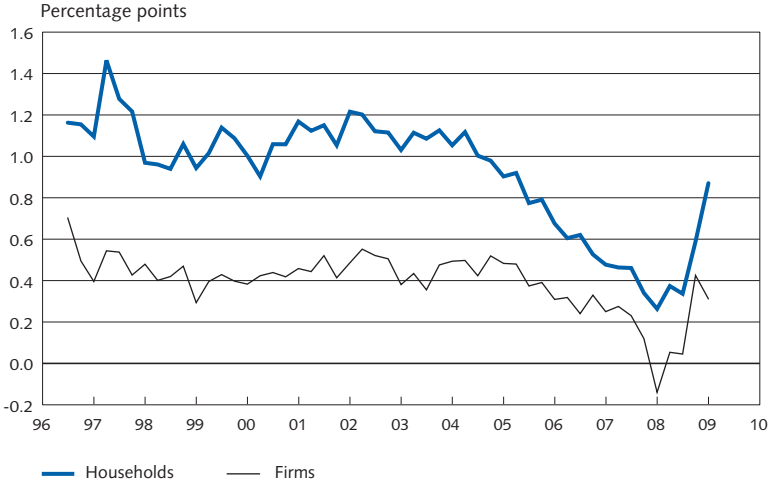
Figure 4. Mortgage institution lending rates to households and firms and the interbank rate, three month maturities
Per cent



Note: Quarterly averages. The interbank rate is Stibor.

Sources: Reuters Ecowin and Sveriges Riksbank

Figure 5. Spread between mortgage institution lending rates and interbank rate, three month maturities
Percentage points



Note: Quarterly averages. The interbank rate is Stibor.

Sources: Reuters Ecowin and Sveriges Riksbank

are greater than for lending to firms. The loan volume per firm is usually greater than per household, which can mean that the average cost of a loan to a household is higher than for a loan to a firm. Finally this may also be due to greater competition in the corporate loan market than in the household loan market.

Until the end of 2003 interest rates to households were on average 1.1 percentage points over the interbank rate, while the interest rate to firms was 0.45 percentage points over the interbank rate (see Figure 5). From 2004 the interest rate to households started to fall in relation to both the corporate rate and the interbank rate, and about one year later the corporate rate also started to fall. In the general rise in interest rates that started in late 2005, lending rates did not rise as fast as the interbank rate, so the interest rate spreads narrowed considerably. This may possibly have been because mortgage institutions eased credit terms, consciously took greater risks or estimated that the risks of lending had decreased.

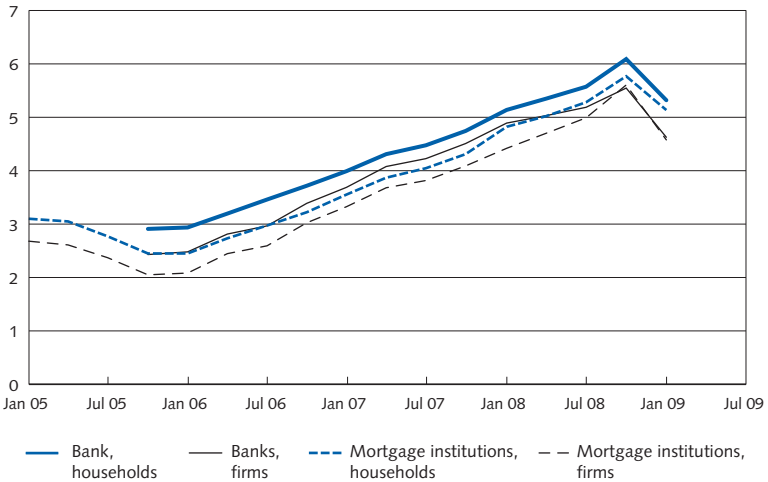
Interest rate spreads were smallest at the end of 2007, when interest on loans to households was only 0.26 percentage points more than the interbank rate and the corporate rate was 0.14 percentage points lower than the interbank rate. In 2008 interest rate spreads again increased, and the spread for corporate loans is now close to the historically normal level, while that of loans to households is still low from a historical perspective. Thus the rise in short-term lending rates reflects a return to more normal levels, after a period of very low interest rates in 2006 and 2007.

As we can see in Figure 1 the interbank rate has risen more than the government bond rates in the past year. Since the interbank rate affects lending rates this contributed to lending rates also rising more than government bond rates so that the spread between short-term lending rates and the repo rate and three-month treasury bill rate respectively has increased. Figure 4, however, shows that the greater spread in relation to government bond rates is due to a great extent to the rise in the interbank rate, making banks' borrowing more expensive.

Households and firms borrow not only from banks' mortgage institutions, but also directly from the banks. However, we only have access to data on banks' lending rates from the end of 2005. Figure 6 therefore compares mortgage institution lending rates to households and firms with maturities of up to three months with banks' lending rates with the same maturity for this period. The banks' lending rates are typically higher than those of the mortgage institutions, since mortgage institutions require housing as collateral for their loans. Otherwise the different lending rates follow the same pattern. The conclusions concerning mortgage institution lending rates probably also apply to banks' lending rates to households and firms.

Finally, Figures 7 and 8 show five-year interest rates for mortgages, mortgage bonds (i.e. mortgage institutions' borrowing rate with longer maturities) and government bonds. For natural reasons the mortgage rate is higher than the rate for mortgage bonds, which in turn is typically higher

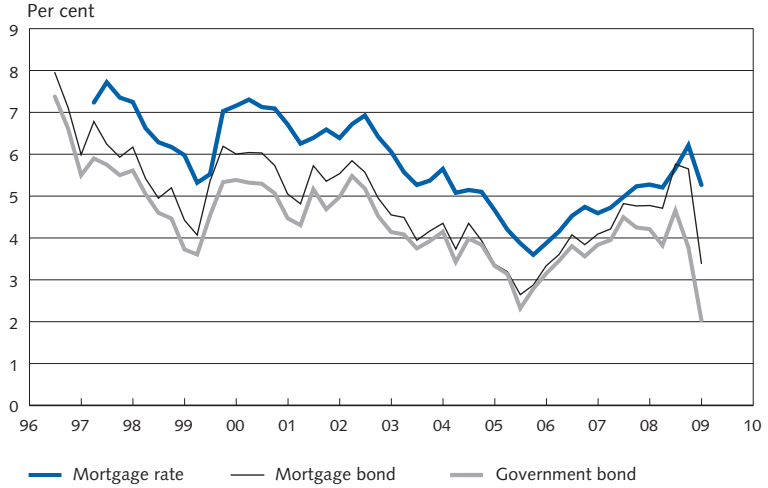
Figure 6. Mortgage institution and bank lending rates to households and firms, three month maturities
Per cent



Note: Quarterly averages.

Source: Reuters EcoWin

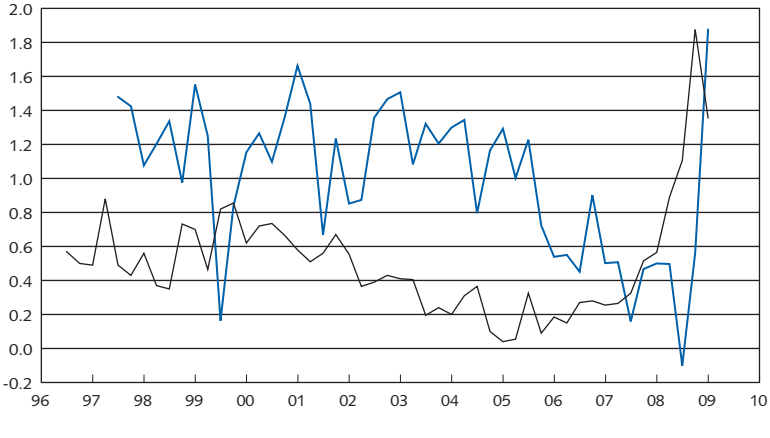
Figure 7. Interest rates on mortgages, mortgage bonds and government bonds, five year maturities
Per cent



Note: Quarterly averages.

Sources: Nordea, Reuters EcoWin, SBAB, SEB, Spintab, Stadshypotek and Sveriges Riksbank

Figure 8. Interest rate spreads between mortgages, mortgage bonds and government bonds, five year maturities
Percentage points



Note: Quarterly averages.

Sources: Nordea, Reuters EcoWin, SBAB, SEB, Spintab, Stadshypotek and Sveriges Riksbank

than the government bond rate. The first interest rate spread corresponds approximately to the banks' margin on long-term mortgages, while the second interest rate spread reflects the fact that investors require a higher risk premium to lend to mortgage institutions than to the government.

The interest rate spread between mortgage bonds and five-year government bonds was usually between 0.4 and 0.8 percentage points until 2003. In the same period the spread between the mortgage rate and the mortgage bond rate normally varied between 0.8 and 1.5 percentage points. However, when interest rates started to fall in 2002, the mortgage bond rate fell faster than the government bond rate and the mortgage rate fell even more sharply. Consequently, interest rate spreads fell to historically very low levels. The mortgage bond rate was at times lower than the government bond rate, while mortgage rates at their lowest were only 0.4 percentage points higher than the mortgage bond rate.

In mid-2007 the interest on mortgage bonds and mortgages started to increase in relation to government bonds. This was mainly because the government bond rate fell in the second half of 2007, while the mortgage rate and mortgage bond rate continued to climb. This can again be explained by the fact that market participants were more negative towards risk and sought safer investments. At the end of 2008 all these interest rates fell back, but bond rates fell faster than mortgage rates. Consequently, at the end of 2008 the difference between the mortgage rate and the mortgage bond rate, and in particular the interest rate spread

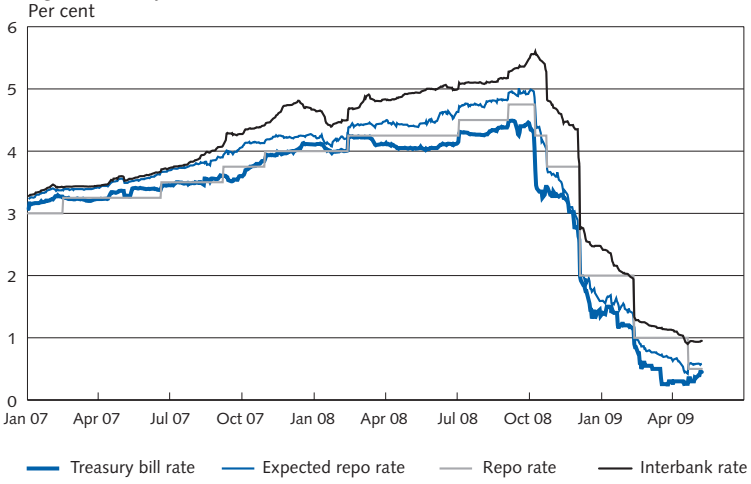
between mortgage bonds and government bonds, was great compared with historical levels.

To sum up, this review shows that market interest rates in 2007 and 2008 seem to have moved in a way that is to a lesser degree dependent on monetary policy. But this development started already in 2003–2004, when many market rates fell to historically very low levels in relation to interest rates on treasury bills and government bonds. The financial turbulence that started in the second half of 2007 has led to a rise in many market rates in relation to treasury bill and government bond rates. But at the same time treasury bill and government bond rates have also fallen to low levels, which probably reflects the fact that market participants are seeking safer assets. In most cases the rise in market rates has led to the normalisation of interest rate spreads in relation to government bond rates, and a return of banks' lending rates to more normal levels compared with the cost of banks' funding. One exception is the spread between the interbank rate and the treasury bill rate, which reached very high historical levels (see Figure 2). In the next section we attempt to explain why this interest rate spread has increased so substantially.

Why have interest rate spreads grown?

As we saw in the previous section, the spread between the interbank rate and the treasury bill rate increased from an average level of about 0.2 percentage points per quarter until mid-2007 to 1.35 percentage points at the end of 2008. If daily data is analysed instead, the rise is even more marked, which can be seen in Figures 9 and 10. The interbank rate peaked at a level almost 2.2 percentage points higher than the treasury bill rate. At the same time the banks' and mortgage institutions' lending rates have returned to more normal levels in relation to their borrowing rates; levels similar to those up to 2003. Since the banks' lending rates to a large degree are determined by their funding costs, including the interbank rate, we mainly need to understand the rise in interbank rates to be able to explain the rise in the banks' lending rates. This section aims therefore to explain why the interbank rate has risen so steeply since mid-2007 compared with the treasury bill rate.

