Monetary tactics with an inflation target: the Swedish case

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Introduction

In November 1992, the Riksbank was forced to abandon the fixed exchange rate regime. The ultimate objective of monetary policy remained price stability, but the decision to let the Krona float involved a change in the overall strategy of monetary policy for achieving this ultimate objective. The Riksbank decided against replacing the fixed exchange rate with some other kind of intermediate target, such as a money supply target. In January 1993 the Governing Board of the Riksbank adopted an explicit inflation target by stating that the monetary policy target is to "limit the annual increase in the consumer price index in 1995 and onwards to 2%, with a degree of tolerance of ±1%." In 1993 and 1994, that is, before the target became operative, monetary policy was to be directed towards preventing the underlying rate of inflation from rising.

The framework within which monetary policy is conducted in Sweden contains four distinct elements: the instruments under the direct control of the Riksbank (the portfolio and the terms of credit facilities); the operational target upon which the instrument changes operate (short-term market rates or monetary conditions); the Riksbank's inflation forecast; and the inflation target. The transmission mechanisms through which monetary policy influences the inflation rate is crucial within this framework. The transmission mechanisms of monetary policy includes interest rate effects, exchange rate effects, other asset price effects and the so-called credit channel. Monetary policy influences the inflation rate with a considerable time lag. The full effects on demand and inflation on average take about 1-2 years to show up. This implies that the Riksbank must base monetary policy on an assessment of the future inflation rate. The Riksbank works with a broad spectrum of indicators for future inflation. However, the main factors for future inflation are the current and future states of supply and demand, the expectations about future inflation and exchange rate movements. The inflation forecast is made conditional on the current state of the instruments and all other information considered relevant. The next step is to pin down a path for the instruments believed to put developments of monetary conditions (essentially, the weighted sum of real interest rates and the real exchange rate) so that the inflation forecast equals the target over a horizon of 1-2 years. The actual inflation rate will of course differ from the target, because of forecast and control errors. However, if the policy is successful, the mean deviation from target will be zero, and the variance of deviations minimised.[2]

Monetary tactics concern the first step of the transmission mechanism, that is, the central bank's interaction with the financial markets. Monetary tactics include, for instance, the choice of instruments for implementing monetary policy, how the instruments are used to reach operational targets, and the principles for the central bank's communication with the markets, including the attitude towards information disclosure and transparency. This paper takes a Swedish perspective on some of these issues. Section 1 explains the current system of interest rate policy instruments, which was introduced in 1994 partly as a response to the move to a flexible exchange rate. The tactics of policy rate adjustments and the need for transparency and information disclosure with an explicit inflation target are discussed in Section 2. Section 3 examines the influence of monetary policy

[1] We are grateful to Claes Berg and Hans Dillén for helpful comments. The views in this paper are those of the authors and do not necessarily reflect those of the Sveriges Riksbank.

[2] See Svensson (1996) for an excellent discussion of inflation targeting.

announcements by estimating the effects of speeches, inflation reports and changes in the instrumental rates on market interest rates. The final section summarises the discussion and our conclusions.

2 Monetary instruments

A new system for the practical management of monetary policy was introduced in June 1994. In the earlier system, the interest rates on lending and deposit facilities took the form of an ascending scale, whereby the marginal cost of a bank's borrowing from the Riksbank rose with the amounts borrowed. The highest step at which a bank borrowed was known as the marginal rate. The Riksbank determined the level of the marginal rate by managing liquidity so as to bring net borrowing by the banking system up to the desired step on the scale. The transition to a flexible exchange rate in November 1992 and the introduction of the inflation target altered the requirements for monetary policy signalling. Interest adjustments of 0.25 percentage points, which were the smallest adjustments the interest rate scale permitted, seemed unduly large with a more gradual approach to interest rate management. Another disadvantage of the system was the complete focus on the marginal rate, which limited flexibility and implied that the Riksbank only had one policy rate for signalling.

The new system provides one deposit and one lending facility. The deposit rate (i_0) and the lending rate (i_1) are set by the Governing Board of the Riksbank and form a corridor within which the repo rate – the Riksbank's primary instrumental rate – is set by the Governor in accordance with monetary policy guidelines established by the Governing Board (see Figure 1). The interest rate corridor provides the Riksbank with a tool for signalling its long term intentions concerning the repo rate (see Figure 2). This kind of signalling became more important after the introduction of the inflation target.

