

■ Monetary policy when the interest rate is zero

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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

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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

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.

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 $r_r = i_r - E_t[\pi_{t+1}]$ where i_r 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.

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

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

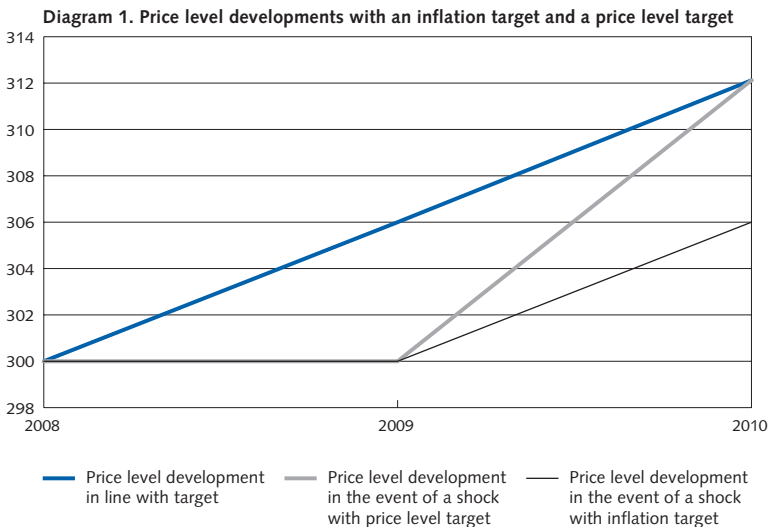
$$x_t = -\sigma \sum_{j=0}^{\infty} E_t [i_{t+j} + \delta_{t+j} - \pi_{t+j+1} - \bar{r}_{t+j}].$$

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-



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.

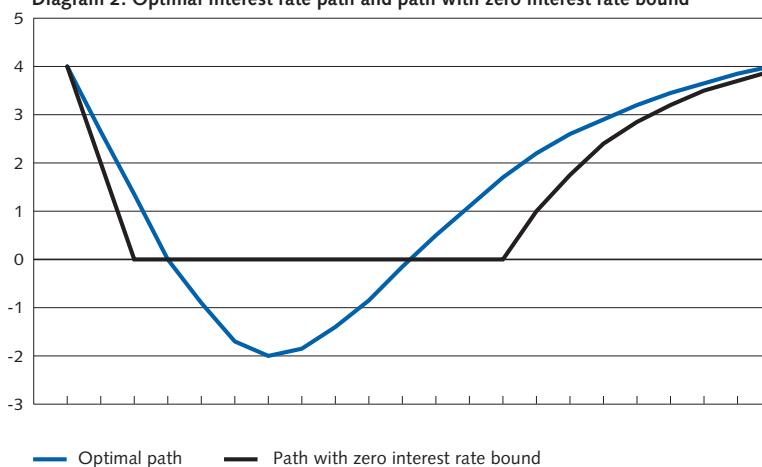
ZERO INTEREST RATE TOMORROW SUPPORTS DEMAND TODAY

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-

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 $vM_t = P_t Y_t$. 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 $i_t^n = \frac{1}{n} \sum_{j=0}^{n-1} E_t [i_{t+j}] + \delta_t^n$, 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

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

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.

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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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_r 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 $-r_r$. 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 instance, Khan, King and Wolman (2003) and Aruoba and Schorfheide (2009).

³⁷ See also King (1994).