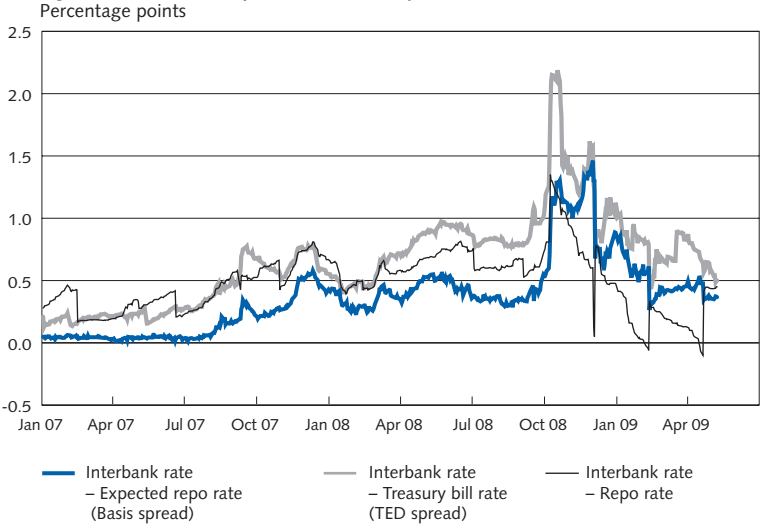
Figure 9. Money market rates, three month maturities
Per cent



Note: Daily data. The interbank rate is Stibor, the expected repo rate is the rate for a Stina swap.

Sources: Reuters Ecowin and Sveriges Riksbank

Figure 10. Interest rate spreads on the money market, three month maturities
Percentage points



Note: Daily data. The interbank rate is Stibor, the expected repo rate is the rate for a Stina swap.

Sources: Reuters Ecowin and Sveriges Riksbank

IS THE INCREASE UNUSUALLY GREAT?

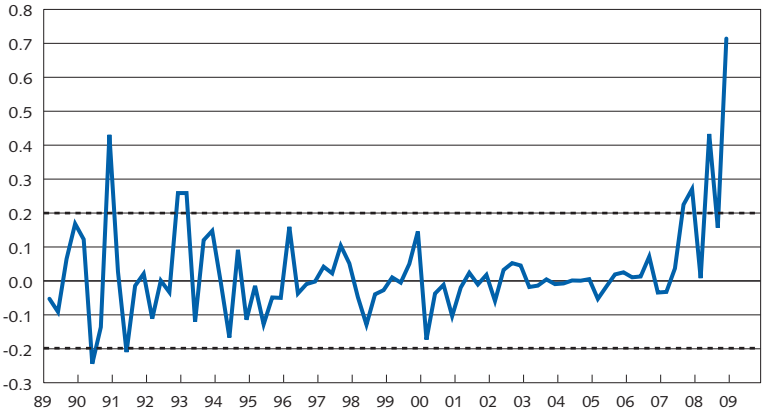
We start by examining whether the increase in the interest rate spread is unusually great from a historical perspective. We set up a simple statistical model for the spread between the interbank rate and the three-month treasury bill rate. The model describes how the interest rate spread develops over time as a function of the previous period's interest rate

spread and an unexplained disturbance. We first estimate the model for the period from the second quarter of 1987 up to the second quarter of 2007. We then use the model to make forecasts up to and including the end of 2008. The difference between the model's forecasts and the actual outcomes gives the series of disturbances needed to explain the observed interest rate spread.[6]

Figure 11 shows the disturbances (residuals) in our estimated model since 1987. The horizontal lines represent a 95 per cent confidence interval for the estimated disturbances. This means that we expect the disturbances to be outside the confidence interval once every 20 quarters. We see in the figure that this happens four times in the 20 years until mid-2007.

We also see, however, that many of the disturbances since mid-2007 ended up outside the confidence interval and that they were very great. The probability of getting such a sequence of disturbances is very low. For example, in the third and fourth quarter of 2007 the disturbances are 0.22 and 0.27 percentage points respectively. Given the observed disturbances until the second quarter of 2007 the probability of such great disturbances occurring two quarters in a row is less than one in 10 000. The disturbances in 2008 are even greater, so the probability of such a

Figure 11. Disturbance terms in a model for spreads between the interbank rate and treasury bill rate, three month maturities
Percentage points



Note: The broken lines represent a 95 per cent confidence interval.

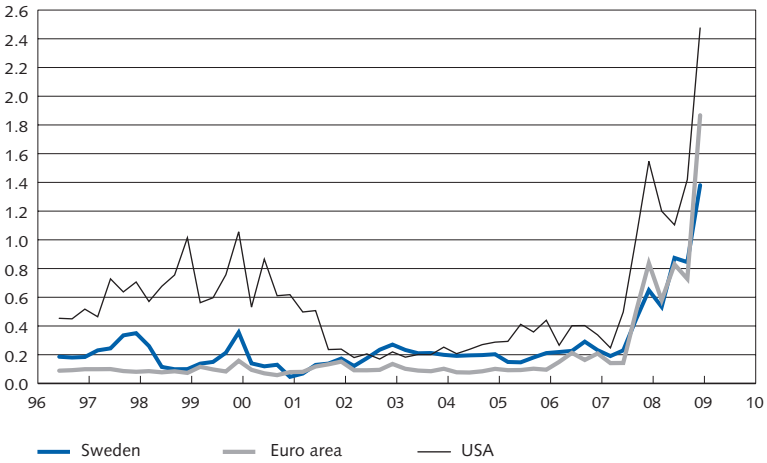
[6] The model can be expressed as $\delta_t - \delta = \rho\,(\delta_{t-1} - \delta) + \alpha\, d_{92:4} + \varepsilon_t$, where δ_t is the interest rate spread in quarter t, δ is its mode, $d_{92:4}$ is a dummy variable that takes the value one for the fourth quarter of 1992 and minus one for the first quarter of 1993 and ε_t is a residual (or disturbance). We estimate the model with the help of quarterly data from the fourth quarter of 1987 up to and including the second quarter of 2007 and make forecasts for the period from the third quarter of 2007 up to and including the fourth quarter of 2008. The estimated coefficients are $\rho = 0.72$ and $\alpha = 0.72$, which are both statistically significant at the one per cent level. The explanatory power of the regression (adjusted R^2) is 0.52.

sequence is even smaller. So there are strong indications that the interest rate spread has increased to an unusually great extent from a historical perspective.[7] We have made the same analysis of the spread between mortgage institution lending rates to firms and households and the treasury bill and government bond rates. The disturbances in 2008 are unusually great for these interest rate spreads too, though the results are not as strong as for the spread between the interbank rate and the treasury bill rate.

HOW CAN WE EXPLAIN THE INCREASE?

To attempt to explain the unusually great historical increase we need to take into account both domestic and international factors. The financial crisis is mainly rooted in problems in the US housing market that spread across the world. So it is natural to assume that the Swedish interest rate spreads to some extent are determined by international factors. This is suggested in Figure 12, which shows the Swedish three-month interest rate spread together with the interest rate spreads in the USA and euro area. The increase in the Swedish interest rate spread has not been as substantial as the increase in the international spreads. This is probably because foreign banks have been more exposed to the financial crisis than banks in Sweden. But the Swedish interest rate spreads may possibly to

Figure 12. Spread between interbank rate and treasury bill rate in Sweden, the USA and the euro area, three month maturities
Percentage points



Note: Quarterly averages. The euro area before 1999 refers to Germany, the interbank rate for Sweden is Stibor, the interbank rate for the euro area (Germany) and the USA is Libor.

Source: Reuters EcoWin

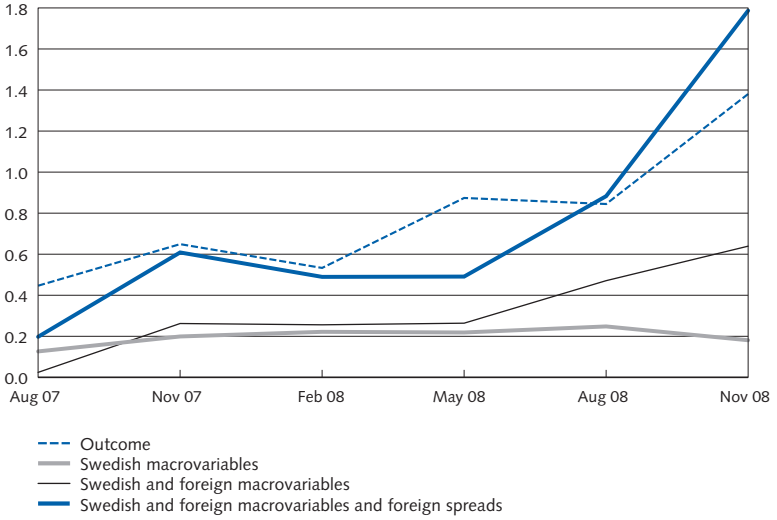
[7] An analysis of the American interest rate spread gives similar results, see Taylor and Williams (2009).

some extent also be due to Swedish conditions, such as fluctuations in the Swedish business cycle. In this sub-section we therefore examine how important Swedish and international factors have been for the increase in the Swedish interest rate spread.

We use an econometric model that explains the interest rate spread using Swedish macroeconomic variables (the repo rate, GDP growth and CPI inflation), foreign macrovariables (a weighted average of the same variables for Sweden's most important trade partners and the Swedish real exchange rate) and interest rate spreads in the USA and the euro area. We first estimate the model for the period from the first quarter of 1993 up to and including the second quarter of 2007. We then use the model to forecast the Swedish interest rate spread from the third quarter of 2007 to the fourth quarter of 2008.[8]

Figure 13 shows the actual increase in the interest rate spread since mid-2007. It also specifies the extent to which the increase can be explained by Swedish macrovariables (excluding the exchange rate), foreign macrovariables and foreign interest rate spreads respectively. Measured as a quarterly average the interest rate spread has increased by

Figure 13. Outcome and forecast for spread between interbank rate and treasury bill rate, three month maturities
Percentage points



Note: Quarterly averages.

[8] Our model can be expressed as $\delta_t - \bar{\delta} = \alpha_1(L)(z_t - \bar{z}) + \alpha_2(L)(z^*_t - \bar{z}^*) + \alpha_3(\delta^*_t - \bar{\delta}^*) + \varepsilon_t$, where δ_t is the Swedish interest rate spread in quarter t, z_t is a vector with Swedish macrovariables, z^*_t is a vector with foreign macrovariables and δ^*_t is a vector with the interest rate spreads in the USA and the euro area. The coefficients $\alpha_1(L)$ and $\alpha_2(L)$ are lag polynomials with four lags, so the regression contains the macrovariables in quarters t to t–4. All variables are measured as deviations from their modes ($\bar{\delta}$ and $\bar{\delta}^*$) and average values respectively ($\bar{z}$ and $\bar{z}^*$) over the period from the first quarter of 1993 up to and including the second quarter of 2007. The models with all variables have an explanatory power (adjusted R^2) of 0.48.

about 1.1 percentage points since mid-2007 (from 0.25 to 1.35 percentage points). This increase cannot by and large be explained by developments in the Swedish economy: the Swedish variables contributed to the interest rate spread by 0.20 percentage points during the whole period. About half of the increase, 0.65 percentage points, can, however, be explained by Swedish and foreign macrovariables together. When we also include foreign interest rate spreads in the regression the model produces a forecast for the interest rate spread that is higher than the actual spread; about 1.75 percentage points. Thus, when we analyse quarterly averages the entire increase in the interest rate spread can be explained by a small number of variables, and Swedish factors do not seem to have contributed much to the increase. The increase rather seems to be largely due to developments in other countries, and in particular to developments in foreign financial markets.

Empirical studies of the American interest rate spread indicate that the wider spread in the USA can be explained by an increase in counterparty risk in the banking sector. This means that the American interbank rates seem to have risen because lending between banks has become more risky as uncertainty about the macro economy, financial markets and possible credit losses has increased.[9] Our results indicate that this uncertainty has also spilled over into the Swedish financial markets. It may be because Swedish banks also conduct business abroad and therefore invest in the same assets as foreign banks. When the risk of such investments grew, Swedish banks were also affected. But they were affected somewhat less than foreign banks, which was probably because the Swedish banking sector as a whole was less exposed to the riskiest assets.

Has the financial turbulence affected the monetary policy transmission mechanism?

Since summer 2007 interest rates on the interbank market and banks' lending rates have increased substantially compared with the repo rate and treasury bill rate. We have shown that the increase in the spread between interbank rates and treasury bill rates is to some extent due to the fact that the latter have fallen to low levels compared with the repo rate. We have also shown that the increase in the interest rate spread to a great degree was driven by foreign factors rather than Swedish conditions.

If market rates largely reflect other factors than Swedish monetary policy there is, however, a risk that the Riksbank's changes in the repo

[9] See Taylor and Williams (2009) and Wu (2008).

rate will not affect market rates in the way that can normally be expected. Consequently the effect on the rest of the economy will not be that expected either. In that way financial turbulence could weaken the monetary policy transmission mechanism. But even if the interest rate spread in Sweden can largely be attributed to foreign factors the Riksbank could counter the increase in interbank rates by cutting the repo rate. Recent developments also indicate that monetary policy still has a great effect on the interbank rates and consequently the other market rates.