The repo rate is the rate at which, as a means of managing the liquidity of the banking system, securities with a maturity of one week are bought or sold by the Riksbank under a repurchase agreement. The repo rate may be interpreted as the Riksbank's target for the level of the overnight rate (i) in the interbank market. Repos or reversed repos are placed by tender every Tuesday. The repo rate is either fixed and determined by the Riksbank, or variable and set by tender. A fixed repo rate constitutes a considerably clearer signal to the market and provides a distinct indication of the desired direction of interest movements. Repos are normally offered at a fixed rate, leaving the Riksbank's counterparties to tender the volumes they are interested in depositing or borrowing for one week at that rate.

Figure 1
The interest rate corridor

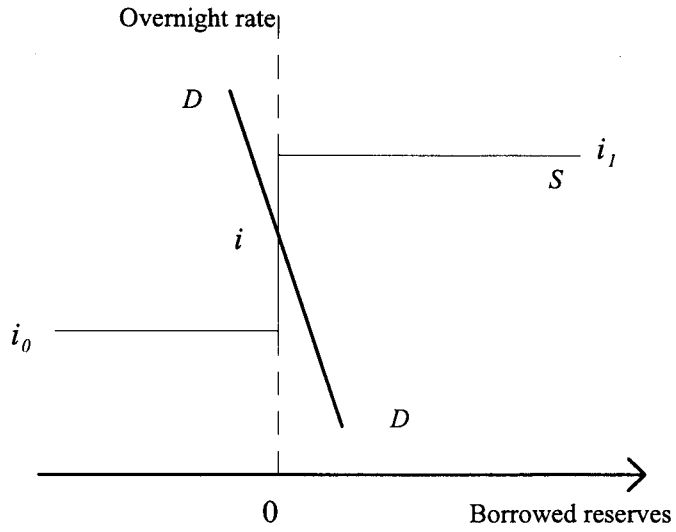
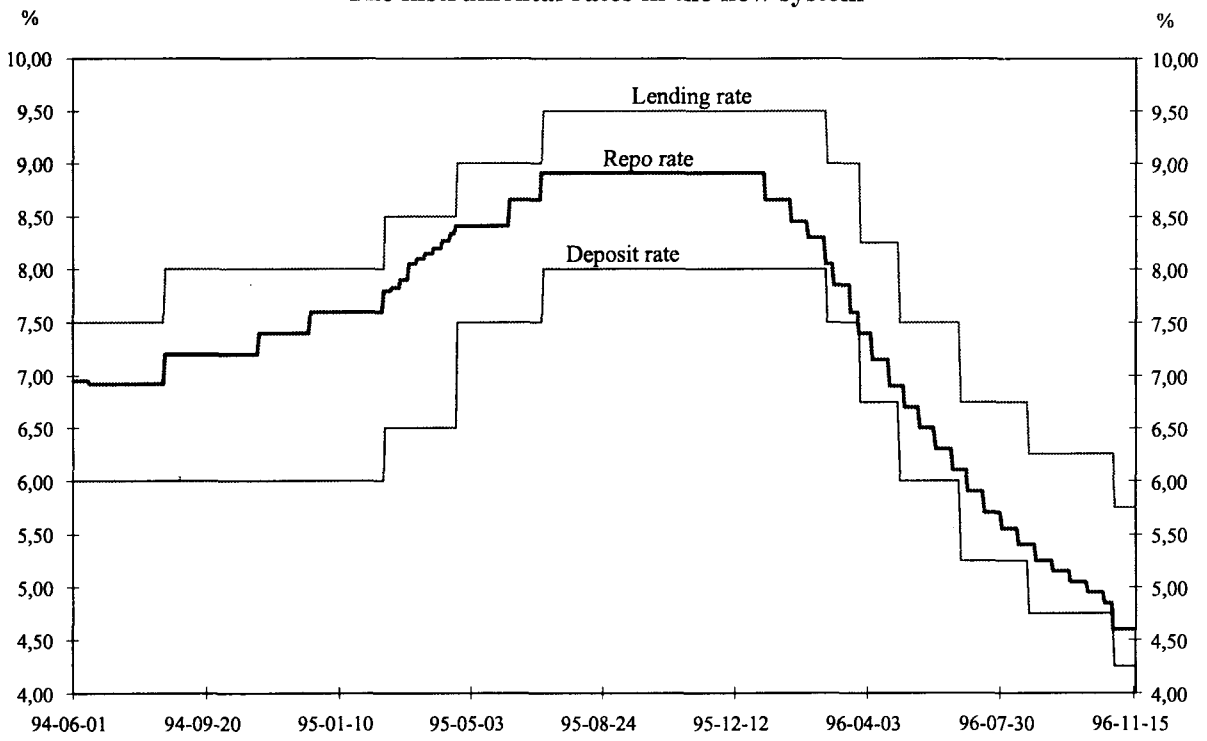