If we go back to Figures 9 and 10 we can see how the monetary policy decisions have affected the interbank rate and three-month treasury bill rates. The increases in the repo rate in 2007 did not have any great effect on market rates, but seem to have been predicted by the market participants. On the other hand, the tightening in February 2008 seems to have been unexpected. This led to major upward adjustments of the treasury bill rate (which rose by 0.24 percentage points), the interbank rate and the expected repo rate (which both increased by 0.17 percentage points). In the same way, market rates rose somewhat after the repo rate increases in July and September in the same year.

Since the start of financial turbulence in mid-2007 the interbank rate has, however, risen more than the treasury bill rate and the expected repo rate. The spread between the interbank rate and government bond rate increased from about 0.3 percentage points in July 2007 to more than 1 percentage point at the beginning of October 2008, while the spread between the interbank rate and expected repo rate increased from about zero to 0.6 percentage points. The repo rate reduction early in October led to a steep fall in the treasury bill rate (by 0.35 percentage points) and in the expected repo rate (by 0.24 percentage points), but it had no effect on the interbank rate, which rose somewhat instead. This monetary policy expansion thus had little or no effect on the interbank market. The spread between the interbank and treasury bill rates initially increased from 1.5 to 1.9 percentage points, and subsequently somewhat more in the following days. The spread between the interbank rate and the expected repo rate increased to just over 1.1 percentage points.

The spread between the interbank and treasury bill rates did not decrease until the Riksbank cut the repo rate once more by 0.5 percentage points at the end of October. The interest rate on the interbank market then fell by 0.45 percentage points. The interest rate spread in relation to treasury bills then decreased from 1.8 to 1.4 percentage points, but it still remained at a very high level. The spread between the interbank rate and the expected repo rate did not change much, however. It decreased by about 0.1 percentage points.

The vigorous monetary policy stimulus in December, when the Riksbank cut the repo rate by 1.75 percentage points to 2 per cent, had a great effect on both the interbank rate and the treasury bill rate. The three-month treasury bill rate and the expected repo rate started to fall already in the middle of November, when it was regarded as increasingly probable that the Riksbank would cut the repo rate in December. The interbank rate also fell somewhat in November. At the beginning of December the interbank rate fell substantially (by 0.45 percentage points) when the Riksbank announced that the monetary policy meeting had been moved from 16 December to 3 December, and when the decision was published it fell by a further 1.07 percentage points. The treasury bill rate, which was more than 1.10 percentage points lower than the repo rate before the December decision, fell by 0.7 percentage points when the decision was announced.[10] The expected repo rate also fell steeply by about 0.6 percentage points.

After the cut in the repo rate to 2 per cent in December 2008 the treasury bill rate stabilised around 1.5 per cent and the interbank rate around 2.5 per cent. At the end of 2008 the interest rate spread was therefore around 1 percentage point, which is the same level as at the beginning of October 2008, while the spread between the interbank rate and the expected repo rate was around 0.8 percentage points, which was about 0.3 percentage points higher than at the beginning of October. In the first months of 2009 the interbank rate has continued to fall faster than both the treasury bill rate and the expected repo rate. The interbank rate fell by 0.6 percentage points after the repo rate was cut by 1 percentage point in February 2009. The interest rate spread in relation to treasury bills was then about 0.4 percentage points and in relation to the expected repo rate 0.3 percentage points, which were the lowest levels since February 2008. The interest rate cut in April 2009 of 0.5 percentage points brought no major changes in the interbank rate, while both the treasury bill rate and expected repo rate rose by about 0.1 percentage points. This reduced the spread between the two interest rates and the interbank rate by about the same.

This review thus shows that the Riksbank can still affect the level of market rates, even if the spread between market rates and the repo rate in the present circumstances seems also to be influenced by other factors. The high interest rate spreads mean, however, that the Riksbank needs to set a lower repo rate to achieve the same desirable level of market rates than in more normal circumstances. This may be a problem when the

[10] The treasury bill rate did not fall until the day after the decision in December. That is why the interest rate spread first narrowed considerably before increasing again.

repo rate approaches zero and cannot be reduced any more, since the general interest rate level then is higher than would have been the case in more normal circumstances in the financial markets. It may therefore be desirable for the Riksbank and other institutions to take other steps to reduce interest rate spreads. The article by Söderström and Westermark in this issue of Sveriges Riksbank Economic Review discusses in more detail how monetary policy can be conducted when the key interest rate is zero.

Summary and conclusions

Monetary policy mainly affects the economy by changing the general interest rate level. A tightening of monetary policy (an increase in the repo rate) leads to higher interest rates in the economy, which in turn reduces the aggregate demand for goods and services through a number of different channels. We describe these channels in detail in a separate article in this issue of Sveriges Riksbank Economic Review.

From mid-2007 to the end of 2008 many market rates moved in a way that did not seem to be directly due to monetary policy. This applied to interest rates in the interbank market, treasury bill rates and banks' and mortgage institutions' lending rates to households and firms. The interbank rates rose steeply as a result of the international turbulence in the financial markets, and there is much to indicate that the increase in Swedish interbank rates to a large extent was due to international rather than Swedish factors. Treasury bill rates fell steeply, probably more than can be attributed to the effect of monetary policy. This can possibly be explained by increased demand from market participants for safe and liquid assets. The banks' and mortgage institutions' lending rates also rose in relation to interbank market rates and interest rates on treasury bills and government bonds. But these interest rate spreads grew from very low levels in 2004–2005, and are now back to historically normal levels.

Even if interbank rates rose compared with the repo rate and treasury bill rates, and this increase is mainly due to international factors, Swedish monetary policy still appears to have a great effect on interest rates in the interbank market and hence on other market rates. The monetary policy stimulus that has taken place since October 2008 has had a great impact on fixed income market rates, even though some interest rate spreads continue to be greater than before the outbreak of financial turbulence. Consequently, our conclusion is that monetary policy has not become ineffective in the financial turbulence and subsequent financial crisis. However, our analysis indicates that it is difficult to reduce interest rate spreads using only Swedish monetary policy measures. Recent developments indicate that extensive global measures are required before the

crisis in the international financial markets can be alleviated, and that the repo rate level therefore needed to be cut drastically to achieve a desirable interest rate level in the interbank market. As the repo rate is now approaching its lower limit and cannot be reduced much more, it may be relevant for the Riksbank to take other steps to try to influence the interest rate level in the Swedish economy.

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The connection between IT investments, competition, organisational changes and productivity

Bengt Pettersson

The growth of productivity in Sweden was high from the early 1990s up to 2006. Studies of development in the USA indicate that previous IT investments, organisational changes and internal training have played a decisive role in the strong growth of productivity since the mid-1990s. This article addresses the preliminary main results of a project at the Riksbank on the factors behind the earlier strong growth in productivity in Sweden. The working hypothesis in the project – and the question that is posed in this article – is whether the productivity growth trend in Sweden can be explained by factors similar to those in the USA. The results support this view. They show that the spread of IT investments throughout the economy is not sufficient to increase the productivity growth trend. Complementary investments in organisations and human capital are also required. It is only then that the companies can gain the greatest possible benefit from the IT investments.

IT investments and productivity

Between 1992 and 2008, the labour productivity[1] trend increased more rapidly in Sweden than in most comparable countries. It also increased rapidly in the USA from and including the mid-1990s. Studies of development in the USA indicate that a combination of IT investments, organisational changes and internal training may explain the strong growth in productivity. An interesting question is to what extent there are similar

[1] Productivity aims to measure the amount of goods and services that can be produced for a given input of production factors. A higher level of productivity means that production is increasing more rapidly than the input of production factors, that is that the available resources in the form of capital and labour are being used more efficiently. There are different ways of doing this. The most common measure of productivity is labour productivity. Labour productivity is usually measured as production in relation to the number of employees or to the number of hours worked. In Europe, the measurement method based on the number of employees predominates. In the USA the predominant method is the one based on the number of hours worked. These two methods may provide different results.

factors behind the development in these two countries. This is also the question addressed in the Riksbank's productivity project, which was initiated in the autumn of 2005.

Investments in IT were considerable already in the 1970s and 1980s. This applies to both personal computers and fibre optics, as well as to wireless communication and the Internet.[2] The first computer was introduced as early as 1945. It was some time, however, before any effects on productivity were noted.[3] The turning point came in the USA in the mid-1990s. The productivity growth trend in the USA increased and between 1995 and 2007 averaged 1.8 per cent per year.[4] Between 1971 and 1994, it had averaged 1.1 per cent.

Studies of development in the USA indicate that it was IT investments in combination with organisational changes and internal training that lay behind this increase.[5] It is probable that these effects on productivity became possible thanks to the great flexibility, or adaptability, of the US economy. A flexible labour market makes it easier for companies to reorganise with the aim of drawing the greatest possible benefit from, for example, the IT investments made. Companies in the USA have probably been forced to make these changes in order to increase efficiency so that they can survive in the face of the fierce competition that prevails on the US market. Once these changes have been made and spread throughout the economy, they have had positive effects on trend productivity growth.

As used here, the term trend productivity growth refers to long-term, sustainable growth and not to short-term changes that can be explained by fluctuations in economic activity. If there is an upturn in economic activity, it often takes some time before the companies are sure that the increase in demand will last. They may then wait to expand their production capacity which – if production increases – means per definition that productivity will increase in the short term. The opposite often occurs in connection with downturns in economic activity, that is the companies are cautious about making employees redundant during a downturn before they are sure that the decrease in demand will last. These effects are, however, short term and do not reflect structural changes.

In Europe, productivity growth has long been significantly weaker than in the USA, even though there are some exceptions such as Sweden (see Figure 1).

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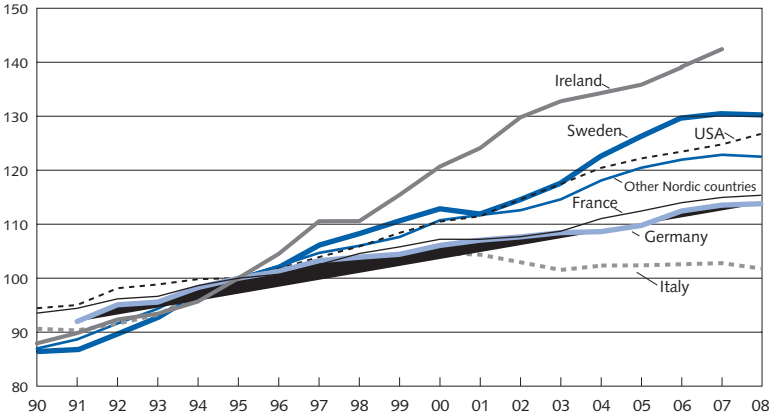
2 See Ferguson, BIS Review 1/2004.

3 Many economists wondered when the effects would become tangible. One example is Robert Solow, …"we see the computer age everywhere except in the productivity statistics"…, New York Times Book Review, 12 July 1987.

4 According to OECD statistics. Production per employee in the total economy.

5 See Bart Van Ark (2006), Brynjolfsson (2003).

Figure 1. Productivity in various regions 1990–2008
Index 1995=100



Note: The figure shows production per employee in the total economy according to internationally-comparable statistics. In the case of Ireland, no statistical outcomes are available for 2008.

Source: OECD.

It can be noted that productivity in Sweden increased more rapidly between 1992 and 2008 than in most other countries in the OECD area. According to OECD statistics, productivity in Sweden increased by an average of 2.4 per cent per year during the period.[6] At the same time, productivity also increased rapidly in the other Nordic countries and in the USA and Ireland. A common factor for these countries is that they have all invested heavily in IT. They have also implemented far-reaching structural reforms, including deregulation and privatisation processes that have increased competition. Studies conducted by the OECD indicate that there is a clear positive link between competition and productivity.[7] Greater competition forces companies to find new ways of retaining their market shares, which increases the likelihood that they will reorganise. The companies may thus have been forced to reorganise and train their personnel in order to draw the most benefit from the IT investments they have made.

Given this background, the question that can be asked is whether a combination of IT investments, organisational changes and internal training can, as in the case of the USA, explain the high growth in productivity in Sweden.[8] Here it is worth noting that productivity growth in the USA was strong both in the sectors that produce IT and in those that use it to a great extent, for example the retail and financial sectors. There are also

6 Here expressed as production in relation to the number of employees.
7 See, for example, various annual issues of "Economic Policy Reforms, Going for Growth".
8 The high growth in productivity in the 1990s may of course also be explained by the recovery process following the recession in the early 1990s. It is easier to increase productivity in an upturn than in a downturn. The interesting thing is, however, that the productivity growth trend was also strong during most of the previous decade.

studies that show that it has been possible to confirm similar effects in the UK.[9]

In contrast to the USA, the Nordic countries and Ireland, productivity growth in the major euro countries – Germany, Italy and France – has been weak over the last ten years. There is no real consensus in the research as to why the development of productivity in these countries has been so weak compared with development in the USA.[10] It can, however, be noted that factors common to these countries are that their IT investments as a percentage of GDP have not been as large as in those countries with higher productivity growth mentioned above and that deregulation and privatisation processes have not been as extensive.[11]

Research on the link between IT investments, work organisation and productivity has generally intensified over the last six to eight years. An increasing number of studies are reaching the conclusion that there are clear positive links between these factors.[12] Studies show that a strict labour market policy may be an obstacle to the positive effects of IT investments spreading throughout the economy.[13] This may explain the difference between the strong development of productivity in the USA and the weak development in the euro area. Strict labour market legislation makes it more difficult for the companies to adapt their organisations and may prevent the realisation of all the measures that would otherwise improve efficiency. It is interesting to note in this context that Swedish companies are rated highly with regard to the degree of decentralisation of decision-making and responsibility.[14] A decentralised structure may be a factor that makes it easier to conduct the change process in companies that have invested in advanced technology even in countries that have – at least on paper – a rigid labour market policy. [15]

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9 See Crespi, Criscuolo and Haskel (2007) and Caroli and Van Reenen (2001).

10 See Van Ark (2006).

11 See, for example, OECD's country reports and the European Commission's evaluations of countries in the Lisbon process.

12 Several studies indicate that there is a need for complementary investments in organisation and internal training in order for the companies' IT investments to achieve their full impact (see, for example, Bart Van Ark (2005), Brynjolfsson (2003)). Studies based on US data show that work routines, further training, and the use of IT are important determinants for productivity (see, for example, Björn Andersson and Martin Ådahl, Sveriges riksbank Economic Review 2005:1). The percentage of employees that use computers in their work and their level of education are factors that have a positive impact on productivity (see Black, Lynch (2001) data for the period 1987-1993). Studies also show that the greatest positive effects of reorganisation processes on productivity occur in companies with a high percentage of highly-educated labour (see Caroli, Van Reenen (2001). The level of education of the employees of a company is decisive not only in terms of making it possible to rapidly reap the benefits of new technology but also for reorganisation processes leading to positive effects (Aghion, Caroli and Garcia-Penalosa (1999). One study also shows that US multinational companies in the UK are more productive than British companies. The explanation may be that US companies export their organisational structures to subsidiaries in other countries (see Bloom, Sardun and Van Reenen (2007). Evidence of similar positive effects has been found in Sweden (see Karpaty (2007).

13 Bloom, Sadun and Van Reenen (2007).

14 See Bloom, Van Reenen (2007).

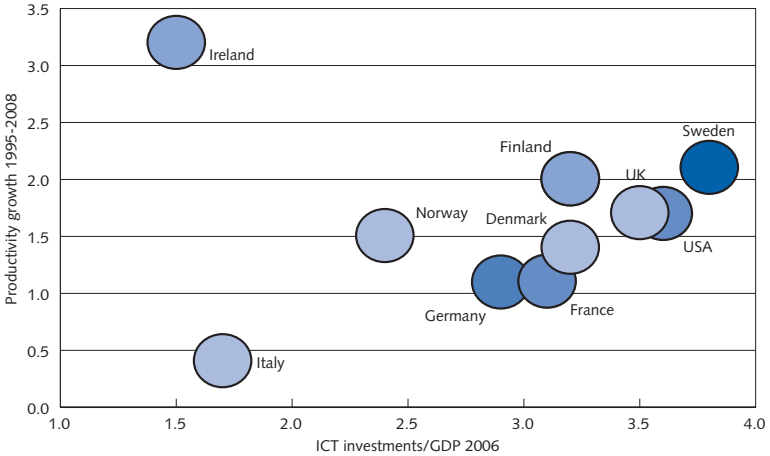
15 See Bresnahan, Brynjolfsson and Hitt (2002). Similar conclusions are drawn by Lindbäck and Snower (2000), Black and Lynch (2001) and Kling (1995).

So what is the relationship between IT investments and productivity on the one hand and between the flexibility of the companies and productivity on the other?

IT INVESTMENTS AND PRODUCTIVITY

Those countries that have invested a lot in Information and Communication Technologies (ICT) have also experienced high productivity growth over the last ten years. ICT investments as a percentage of GDP were high in Sweden in 2006 in comparison with other countries (see Figure 2). The difference was even greater, in Sweden's favour, in the early 2000s. The relative positions of the countries changed only marginally between 2002 and 2006 however. Those countries that had the highest percentage of ICT investments in 2002 were also those that had the highest percentage four years later.

Figure 2. ICT investments 2006 and annual average productivity growth



Note: Investments in ICT as a percentage of GDP. This statistic has served as an indicator for IT investments. Annual average productivity growth refers to labour productivity expressed as production in relation to the number of employees. The statistics are comparable between countries. In the case of Ireland, no statistical outcomes are available for 2008.
Source: Eurostat and the OECD.

Examples of countries with high IT investments and high productivity growth are the Nordic countries, the UK and the USA.

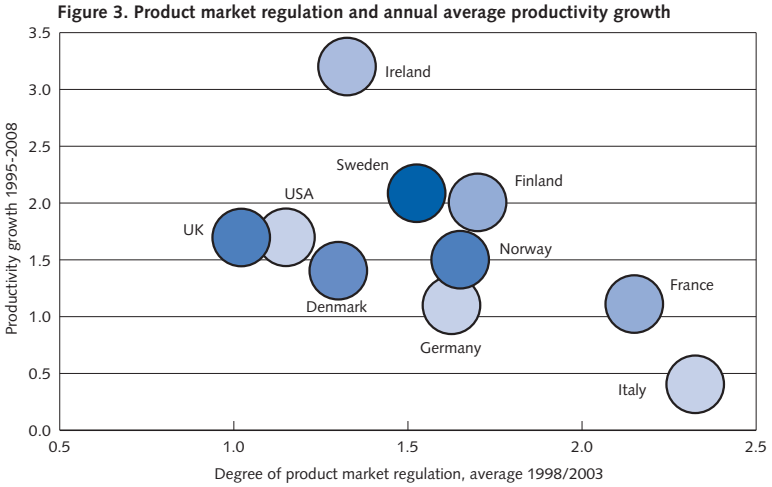
DEREGULATION AND PRODUCTIVITY

Those countries in which IT investments and productivity growth have been high have also implemented extensive deregulation processes and

economic reforms.[16] Some countries did this in the 1980s, some in the 1990s and some in the 2000s. Examples of countries that have done this and where the degree of regulation is low in international terms include the USA, the UK, Sweden, Finland and Denmark (see Figure 3).

Italy is an example of a country with low productivity growth, low ICT investments and a relatively high degree of regulation. France, on the other hand, has experienced relatively low productivity growth despite a relatively high percentage of ICT investments. A possible explanation of this is that the French economy is still relatively high regulated and that this prevents the companies from drawing the maximum benefit from their ICT investments. This is indicated in Figure 3. In Germany, productivity growth has been relatively low despite the fact that the economy is fairly deregulated compared to the average for the other countries and that ICT investments have been relatively high. The development of productivity in Germany has not, however, deviated very much from the links indicated in Figure 2.

Figure 3. Product market regulation and annual average productivity growth



Note: Product market regulation is presented using an average index for the years 1998 and 2003 in accordance with the OECD's "Going for Growth". The higher the index, the higher the degree of product market regulation there is assessed to be in the economy concerned. Here, product market regulation has been assumed to be a good indicator of the total degree of regulation in an economy. This statistic provides the same picture of the position of the countries in relation to each other as in the "World Economic Forum Global Competitiveness Index" 2001-2008 and the European Commission's annual evaluations of the Member States in the Lisbon process. Annual average productivity growth refers to labour productivity expressed as production in relation to the number of employees. The statistics are comparable between countries. In the case of Ireland, no statistical outcomes are available for 2008.

Source: OECD

[16] European politicians have noted the weak productivity growth trend in the EU and the negative effects on welfare. The propagation of the IT society and the promotion of research, innovation and deregulation with the aim of increasing competition are therefore central elements of the EU's Lisbon Strategy, which was adopted in 2000. The aim is to increase the potential for growth and employment in the Member States. Obviously, European politicians see a need to orient economic policy towards stimulating higher trend productivity growth.

The country where the link between ICT investments and productivity growth is not as clear as in other countries (at least according to official statistics) is Ireland. Despite low ICT investments (according to statistics from Eurostat), productivity growth in Ireland has been very high. This could possibly be explained by a "catching up" effect. At the end of the 1980s, Ireland was well down the OECD's world ranking in terms of GDP per capita. Overall, the Irish economy has since grown very rapidly from this low level. Structural reforms and a more effective economic policy have contributed to a situation in which average growth has been very high over a long period of time.[17] Economic policy has, among other things, aimed to attract foreign capital by offering very low levels of taxation for foreign companies. The Irish economy has become more open and foreign trade as a percentage of GDP has increased significantly. Ireland is thus competing more and more on the international market. The powers of the competition authority have been increased and competition has been strengthened.[18] Figure 3 also indicates that there is a positive link between deregulation and productivity growth in the case of Ireland.

It thus appears that there are positive links between IT investments, competition and productivity growth. The results of studies of other countries indicate that increased competition is a factor that forces the companies to implement organisational changes with the aim of drawing the greatest benefit from their investments. This appears to lead to increased long-term growth in productivity.

IT investments, flexibility and productivity in Sweden

Figures 2 and 3 above indicate that the high productivity growth trend in Sweden since the mid-1990s can at least in part be explained by the same factors as in the USA. The results of a recent Swedish study, funded by the Riksbank, show that there is a positive link between IT investments and organisational changes on the one hand and productivity in Sweden on the other, at least in the 2000s.[19] The study has used questionnaires to investigate how 120 companies have invested in IT during the 2000s, to what extent they have changed their organisation and, finally, the educational level of their employees. The study shows that productivity growth, with a certain time lag, was much higher in those companies that invested in IT above the median value and carried out reorganisations compared

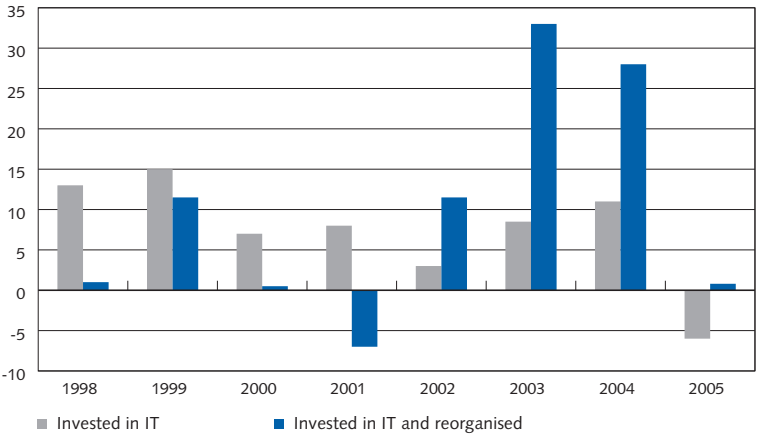
[17] See OECD Economic Surveys: Ireland 1999, pp 61–62.
[18] See OECD Economic Surveys: Ireland 2003, pp 84–85.
[19] Sveriges riksbank, June 2009, Working Paper No. 230, Christina Håkanson. This Working Paper is an important part of the Riksbank's productivity project which was initiated in the autumn of 2005 and has been underway since the spring of 2006. Bengt Pettersson at the Riksbank is responsible for the project.

to those that did not change their organisation (see Figure 4). The reorganisations investigated in the study were implemented between 2000 and 2002, although the majority were carried out in 2001. IT investments have been measured for the same period. The fact that the positive impact of IT investments and reorganisations on productivity is not immediately evident in 2001 is probably because it takes time for the employees of the companies to adapt to and learn from the new situation.[20] In the short term – in this case this largely means within the same year – the impact on productivity may even be negative.

An interesting observation in the study is that those companies that have implemented reorganisations – but not invested so much in IT – do not exhibit any statistically significant effects on productivity.

However, the results of the study should be interpreted with a certain degree of caution. The number of companies included in the study is small and the period 2000-2002 was a period of low economic activity in Sweden in connection with the dotcom crash. It can not be ruled out that a number of companies, particularly in the IT sector, were forced to reorganise for this reason alone and not as a result of needs that arose in connection with IT investments. The companies analysed in the study

Figure 4. Productivity growth (TFP) for companies with high IT investments who have carried out organisational changes and those that have not reorganised respectively
Annual percentage change



Note: TFP stands for total factor productivity. The change in total factor productivity is usually calculated as the change in value added divided by the overall change in the number of hours worked and the capital stock. This provides a measure of the production increase that is not due to an increase in the input of labour or an increased supply of capital. Total factor productivity is used to analyse the entire economy or large aggregates. Here, the reorganisations have been measured during the period 2000-2002, although most were carried out in 2001.

Source: "Effects of Organisational Change on Firm Productivity", Christina Håkanson

[20] See Brynjolfsson (2003).

are, however, by no means concentrated to the IT sector but represent a broad spectrum of sectors in the Swedish economy.