Figure 2
The instrumental rates in the new system



In recent years the Swedish banking system has had an underlying surplus liquidity. To withdraw this surplus, the Riksbank has employed reversed repos; instruments known as Riksbank's certificates are also offered to drain the liquidity (see Table 1).

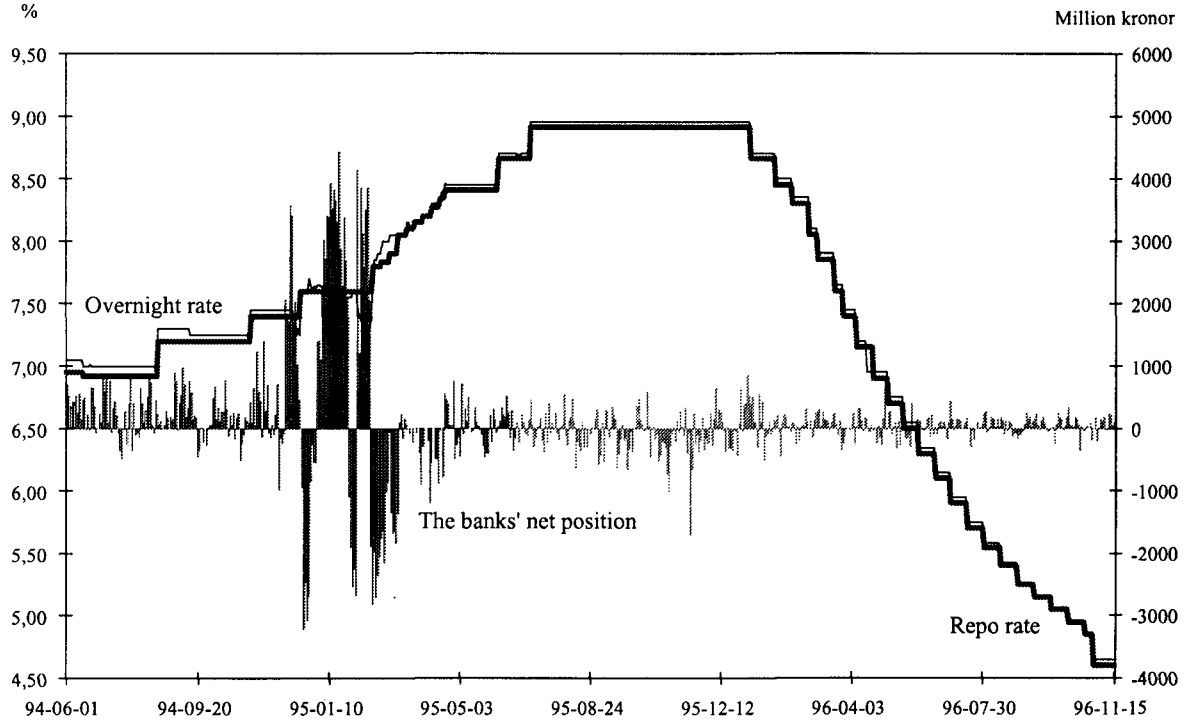
Table 1
The Riksbank's balance sheet, end of October 1996
In billions of Swedish kronor

Assets		**Liabilities**	
Foreign reserves	149	Notes and coins	72
Securities	62	Standing facilities	0
		Riksbank's certificates	59
		Others	80
Total assets	211	Total liabilities	211

The demand for borrowed reserves (the net position of the banking system in the central bank's deposit and lending facilities) is, in practice, entirely determined by the Riksbank's liquidity management (the supply of non-borrowed reserves). As the reserve requirement is zero, the banking system has only two alternatives during the repo period: to use the Riksbank's facilities to deposit/borrow any liquidity surplus/deficit or adjust its demand for bank notes. Since demand for bank notes is insensitive to interest rates in the short run, the interest rate elasticity of demand for reserves is low. Hence, an unexpected shift in the demand for borrowed reserves may have a strong impact on the overnight rate; see the episodes during 1994 and 1995 in Figure 3.