It is, however, important to point out that the growth in productivity in Sweden since 1992 can also be explained by a number of other conceivable factors than those presented above. The IT sector grew rapidly in Sweden in the 1990s. It is therefore probable that it is productivity in the IT-producing sector rather than in the IT-using sector that accounts for the main part of the increase in productivity, at least in the 1990s. Another conceivable explanation may be that there was a natural recovery in the growth of productivity after unproductive companies went to the wall in connection with the financial crisis in the early 1990s.

It appears, however, that development in Sweden, the other Nordic countries and the USA differs from that in the euro area. There are clear similarities between development in Sweden and the USA. This may be surprising given the considerable differences that exist regarding the degree of regulation on the labour market. A flexible labour market has probably facilitated the restructuring of the companies in the USA. In the field of labour market legislation, the similarities are actually greater between Sweden and the euro area. One factor that could explain the ability of Swedish companies to also benefit substantially from IT investments by means of organisational changes may be that the organisational structure of Swedish companies differs from that in the euro area. International studies show that the structure in Sweden is much less hierarchical.[21] This could be a factor that makes it easier for company managements to get support for the organisational changes required to make the most of the IT investments made.

How long can the effects of the new technology last?

Following the long period of strong trend productivity growth in Sweden since the early 1990s, productivity declined in 2007. The development of productivity has been weak since then. It is difficult to say how long it will be before there is an upturn in productivity and to what extent the slowdown in Sweden is a sign of a decrease in trend productivity growth. It is still too early to determine whether the downturn in productivity in Sweden is only due to temporary variations in connection with short-term fluctuations in the economy. Companies do not always adapt immediately and completely to changes in demand as, for example, in connection with the most recent economic downturn.

[21] See Bloom, Van Reenen (2007).

Historically speaking, it has taken a long time for the positive effects of previous technological shifts on productivity to become apparent. For example, it took 20 to 30 years before the industrial revolution and electricity had an impact on productivity. One of the reasons for this may have been that the economic value of new technology and the possibility to benefit from it was underestimated.[22] There are several examples that illustrate that it takes a long time for new technology to have an impact on productivity. The steam engine was invented already in the 1700s, long before it had any tangible effect on the production process in, for example, the USA.[23] The construction of railways began in the USA in the 1840s, but it also took a long time before they had any effect on productivity.

The reason that the lead times between technological shifts and productivity are so long is that complementary research is often needed to demonstrate the potential practical applications of the new technology. The dissemination of new technology has often been slow to start with as the initial investments have been expensive and it has taken time for them to provide a return. As mentioned earlier, in the short term these investments often have a negative effect on productivity as it takes time to learn to use the new technology in the right way.

A clear example is electrification in the USA at the end of the 1800s. It took several decades to determine the best way to use electricity in production. It took a long time before people realised that the factories had to be converted in order to able to exploit all the advantages of electricity. Instead of building multi-storey factories where the power source was centrally located, it was realised that flexibility would be improved by giving each workplace or production line access to its own power source when this was made possible by electricity.[24] This in turn made it possible to optimise the use of materials and to change the production process when necessary, and it also enabled the maintenance of separate parts of the production apparatus without needing to shutdown the entire process.[25]

However, once the companies have learned the best way to benefit from the new technology, the effects have often lasted for several decades. This could indicate that there is still potential for a continued high level of trend productivity growth. It is difficult, however, to draw any

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[22] Examples of this are: "What shall we do with a toy like that?" – Western Telegraph Company in response to Graham Bell's offer to sell his telephone patent for USD 100.000 in 1877. A few years later the company offered to pay USD 25 million for the patent but Bell rejected the offer. I think there is a world market for maybe five computers." – Thomas Watson, President of IBM in1943. "There is no reason anyone would want a computer in their home." – Head of Digital Equipment Corp. 1977.

[23] See Ferguson 2004.

[24] See, for example, Kroszner 2006.

[25] See David 1990.

clear conclusions. The long-term growth of productivity depends, among other things, on the scope available for companies to further increase the use of ICT in their production, how efficiently the ICT investments are used and how this efficiency spreads throughout the companies. There is also a lack of statistics for the last few years on what organisational changes the companies have made in order to gain the greatest possible benefit from their investments. It is therefore difficult to draw any far-reaching conclusions on the future prospects for long-term productivity growth.

Conclusions

There are signs that a combination of IT investments and organisational changes has had a positive impact on the growth of productivity in both the USA and Sweden. A recent study, funded by the Riksbank, indicates that these are important explanatory factors for the development of productivity in the 2000s. There are also certain common denominators for development in Sweden and the other Nordic countries. IT investments have been high, the economies have been deregulated and competition has been strengthened. Increased competition has probably forced the companies to make changes with the aim of improving efficiency in order to survive. It is also likely that the restructuring of the companies is an important factor that enables the companies to draw the greatest possible benefit from productive IT investments. In countries where the economic policies pursued help to increase competition, the growth of productivity is probably increased in the long term when the technology and infrastructure required is spread throughout the economy.

The extent to which other countries in Europe that have had a long period of low productivity growth will experience the same effects as the Nordic countries, Ireland and the USA is an interesting question. The countries with low productivity growth probably need to speed up the reform process. The European Commission's evaluations of the measures taken by the Member States indicate that there is more to be done in this respect, not least in the major EU countries.[26]

Trickier questions are when the growth of productivity will pick up speed in Sweden again and how high long-term, sustainable productivity growth will be. The positive effects on trend productivity growth of previous technological shifts have often lasted for several decades. Exactly how much and how long a period of time of the growth of productivity

[26] See the European Commission's evaluations of the countries' measures on the Commission's website (http://ec.europa.eu/economy_finance/analysis_structural_reforms/growth_and_jobs247_en.htm).

in Sweden can be explained by IT investments and organisational changes is, however, difficult to say with any degree of certainty. It is therefore difficult at present to draw any far-reaching conclusions about this for the Swedish economy. It is probable that there will be an upturn in productivity in Sweden when there is an upturn in the economy. It can not be ruled out that the main effects of previous IT investments and deregulation processes in the economy will continue to affect growth in the future. Nor can it be ruled out, however, that the main effects on trend productivity growth have begun to peter out. If this is the case, the level of trend productivity growth in the period ahead will probably be lower than it was from the early 1990s to the end of 2006.

Lower trend productivity growth means – all else being equal – that the level of potential growth in the economy will be lower than it has been for a decade. This would entail partly new preconditions for monetary policy in Sweden compared to the situation during the past ten years or so.

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The monetary policy landscape in a financial crisis

Stefan Ingves and Johan Molin[1]
Stefan Ingves is the Governor of the Riksbank and Johan Molin is an adviser at the Riksbank's Financial Stability Department.

Introduction

For some time now, the world has been in the throes of a severe financial and real economic crisis. A slightly unusual way of attempting to describe the crisis and its causes may be to start with a picture.

The picture shows an oil painting that was done in 1842 by the English artist William Turner.[2] It is called *"Snow Storm – Steam-Boat off a Harbour's Mouth"*. It is part of the collection at the Tate Gallery in London. This Turner should thus not be confused with the Head of the

[1] The article is based on a speech made by Stefan Ingves at the meeting of the Swedish Economics Association on 31 March 2009. The authors would like to thank Mikael Apel, Claes Berg, Joanna Gerwin, Tora Hammar, Lina Majtorp, Kerstin Mitlid, Marianne Nessén, Lena Strömberg, Lars E.O. Svensson, Staffan Viotti, Anders Vredin and many other employees at the Riksbank for their great commitment and valuable contributions. Our thanks also go to Gabriel Urwitz and the other participants at the meeting of the Swedish Economics Association who contributed to a lively discussion and made valuable comments.

[2] Joseph Mallord William Turner (1775-1851), British artist most famous for his Romantic landscape paintings, whose style can be said to have paved the way for Impressionism.

British Financial Services Authority, Lord Turner, who recently published a report that attracted a great deal of attention.[3]

What is interesting about the painting from our point of view is that William Turner used a very special technique. He built up the image gradually by painting several thin, semi-transparent layers on top of each other. He then added somewhat thicker, more pastose sections. This layer-by-layer technique gave his paintings a special lustre and a special atmosphere. As reality is made up of different layers, Turner's technique can also act as a starting point for a description of the situation today. Every layer that is added or peeled away reveals a partly new landscape.

We can compare the financial crisis to the snow storm in Turner's painting. In order to paint the picture of the complete storm we need to begin with a layer that describes the macroeconomic preconditions, *the macroeconomic landscape*. Then comes a layer that describes *the financial landscape*. This consists of financial players, institutions, markets and instruments. Over this there is yet another layer that describes *the regulatory landscape*, that is the special legislation, regulations and supervisory arrangements that cover the activities of financial companies.

Somewhere in the centre of the painting, symbolised by the steam boat that is trying to navigate the right course through the snow storm, we have the Riksbank which is struggling to both meet the inflation target and safeguard the stability of the payment system. For the Riksbank, as for steam boats at sea, the room for manoeuvre is determined by the conditions in the surrounding landscape. We have to understand how the weather, visibility and other prevailing factors affect our chances of steering the boat in the right direction. This becomes particularly important when conditions are difficult, when there is a snow storm raging at sea. But how did we get caught up in the storm in the first place?

From fair weather to the perfect storm – what went wrong?

The metaphor of the different layers in Turner's painting can be used to describe the causes of the current crisis.

GLOBAL IMBALANCES WERE BUILT UP

If we are to understand the origins of the crisis, we cannot ignore certain factors in the macroeconomic landscape. This applies in particular to the

[3] The Turner Review: A regulatory response to the global banking crisis, Financial Services Authority, March 2009.

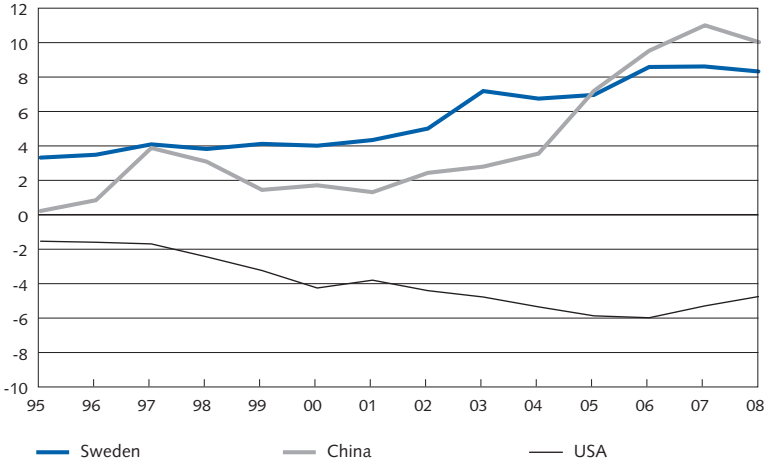
major global imbalances that were built up over a long period of time. In the rapidly-developing economies in the oil-producing countries and Asia, particularly China, domestic saving reached a level that was higher than required to fund domestic investments. This led to substantial current account surpluses. Large amounts of capital were built up which sought an outlet on the global financial markets. These were used, for example, to buy assets in the West.

At the same time, the economies in the West, particularly the USA, experienced an unusually long, uninterrupted period of favourable conditions with strong growth and low inflation. Policy largely focused on maintaining these good conditions. It was possible to stimulate domestic demand at the cost of a gradually increasing current account deficit. The large capital flows on the financial markets helped to keep interest rates down. With consumer prices held in check, it was also felt that there was no real reason to conduct a stricter monetary policy. As a result, significant global imbalances arose with a sustained savings surplus in some countries and deficits in others.

THE MARKETS PRICED RISK INCORRECTLY

This also laid the foundations for changes in the financial landscape. The ample supply of capital available for investment and the low interest rates for risk-free assets increased the demand for assets with a higher yield, a "search for yield" arose. However, investors all over the world, including many major banks, largely ignored the fact that, in the long term, higher yield can only be achieved by taking greater risks. This contributed to a

Figure 2. Current account as a percentage of GDP



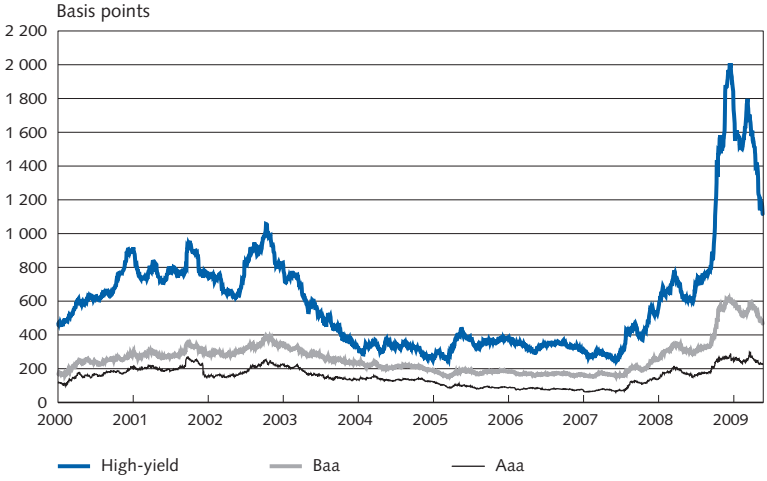
Source: IMF

dramatic increase in asset prices. The very favourable conditions that prevailed on the global financial markets meant that the premiums for credit risk were generally extremely low for a long period.

The explosion in asset prices was fuelled by a rapid expansion in credit. Money was lent more carelessly than previously. Housing bubbles developed in several parts of the world. In the USA, the development of such bubbles was reinforced by the inadequate regulation of the mortgage market and a political agenda that aimed to promote house ownership among people on low incomes.

The search for yield drove investors to borrow more in order to achieve greater leverage in the investments. Financial innovations helped to drive this development. A steady flow of new and increasingly complex instruments were created to satisfy the demand for investments with a higher yield. Advanced techniques arose for the securitisation of different forms of credit, including mortgages for less creditworthy borrowers Many banks around the world – although this applies to a lesser extent to Swedish banks – thereby changed their business model. While previously they had specialised in developing long-term customer relations and in evaluating and monitoring credit risks, the banks now increasingly went over to repackaging and selling their credit risks as quickly as possible. One might think that the banks used securitisation to get rid of a large proportion of their credit risks. Unfortunately, this was largely an illusion. The banks created special intermediaries off their balance sheets to hold and structure the securitised credits. This made it possible for the banks to increase the debt/equity ratio both on and off the balance sheet.

Figure 3. Difference between the interest rate for corporate bonds and the interest rate for T-bonds in the USA.
Basis points



Source: Reuters Ecowin

However, explicit and implicit guarantees from the banks to these special companies meant in practice that the risks led directly back to the banks' balance sheets.

The result of all these new instruments and artificial intermediaries was a motley and almost impenetrable structure. A wide range of asset types with idiosyncrasies in pricing arose. This also made them more difficult to value. Moreover, the complicated links between the banks and their special investment vehicles made it difficult to see exactly what the banks' exposures were. Eventually, no one knew where the risks were. The increasing amount of credit not only made investors highly indebted in relation to their equity, many banks also did not really have enough capital in relation to the risks they took.

When economic activity began to decline in the USA and prices fell on the US housing market, many institutions suffered major losses. Above all, however, a great deal of uncertainty arose. It was simply impossible to know with any certainty who was exposed to "toxic assets", that is assets that risked losing value as a result of major credit losses. The realisation that many institutions could be more in debt than appeared to be the case on their balance sheets fuelled this uncertainty. The resulting anxiety led to the waning of trade on a number of financial markets. As the banks have become increasingly dependent on the financial markets for their funding, many banks now found it difficult to refinance their operations. In other words, they found it difficult to borrow in order to cover their lending.

When the US investment bank Lehman Brothers was forced to apply for bankruptcy protection in September 2008, this had major repercussions in many parts of the world. The global financial crisis escalated and the Swedish banks were also affected to an increasing extent. When conditions on the global financial markets deteriorated, there was a general increase in credit risk premiums. For those borrowers – financial institutions or countries – that were deemed to entail the highest risks, the premiums increased more than for others. A process to reduce exposures and debt/equity ratios began among banks and other financial institutions around the world. The rapid decline in borrowing reinforced the downturn in global economic activity. This in turn accelerated the substantial fall in asset values and the increase in the bank's credit losses. A vicious circle arose in the global economy in which the financial turmoil aggravated the weakening of the real economy and vice versa.

The events in the financial sector reflect fundamental failures in the risk management of the financial players. Securitisation partly removed the banks' incentive to monitor credit risks. The credit rating institutions largely took over this role. But the models used by the rating agencies

were in many respects inadequate and the credit ratings were interpreted incorrectly. The correlation between credit risks was underestimated, as were the liquidity risks. The market thus priced risks incorrectly. This does not mean, however, that all of the players acted irrationally. Many players were able to make a lot of money in the upturn while others had to bear the losses in the downturn. The reward systems in many cases thus encouraged exaggerated risk-taking by promoting short-term profits.

There were thus major shortcomings in basic corporate governance. These shortcomings were not helped by the fact that many institutions had developed into large and complex organisations – too large in some cases to be allowed to fail.

GAPS IN REGULATORY FRAMEWORKS AND SUPERVISION

These developments of course all took place against the background of the landscape of regulations and supervisory arrangements that surround the financial system. A general problem in all forms of financial regulation is that, if the regulations are binding, players attempt to conduct an increasing proportion of the activities outside the regulated sector. There were without doubts large gaps in the regulatory frameworks that enabled so-called regulatory arbitrage. Some institutions, for example many investment banks, were not subject to the same insight or constraints as ordinary banks. Some markets, for example the OTC market for credit derivatives, were permitted to grow explosively without the authorities having any real oversight. The capital adequacy frameworks also made it cheaper in many areas for the banks to expand off their balance sheets. After the event, we can also note that the regulatory frameworks focused too little on liquidity risks. Many of these gaps in the frameworks are now being closed. However, the eternal problem is of course that the markets are always faster at finding new ways of circumventing the regulations than the authorities are at closing the gaps.

Perhaps a more fundamental problem was that there was too weak a link between financial supervision and macro factors and other factors that affect the risk of shocks in the financial system as a whole. There was quite simply too much focus on individual companies and too little focus on broader developments. Nor did the supervisory arrangements adequately reflect the increased internationalisation of the financial sector. In recent decades, the financial markets have become increasingly interlinked and huge sums are transferred across the globe every day. Large, complex banks and other financial institutions now conduct extensive operations in several countries. At the same time, supervision was mainly conducted on the basis of national mandates and focused on companies

within individual, national jurisdictions. Supervision thus lacked the oversight required.

MANY FACTORS INTERACTED

A number of interacting factors thus lay behind the situation that arose. Global macroeconomic imbalances, fundamental shortcomings in the risk management of the financial players and gaps in regulatory frameworks and supervision together formed the underlying layers in the current financial and economic crisis – a crisis that many observers regard as the worst since the 1930s. In order to avoid a total breakdown in the financial system, governments, central banks and other authorities around the world have been forced to take a range of massive and unusual measures.

Massive and unusual measures on the part of the authorities

So, what have the authorities done? The central banks have lent large sums of money to the banks at longer maturities and against other forms of collateral than has normally been the case. This has improved the banks' short-term funding situation. Several central banks have also provided emergency liquidity assistance to individual institutions. The Federal Reserve, the European Central bank and other central banks have also entered into agreements to provide loans in their own currencies to other central banks to mitigate the effects of the crisis in other countries. The central banks have also cut policy rates rapidly and forcefully, sometimes in coordinated actions, to alleviate the repercussions of the financial crisis on production, employment and inflation. Governments have offered guarantees and capital injections to reduce the risk of further bankruptcies in the banking sector. Deposit guarantee schemes have been extended. Several countries have also adopted fiscal policy stimulation packages to mitigate the effects on the real economy.

In Sweden too, authorities such as the Riksbank, the National Debt Office and Finansinspektionen have acted to alleviate the crisis. As in many other countries, the government has increased the ceiling for the national deposit guarantee scheme and has extended it to cover all forms of deposits in accounts. The government has also introduced a guarantee programme, set up a guarantee fund and decided on capital injections for banks. At the same time, the government is conducting a more expansionary fiscal policy than previously to mitigate the effects on the real economy.

The Riksbank has implemented a large number of measures to safeguard financial stability and mitigate the negative effects of the financial crisis. We have changed the collateral requirements so that the banks can use more types of security as collateral when they borrow from the Riksbank. We have, for example, begun offering loans with commercial paper as collateral to facilitate the companies' financing. We have also begun to lend at longer maturities, with variable interest rates and with smaller supplements. We have provided special liquidity assistance to Kaupthing Bank Sverige and Carnegie Investment Bank. We have also entered into loan agreements with Iceland, Latvia and Estonia to ease the situation in these countries. All this has meant that during the second half of 2008 the Riksbank increased its total lending to the banks by more than SEK 450 billion.

The Riksbank has also cut the repo rate to the lowest level it has been at since we introduced an inflation target. How monetary policy can be conducted under the prevailing conditions is a question that we will discuss in more detail below. The financial crisis has of course changed these conditions a great deal. But before we get into that it may be appropriate to say something about how monetary policy is supposed to work under normal conditions.

How monetary policy works normally

Normally, monetary policy aims to keep inflation at a low and stable level and to stabilise the real economy. To achieve this, the Riksbank controls the shortest market rate, that is the overnight rate which is the interest rate on loans between the banks from one day to the next. The overnight rate in turn affects the interest rates charged to the general public, and thereby activity and prices in the economy. We have a system in which we influence the overnight rate by determining the conditions for the banks borrowing and lending with the Riksbank so that it is close to our policy rate, the so-called repo rate. The repo rate expresses the level at which the Riksbank wants the overnight rate to lie.

The way in which the monetary policy conducted has an impact on, for example, the banks' lending rates, the development of the real economy and inflation is usually called, somewhat loosely, *the transmission mechanism*. This mechanism is often described in terms of three different channels: *the interest rate channel, the credit channel* and *the exchange rate channel*. These channels are intertwined with each other and the division is mostly for explanatory reasons.

The interest rate channel can be used to influence the cost of saving and borrowing. A lower interest rate means that it becomes less expensive

for companies to finance investments, and for households to borrow for consumption. Lower interest rates normally also make saving less attractive.

Interest rate changes also affect the economy through the *credit channel*. Lower interest rates generally increase the net present value, that is the value today, of the cash flows that financial assets are expected to generate in the future. Lower interest rates also increase the demand for real assets, for example housing. In this way, the prices of both real and financial assets increase. As these assets are used as collateral for loans, the creditworthiness of companies and households also increases. This leads banks and other financial institutions to be less restrictive in their lending and means that they can lend more. This in turn stimulates investment and consumption and thus increases inflationary pressures in the economy.

Through *the exchange rate channel*, monetary policy can influence the value of the currency. Normally, a reduction of the repo rate leads to a weakening of the krona. This is partly because Swedish assets appear less attractive than investments in other currencies. A weaker exchange rate affects inflation directly in that imported goods will become more expensive. At the same time, domestic goods become cheaper than foreign goods. This leads to a decline in imports and a rise in exports. Higher demand for domestic goods contributes to an increase in resource utilisation and inflationary pressures.

Inflation expectations are also important to the way in which companies set prices and to how wage formation functions, and thereby to the development of inflation. If everyone trusts that inflation will remain low, the companies do not need to change their prices so often, and employees do not need to increase their wage demands. This makes it easier for the Riksbank to achieve the inflation target.

This then is mainly how monetary policy is supposed to work normally. But when the financial markets are not working normally the transmission mechanism is also affected. The various channels simply do not work as effectively as they usually do. This also makes the link between monetary policy and financial stability particularly important.

Monetary policy and financial stability are interlinked

As is well known, the Riksbank has more than just a monetary policy mandate. In addition to maintaining price stability, the Riksbank also has the task of promoting a safe and efficient payment system. We thus have two main tasks: monetary policy and financial stability. These tasks are of

course interlinked even under normal conditions. Without stability in the financial system it becomes more difficult to conduct monetary policy, and price stability is part of an effective payment system. Practically and organisationally, however, these are two separate fields of work. It could be said that we normally use two different toolboxes to perform these two tasks.

First, we have a monetary policy toolbox, parts of which we have already described. The monetary policy measures, for example the setting of the repo rate, have a clear objective: to influence economic activity with the aim of maintaining price stability. This is in turn an important component of our efforts to achieve stable development in the real economy.

Second, we have a box of tools for promoting stability in the financial system. Financial stability is a basic prerequisite for a safe and efficient payment system. The Riksbank normally uses tools other than the repo rate to promote financial stability. The analyses of the risks in the financial system that we produce and publish every six months in our "Financial Stability Report" represent the primary tool in this toolbox. If nothing else, this and the other feedback that we provide to the banks makes them more aware of potential vulnerabilities and, in the best case, gets the banks to take preventive measures. This is usually referred to as "moral suasion". But this toolbox also contains more concrete tools. These include the possibility to quickly add liquidity to the banking system.

We thus normally approach these two main tasks somewhat differently and we often regard monetary policy and financial stability as two separate parts of the Riksbank's mission. Recently, however, it has become increasingly clear just how interlinked these two tasks are.

When the interbank markets have been ineffective and interest rates have to a certain extent been governed by a lack of confidence, the impact of monetary policy has been weakened. This has meant that we have needed to use tools from both of the toolboxes during the crisis. The situation has required the use of some tools that we otherwise use rarely. We have even had to reinvent some of the tools and refine them as we go along. The measures have primarily aimed to strengthen financial stability and to maintain the functionality of the financial markets so that the payment and credit systems work effectively. This is a prerequisite for the effective functioning of the economy as a whole.