If financial markets function efficiently and risk premia are stable, the longer market rates are mainly determined by the expected overnight rate for the period in question. To make monetary policy's impact on the somewhat longer market rates as distinct as possible, there needs to be a strong

Figure 3
The overnight market



link between the repo rate and the overnight rate, at least in terms of the average for the period. To ensure this, in the past year the Riksbank has chosen to stabilise the overnight rate at the level of the repo rate by fine tuning liquidity so that the supply of borrowed reserves is very close to zero.[3] There are few participants in the overnight market and their liquidity positions can be followed on a continuos basis, which makes the fine tuning easy to implement. The fine tuning implies that the banking system as a whole encounters a marginal net borrowing cost that equals the repo rate, with the result that the overnight rate is established at the same level.

2 Tactics for key rate changes

2.1 Theoretical models of changes in the key rate

It is not unusual to see models of central bank behaviour that include the volatility of the nominal interest rate in the bank's objective function (a recent example is Söderlind (1996)). In such a model the central bank chooses the short-term interest rate, i, so as to minimise an objective function of the form:

$$E_t \sum_{t=0}^{\infty} \beta^t \left(q_y y_t^2 + (1-q_y)\pi_t^2 + q_i i_t^2 \right),$$

subject to some conditions, where β is a discount factor, y is deviations of log output from trend, π_t is the inflation rate, q_y is the weight on output relative to inflation volatility, and q_i is the weight on volatility in the nominal interest rate. One clearly realises that in such a model there will be a high

[3] In order to provide an incentive to use the weekly repos, the rate for fine tuning is actually somewhat inferior to the repo rate.

degree of persistence in nominal interest rates. For example, Söderlind (1996) estimates the optimal simple rule:

$$i_t = 0.04 y_t + 0.06\pi_t + 0.97 i_{t-1}$$

for quarterly US data from 1Q 1960 to 2Q 1994. The 3-month T-bill rate is then assumed to be equal to the theoretical policy instrument, i , plus a normally i.i.d. error term. Hence, the 3-month rate is close to a random walk. This analysis is also in line with Mankiw and Miron (1986), who argue that the Fed's policy of stabilising short-term rates is the reason why some researchers have found close to a random-walk behaviour in short rates.

However, there is no general agreement in the literature as to *why* the central bank would impart a high degree of persistence to nominal interest rates. In Cukierman (1989) the central bank smoothes interest rates so as to cushion against interest rate shocks that could lead to widespread insolvencies in the banking system. Mankiw (1987) explains interest rate smoothing as optimal inflation tax smoothing. The expected dead-weight loss due to a distortionary inflation tax is minimised by maintaining expected constancy in the nominal interest rate.

Goodfriend (1991) finds these two explanations unsatisfying and offers an alternative explanation. He suggests that the routine pursuit of macroeconomic stabilisation policy might induce the central bank to smooth interest rates. The rationale for this is the following. Output and prices respond to changes in longer-term rates and not to changes in the key rate directly. Longer-term rates are determined as an average of expected future key rates. In order to be able to influence expectations about future key rates the central bank has to communicate its policy intentions very clearly. The easiest way to do this is to maintain an expected constancy in the key rate. The key rate is therefore changed infrequently and in relatively small steps.[4]

Models with key rates that change infrequently in discrete steps have recently been proposed by Balduzzi, Bertola and Foresi (1993), Dotsey and Otrok (1995), Rudebusch (1995), and El-Jahel, Lindberg and Perraudin (1996). The first three papers can be said to be attempts to formalise the analysis in Mankiw and Miron (1986) referred to above. In a realistic model of noisy targeting and infrequent target changes, Balduzzi, Bertola and Foresi (1993) show how expectations of future policy actions introduce persistent spreads between interest rates of different maturities. Dotsey and Otrok (1995) and Rudebusch (1995) both construct a model of the term structure coupled with a model of monetary policy. The Fed is assumed to adjust its funds rate target infrequently and in relatively small steps. Term structure tests on simulated data from the models are able to reproduce the empirical results reported in the literature. These results are thus consistent with rational expectations. El-Jahel, Lindberg and Perraudin (1996a) supply analytical solutions for interest rate densities and bond prices under the assumption that short rates follow a pure jump process of which the rate of jump is a function of an Ornstein-Uhlenbeck process. This modelling approach is implemented in El-Jahel, Lindberg and Perraudin (1996b).

2.2 The Riksbank's tactics for key rate changes

An ambition to be transparent and clear should be a fundamentally reasonable premise for any central bank. Transparency is particularly necessary when central banks become more powerful and independent. It is then all the more important that people are able to understand the central banks' objectives, assess their actions and call them to account. Moreover, transparency and clarity are natural components in the smooth functioning of a market-oriented monetary policy. If market agents do not understand the central bank's actions or feel deceived by the measures taken, monetary policy will be less effective. Furthermore, transparency is an important element in the process of establishing credibility for a new monetary policy regime.

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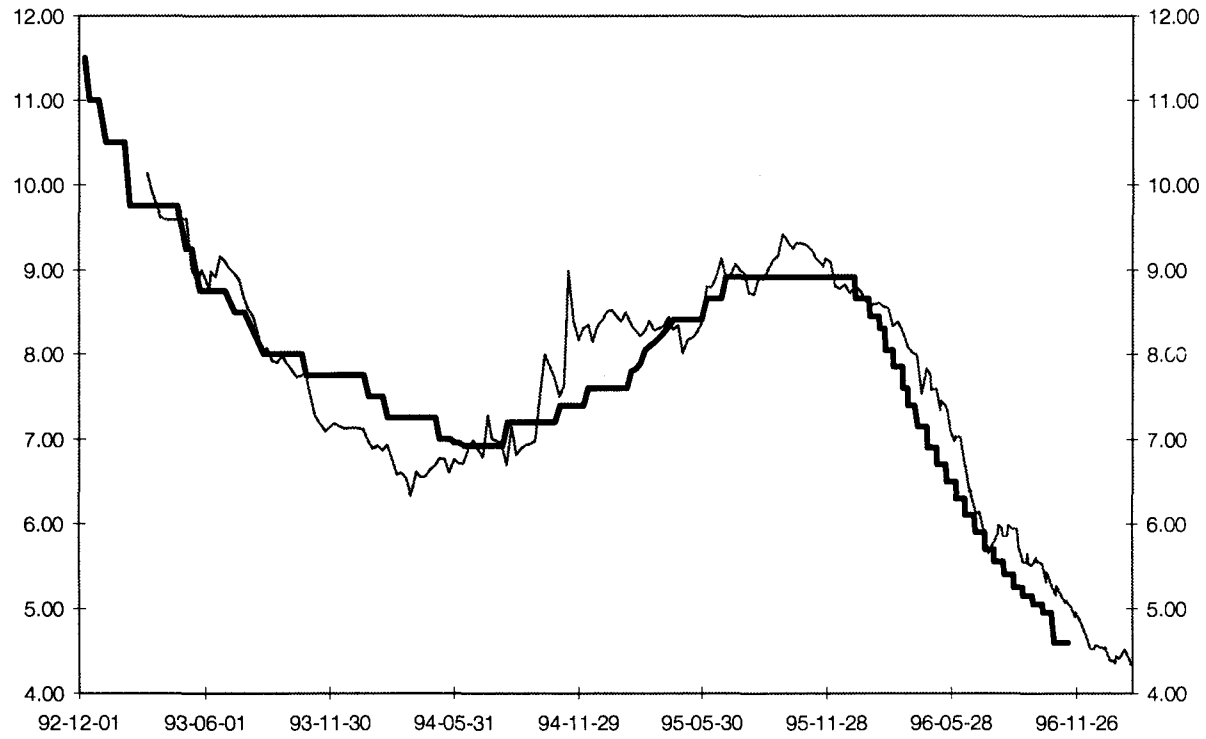
[4] A key rate can be defined as an operational target for a market determined interest rate or as an instrumental rate under the direct control of the central bank.

The Riksbank's intention has been to be transparent in its monetary policy considerations since the explicit inflation target was introduced. There are various ways in which a central bank can influence expectations about monetary policy. The traditional channel of information are speeches and lectures by the Governor and staff of the Riksbank. The Riksbank also issues an inflation report four times a year to present its assessment of future inflation and the conclusions for monetary policy to the financial markets and to the public. In this way the markets get an indication of the Riksbank's intentions and changes in monetary policy will not come as a surprise. The reports also raise the Riksbank's accountability: the analysis behind monetary policy actions is continuously open to public scrutiny and the performance of monetary policy can be evaluated against the objectives.

The market participants have been quite successful in predicting the Riksbank's actions in the short run during the last year. Figure 4 shows the actual repo rate and the expectations three months earlier measured by the overnight forward rate on the same horizon.