Many measures that are taken with the aim of safeguarding financial stability at the same time have indirect monetary policy effects. For instance, measures that lead to greater confidence in the markets contribute to lower interest rates and increased access to credit, thereby increasing the impact of monetary policy. Similarly, the Riksbank's interest

rate reductions contribute to financial stability by improving the supply of credit. The measures that are normally taken under the framework of monetary policy or to promote financial stability have thus begun to complement and mutually reinforce each other. To illustrate what we are doing today we can use a simple equation that describes the banks' lending rate – that is the rate charged to households and companies – as the repo rate plus a premium.

[Equation 1] $$i_t^{lending} = i_t + m(c_t, \ldots)$$

The size of this premium depends on the bank's demand for compensation for, for example, credit risks, any maturity differentials and the need to retain sufficient capital to cover the loans. What we are doing now is *partly* to influence the first term, that is the policy rate, and *partly* to try to influence the second term, that is the risk premiums that are today reflected in large credit spreads as a result of the financial turmoil. To do this we must tools from both of the toolboxes. It s against this background that we can view the monetary policy measures of a more or less unconventional nature that are now taken being taken in various parts of the world. We will now try to discuss this in a little more detail.

Unconventional monetary policy

As mentioned earlier, the central banks have reduced policy rates quickly and dramatically in order to mitigate the effects of the financial crisis. At the end of last year, the US central bank cut the target for its policy rate to an interval of 0-0.25 per cent. In early March, the Bank of England cut its policy rate to 0.5 per cent and is thus also close to zero. Many other central banks, including the Riksbank, have also reduced their policy rate to all-time low levels.

When the central banks can no longer use their traditional tools for influencing demand in the economy – when no further cuts in the policy rate are possible – then other options have to be found. In both the USA and the UK, as in some other countries, the central banks have begun to conduct monetary policy using unusual, and in some case untested, methods. It may be worth pointing out, however, that there may be good reasons for implementing a lot of what the central banks have done irrespective of whether the policy rate is close to zero or not. This relates to various measures that aim to improve the functioning of the financial markets and ease the supply of credit.

One way of trying to illustrate the course of events is to study the central banks' balance sheets. The exact form of these balance sheets

varies from country to country, but they have a number of common features. For the sake of simplicity, and without claiming to present an exact picture of reality, let us assume a stylised balance sheet. On the asset side there are foreign and domestic assets and the lending to the banks. On the liabilities side, there are banknotes and coins, deposits from the banks and equity.

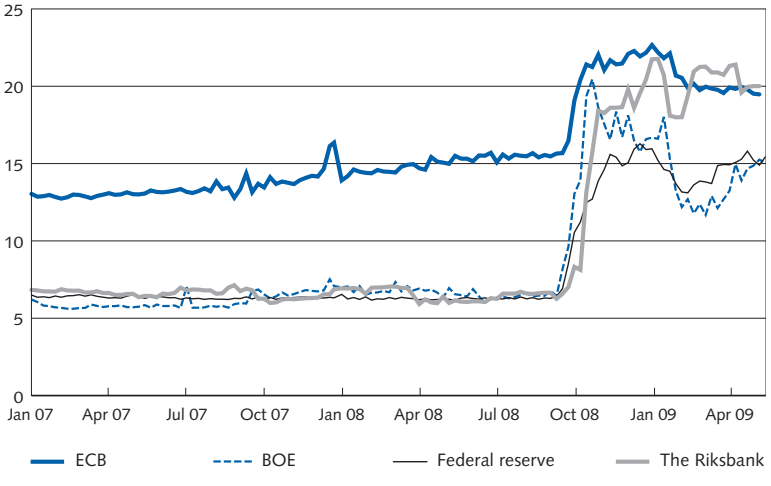
Figure 4. A central bank's stylised balance sheet

Assets	Liabilities
Foreign assets	Banknotes and coins
Domestic assets	Deposits from the banks
Lending to the banks	Equity

The balance sheet totals of the central banks increased dramatically during the autumn of last year and have remained at approximately these levels since then. A major part of this increase is due to the expansion of lending.

As mentioned above, during the second half of 2008 the Riksbank increased its lending to the banks by more than SEK 450 billion. As a result of the increase in lending, the Riksbank's balance sheet grew during

Figure 5: Central banks' balance sheet totals
Percentage of GDP



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

the second half of 2008 from around SEK 200 billion to around SEK 700 billion, that is it more than tripled. What happened was, put briefly, that when the interbank and securities markets stopped working normally, the demand from the banks for loans and liquidity reserves from the Riksbank increased. It could be said that the Riksbank acted as an intermediary in the sense that the banking system was able to borrow at longer maturities in order to invest in a secure and liquid asset in the Riksbank.

If we compare the balance sheets at the end of June and the end of December 2008 – that is before and after Lehman Brothers filed for bank-

Figure 7. The Riksbank's balance sheet 30 June 2008 (before Lehman Brothers)

Assets		Liabilities	
Gold	26	Banknotes and coins	108
Foreign currency reserve	158	Fine tuning	0
Lending USD	0	Riksbank certificates	0
Lending SEK	4	Debts to Fed	0
Other	4	Equity	59
		Other	25
TOTAL	192	TOTAL	192

Figure 8. The Riksbank's balance sheet 31 December 2008 (after Lehman Brothers)

Assets		Liabilities	
Gold	30	Banknotes and coins	112
Foreign currency reserve	200	Fine tuning	**207**
Lending USD	**196**	Riksbank certificates	**49**
Lending SEK	**262**	Debts to Fed	**189**
Other	7	Equity	59
		Other	84
TOTAL	700	TOTAL	700

ruptcy protection – we can see that lending in Swedish kronor increased by approximately SEK 260 billion. This is reflected on the liabilities side by the increase in the Riksbank's fine tuning facility, where the banks deposit their surplus liquidity overnight, and the increase in Riksbank certificates with a maturity of one week. The banks have thus increased their reserves at the Riksbank.

The Riksbank has also lent almost SEK 200 billion in US dollars. We have financed this partly by borrowing against the currency reserve and partly by means of a loan agreement with the Federal Reserve. The fact that the currency reserve appears to have increased is primarily due to exchange rate effects.

The liabilities item "Other" includes the Riksbank's net income and the revaluation accounts. This has increased primarily due to exchange rate effects, but also because we have earned quite a lot of money from these transactions.

Some other central banks, such as the Federal Reserve and the Bank of England, have gone one step further. Apart from increasing their lending to the banks, they have also bought various types of domestic financial assets. When a central bank lends money to the banks or purchases different types of asset, the banks' access to funding increases. This in turn increases the so-called monetary base on the balance sheet's liability side, that is the total of outstanding banknotes and coins and the banks' deposits in the central bank.

A common feature of the measures taken by the central banks is thus that they have inflated the balance sheets and increased the monetary base. There are, nevertheless, some differences and different central banks have also described their measures in slightly different ways. For example, most of the measures taken by the Federal Reserve have aimed to make it easier for households and companies to get access to credit and to reduce risk spreads The strategy has therefore been called credit easing. The Federal Reserve has thus focused on the asset side and has, for instance, bought different types of domestic, private financial assets In this context, what happens to the monetary base on the liability side of the balance sheet has not been the central issue, although of course everything that happens on the asset side of a balance sheet is directly reflected on the liability side and vice versa. Technically speaking, the monetary base has increased in Sweden too because the Riksbank has increased its lending to the banks. This has not, however, been the main aim of the increase in lending and is not something that in the present circumstances can be expected to automatically lead to an increase in lending to borrowers outside the banking system. The Riksbank's lending has, on the other hand, eased trading on the interbank market.

However, increasing the monetary base may sometimes be a deliberate strategy. In such a case we usually talk about quantitative easing. What we mean by this term is that the central bank has moved away from monetary policy easing in the form of reductions in the *price* of the banks' deposits in the central bank, that is the policy rate, to increasing the quantity of the bank's deposits – and the monetary base – directly. Opinion is divided on exactly how quantitative easing works and how it relates to credit easing. Most economists are cautious about describing the concrete channels. In very simple terms, it is possible to illustrate what we want to achieve using a classic quantity equation.

[Equation 2] $M \times V = P \times Y$

This well-known equation says that the money supply times the turnover rate for money is equal to the price level times production. In severe crises, the turnover rate for money, V, declines. To keep up prices, P, and production, Y, we need to increase the money supply, M.

By buying government securities and thus increasing the supply of money, the central banks aim to increase the supply of credit and thereby improve liquidity among private players - and ultimately increase consumption. This presupposes, however, that the banks do not simply hoard these extra reserves but also actually increase their lending. If the central bank buys government securities, risk free interest rates at slightly longer maturities may also fall. It can be said, in simple terms, that the application of quantitative easing entails a focus on the liability side of the balance sheet, while the state of the asset side becomes less important even though this is also reflected in the balance sheet. The express purpose of this shift from price to quantity is usually that "the price" can no longer be affected as the policy rate is zero. It could therefore be said that quantitative easing is a more refined type of monetary policy with a zero interest rate than credit easing. The latter focuses more directly on reducing the spreads and improving the supply of credit in the economy. It should be emphasised, however, that a zero interest rate is not necessarily a precondition for either quantitative easing or credit easing and it may sometimes be possible to find a use for both methods even when the policy rate is positive.

The measures that the Bank of England began to implement at the beginning of March can be characterised as quantitative easing. In its communication, the Bank of England has talked about injecting money directly into the economy. This is done by buying government securities and, to a certain extent, securities issued by private players, for example corporate bonds. The latter can be said to mean that the strategy also

includes elements of credit easing in the sense that the supply of credit to companies is eased. The Federal Reserve has a more explicit focus on reducing spreads on those markets that are considered to be important to the financial system, but has recently also begun to buy government securities on a large scale.

Both quantitative easing and credit easing are examples of a type of policy that is only used in special and unusual circumstances and whose effects we therefore do not really know very much about as yet. It is important to be clear about the fact that the situation that has arisen is new for practically all central banks in countries with well-developed financial markets. It would be wise to address the question of how to best handle the situation with a great deal of humility.

So what is the situation in Sweden - will we need to implement as drastic measures as those now being implemented by, for example, the Bank of England or the Federal Reserve? The answer to this question is that we simply do not know yet. What we can say is that we are prepared to do what is required, when it is required, within the existing frameworks. We also have the advantage of being in a situation where we can get an indication of how well the unconventional measures taken by other central banks have worked, even though the differences between countries of course mean that we cannot draw too far-reaching conclusions. In this sense it is an advantage to us that the crisis is not "home made" and that it has not yet developed to the same point here as in many other countries.

A key to the measures that may become necessary in Sweden is whether traditional monetary policy, that is keeping the interest rate low, will be sufficient. The significant factor for demand in the economy is the real interest rate, that is the nominal rate minus expected inflation. Inflation expectations among households and companies are thus important. The most important thing is to avoid a situation in which the credibility of the inflation target is undermined and the players in the economy expect to see long-term deflation, that is that prices will continue to fall during the foreseeable future. Even if the nominal interest rate has been pushed down to the lowest possible level, the real interest rate may then still be too high to stimulate demand.

The Riksbank's monetary policy framework is a strength in this context. The fact that we have an established, numerical target for inflation probably makes it easier to keep inflation expectations well-anchored on the positive side of zero. Surveys also indicate that expectations are well in line with the target a few years ahead. In the shorter term they are lower, but there is nothing particularly strange about this - inflation in our own forecasts is lower too.

Nor should we forget that the Riksbank is not the only authority that influences interest rates in the economy. Apart from the measures taken by the Riksbank, crisis measures taken by the Ministry of Finance and the National Debt Office of course affect costs (spreads) on the credit market. Fiscal policy stimulation measures also affect the costs of credit risk and thus the price of credit. We should also remember that supervisory and regulatory measures that set up different types of constraint, for example capital adequacy requirements for the banks, can indirectly affect the price of credit

A question that we are wrestling with just now is how serious the credit crunch is and whether there is a risk that it will hit the non-financial sector so hard that it will have major repercussions on the real economy over and above those that normally follow a recession that undermines the creditworthiness of companies and households. On the one hand, the supply of credit declines when the banks want to shrink their balance sheets. Many companies in the Riksbank's company survey state, for instance, that they are finding it difficult to borrow at longer maturities. On the other hand, the demand for credit should also decline as a consequence of weak economic activity. What can be done about this and what is the role of the central banks in easing the credit crunch?

The Riksbank's view is that it is the financial system that as far as possible should be strengthened in order to ease the credit crunch. It is mainly the commercial banks that have knowledge about credit for non-financial companies. Primarily, the banks need more capital in order to increase their resilience to potential losses in the future. This can indirectly be expected to increase the banks' credit capacity. Many banks have already strengthened their capital base. The government's capital programme has also made it possible to inject further capital if the need arises.

In the worst case, it may of course become necessary for the government to provide loans or guarantees directly to the non-financial sector in some way. But this is not primarily a task for the Riksbank. At the same time, it is more important than ever that the authorities co-operate effectively and pull together. Different phases and components of the crisis require different measures from the central bank and from other authorities. It is extremely important that these measures are well co-ordinated and that the division of labour is clear.

How can we prevent crises in the future?

One very important question is of course what lessons we can learn for the future. How can we public authorities help the financial system to

avoid ending up in a similar situation again? Can we in some way ensure that macro economic factors and systemic risk factors have a better impact in our policy measures and supervisory systems?

BURSTING BUBBLES WITH INTEREST RATE POLICY?

Many analysts consider that one important factor behind the current financial crisis is that interest rates have been kept at a low level for a long period of time, particularly in the United States. The outlook behind the policy that has been conducted was that central banks are not particularly good at assessing whether or not an asset bubble is being built up. Monetary policy should therefore only respond to a rapid increase in house prices and indebtedness if the forecast is that this risks leading to overheating in the economy and thereby to excessively high inflation. If this is not the case, the central bank should wait and see, but be prepared to quickly ease monetary policy if the housing market were to collapse and demand in the economy were to fall drastically.

This view has come to be increasingly questioned, not least as the work on "cleaning up afterwards" has proved to be fairly extensive if the central banks have been too passive during the build-up phase. This is particularly so if the price bubble can be linked to a credit expansion. In most cases it is the credit expansion – and not the prices themselves – that is the most worrying.

Should it not be possible to use monetary policy more actively to subdue an upturn in asset prices? This is a difficult question that requires more detailed analysis, but it is unlikely that it will be easy to reach a general policy conclusion. We are, however, convinced that many central banks will review their macroeconomic models and more precisely define the role of asset prices in the transmission mechanism. However, we should not exaggerate the ability of monetary policy to prevent crises from arising. Even if an excessively expansionary monetary policy can contribute to the build-up of a bubble, it is less clear to what extent monetary policy can entirely prevent this from happening. It is probable that this would require fairly substantial interest rate increases, something that may not be received sympathetically when the reasons for the increases are not crystal clear. But more moderate interest rate increases could, of course, contribute somewhat. If nothing else, this would provide a signal from the central bank that it envisages certain development problems. Risk scenarios with a longer forecast horizon may be an option for clarifying what the risks may be in the longer term. It is conceivable that the price of housing or some other asset may be driven by factors that are difficult to explain or which may be assumed to give rise to inefficient risk

allocation and large fluctuations in economic activity and inflation. This would then be taken into consideration in our monetary policy thinking in some way.[4] Nevertheless, it is probably the case that the greatest contribution to a more efficient strategy is to ensure that appropriate regulations and supervision procedures are in place.

NEW FINANCIAL SUPERVISION ARRANGEMENTS

As mentioned earlier, one of the problems was that financial supervision did not give sufficient consideration to factors in the macro economy and to systemic risk. At the Swedish level, it is of course important to ensure that the coordination between the Riksbank and Finansinspektionen functions as efficiently as possible.

It is also necessary to have coordination at the international level. In November 2008 the European Commission appointed Frenchman Jacques de Larosière to lead a task force to draw up proposals for improving the regulatory regime within the EU. The proposals were presented on 25 February 2009.[5] They include establishing a special body, the *European Systemic Risk Council*, with responsibility for overarching macro prudential supervision in the EU. The idea is that the 27 central banks in the EU would be members of the council and that the council would receive resources from the ECB. Its tasks would include pooling and analysing information, for instance on macro economic conditions, which may be significant to the stability of the financial system.

Part of the problem is that financial supervision has had an excessively national focus. The de Larosière group therefore proposes enhanced coordination of the national supervisory authorities. There is already cooperation on financial supervision within the EU. This takes place for instance in the form of special committees for the supervision of banks, securities and insurance. Now it is proposed that these supervisory committees should be given the status of public authorities. This would make it clearer that the joint supervision standards are binding and not, as now, recommendations.

Although in the long term we will probably need to go even further, this is a step in the right direction, and not a moment too soon!

The crisis management routines also need to be reinforced. Supervision, regulation and crisis management are interlinked. This may seem obvious. But here the same psychological phenomenon that has driven

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[4] See Ingves, S. (2007), "Housing and Monetary Policy – a View from an Inflation Targeting Central Bank", speech at a symposium, Housing, Housing Finance and Monetary Policy, arranged by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming, USA, 1 September 2007.

[5] The High-Level Group on Financial Supervision in the EU, Chaired by Jacques de Larosière, Report, Brussels, 25 February 2009.

private actors to take excessive risks has also been found among politicians and others in positions of responsibility. As long as everything is going well they are happy to ignore the risks. It can be noted that Sweden and the Riksbank have been at the forefront of these discussions. It is good that many other countries have now begun to be aware of this.

A TAYLOR RULE FOR CAPITAL ADEQUACY?

Many readers will of course be familiar with the Taylor rules for monetary policy, which have a number of variations. Put briefly, these are short reactive rules to adjust the policy rate in response to changes in both inflation and economic activity. These Taylor rules have become a useful tool in studying and assessing monetary policy without needing to make a more detailed analysis of the supply of and demand for money. As an aside, it may be worth mentioning in this context Knut Wicksell's in many ways pioneering monetary theory, which he presented at the Swedish Economics Association's meeting on 14 April 1898.[6],[7] In his theory on the natural interest rate Wicksell suggested perhaps the simplest of simple reactive monetary policy rules ever: "*If the price rises, the interest rate should be raised; and if the price falls, the interest rate should be cut…*".[8],[9]

Today, a Taylor rule usually expresses the policy rate as a function of the inflation rate and its deviation from the desired inflation rate, the output gap expressed as the logarithm of real GDP and the logarithm of its deviation from potential GDP, as well as the real interest rate.

[Equation 3] $$i_t = \pi_t + r_t^* + \beta_\pi (\pi_t - \pi^*) + \beta_Y (Y_t - \bar{Y})$$

This type of rule is one of many supplementary tools that most central banks currently use in their monetary policy analysis, although these do not replace other, more in-depth analyses and qualitative assessments.

Should it not be possible to use similar simple rules to attain a more balanced credit growth in the economy and a more stable financial sector? Here it ought to be possible to combine supervisory regulations with macro factors into a simple rule to subdue fluctuations and make the banks more resilient. The cost of the banks' lending is partly dependent on the market's capital adequacy requirements, which in turn depend on

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6 In the same year Knut Wicksell published a book on the subject, *Geldzins und Güterpreise* (Gustaf Fischers publishing company, Jena 1898; translated in 1936 *Interest and Prices*, MacMillan, London).

7 See also Siven, C.-H.(1998), "Penningteori utan pengar – hundra år med Knut Wicksell", Ekonomisk Debatt 1998, year 26, no. 6.

8 Wicksell, 1898 [1936], p. 189.

9 See also Orphanides, A. (2007) "Taylor Rules", Board of Governors of the Federal Reserve System, January 2007.

the requirements of the regulatory regime. The principle is that the banks must maintain an amount of equity capital in their balance sheets that is in proportion to the amount of risky assets, primarily in the form of lending. In the same way as the policy rate can be expressed as a Taylor rule, it should be possible to express the banks' capital adequacy requirement as a function of, for instance, the lending gap, or growth in lending in the economy and the output gap.

[Equation 4] $$c_t = \mathrm{c} + \alpha_L (L_t - L^*) + \alpha_Y (Y_t - \bar{Y})$$

Here the capital adequacy requirement the banks are subject to depends on the development of total lending in relation to a long-term trend and economic activity. The idea is that the capital adequacy requirement will increase when lending increases too substantially, and will decrease when lending declines. In this way the banking system will be forced to build up capital reserves in good time, which can in turn be used to cover losses when times are hard. One creates a model that evens out cycles rather than reinforcing them. The current capital adequacy rules are sometimes accused of being procyclical. In the best case, this provides a more balanced development, both with regard to the growth in credit and the banks' resilience to shocks. This is a slightly more general approach than, for instance, the system of dynamic provisioning they have in Spain.[10] The beauty of it is that by using aggregate measures of growth in lending we also capture other things that would otherwise remain off the banks' balance sheets.

Note that one can make a connection between the Taylor rule for the policy rate and a corresponding rule for capital adequacy. Let us refer back to the expression for the banks' lending rate as a function of the central bank's policy rate and a risk premium.

[Equation 1] $$i_t^{lending} = i_t + m(c_t, \ldots)$$

As mentioned, the premium is partly due to the bank's demand for compensation for the need for capital cover for lending. If the capital adequacy requirement is controlled with the aid of our special rule, then not only bank-specific risks but also systemic risk factors will be priced in the lending rate.

The banks' lending rate thus depends on both the policy rate and a premium that in turn depends on the capital adequacy rule. In addition, both the Taylor rule for the policy rate and the capital adequacy

[10] http://www.bde.es/provesta/proestae.htm

rule depend on the output gap. This means that one can in principle link together these equations into a system. In this way we obtain a model that links together monetary policy and financial stability.

It should be emphasised that these are merely very preliminary ideas, which were first discussed at a conference in Geneva in January 2009. Incidentally, an excellent report has been published from this conference.[11] Of course, more work is needed to specify and estimate a model of this type. And there are of course substantial problems in measuring the variables included. Moreover, it would require considerable effort to communicate a rule like this. However, stylised models like this should be useful as a starting point for the consideration of these issues. Concrete quantitative rules of this kind could also provide valuable support to those public authorities that exercise supervision over the banks. Hopefully, this digression may inspire someone to take the idea further. It would give both individual countries and the future *European Systemic Risk Council* something to get their teeth into.

Some concluding thoughts

The current financial crisis is in many ways similar to earlier financial crises. Periods of strong optimism with rapidly rising asset prices and rapid credit expansion that suddenly break down into deep pessimism are nothing new. We have seen such boom-bust scenarios many times before. It appears to be human nature to be drawn into an overoptimistic frenzy and to underestimate the risks as long as things are still on the way up.

What distinguishes this crisis from earlier ones is of course its global range and extreme complexity. This means that we can put a further couple of layers onto the foundation of Turner's canvas. The globalisation and development of the art of financial engineering in recent decades can be said to be part of the first coat of paint on the canvas. The scope and complexity mean that the situation is in many ways much more serious than before. The course of events has also made us more confused than we have been in previous crises.

At the same time, we can now see an increase in deglobalisation in the wake of the crisis. The cross-border integration of the financial sector has come to an abrupt standstill. And in the global economic downturn many countries are tempted to resort to protectionist measures. This is a worrying development.

[11] Brunnermeier, M. et al. (2009). The Fundamental Principles of Financial Regulation. Geneva Report on the World Economy. http://www.voxeu.org/index.php?q=node/2796.

Both globalisation and the development of the financial services sector entail large potential welfare gains. In recent decades an increasingly large share of the world population has obtained a reasonable standard of living, and a smaller share is living in poverty. Financial integration and new services lead to efficiency gains that in the long term benefit households and companies in all countries. It is important that we do not throw these welfare gains out of the window.

At the same time, we have seen the risks in this development in no uncertain terms. The flows in the financial system have increased substantially while the system has become increasingly complex and difficult to survey. The mutual dependence of the various markets has increased. This means that crises can more quickly and more forcefully hit an increasing number of economies at the same time.

The important thing now is to find the right tools for managing these new risks; to find instruments for a better-balanced development. We need a better insight into the build-up of global risks. This requires increased cooperation between public authorities around the world. It requires greater harmonisation of regulations and supervision. It requires a better readiness to manage cross-border crises. And to find the means to counteract the build-up of large imbalances we must begin to think along new lines.

At present the functioning of the financial system is being maintained with the aid of the measures implemented by public authorities. One sign that the crisis is no longer as acute is that the TED spreads have fallen in Sweden, as well as the United States and the euro area. These spreads are now back at around the same levels that prevailed immediately prior to the worsening of the crisis in autumn 2008. But the financial markets are still functioning much less efficiently than normal. It is also still difficult for companies to finance themselves in the capital market.

The major question now is how we can restore confidence in the financial markets so that they can manage on their own. This is a task that authorities around the world have been struggling with for some time now.

There are many indications that we need a purge of the international banking system. The problems that are weighing down the banks' balance sheets must be brought to light. It is only when we see the depth of the losses that confidence can be restored. The great complexity in the current financial system means that this is a much more difficult process than in the Swedish bank crisis of the 1990s. It is difficult to say how long it will take before the programmes currently being implemented around the world have the intended effect. Meanwhile, the Riksbank is prepared

to do whatever it takes to maintain the functioning of the Swedish financial system.

Articles in earlier issues

Hedge funds and financial crises	*Maria Strömqvist*	2009:1
IMF Financial Sector Surveillance	*Björn Segendorf and Åsa Ekelund*	2009:1