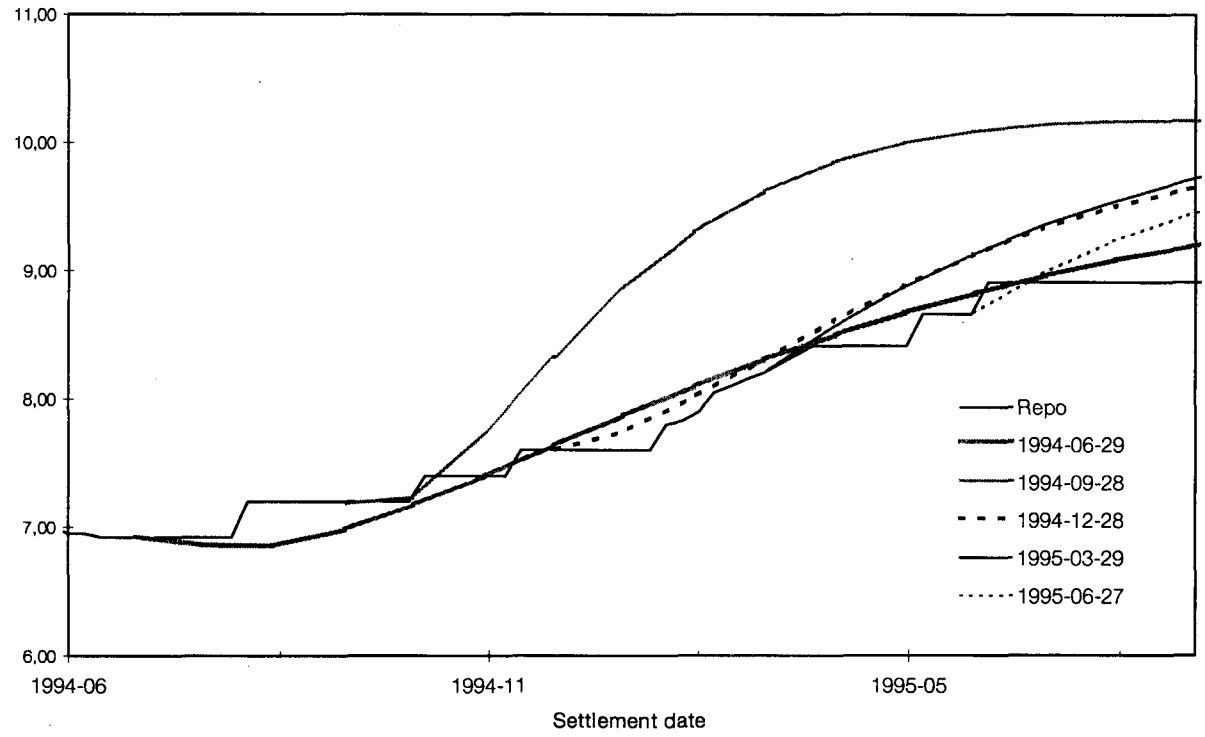
Figure 4
The repo rate and the overnight forward rate, lagged three months



However, there are also episodes when the market participants have failed to predict the repo rate well on a three month horizon. An example of such a period is from mid-1994 to mid-1995. Figure 5 shows the repo rate and the development of the overnight forward rate curve during this period. In August 1994 the Riksbank started to increase the repo rate due to a higher inflation pressure in the economy: the output gap was shrinking, inflation expectations increasing and monetary conditions were fairly expansionary due to the weakness of the krona. The repo rate was then gradually increased by about 2 percentage points to 8.91% in July 1995. The position of the overnight forward curve in late June 1994 indicates that market participants anticipated a tighter monetary policy, but only in the longer perspective. In the short run, they seem rather to have been expecting a lower instrumental rate. The latter was perhaps due to the inflation report in June 1994, which gave a fairly optimistic picture of the inflation pressure. However, new information arrived during the summer that made an immediate monetary contraction unavoidable. The markets seem to have overreacted on the initial interest rate increase with the overnight forward rate curve reaching levels of 9 to 10% within a horizon of a few months. This was partly due to the political turbulence in

connection with the general election in September 1994, but there were also speculations about a return to the old high inflation regime and thus higher risk premia (see Dillén (1996)). After a few months, however, interest rate expectations stabilised along a path that was more in line with the Riksbank's intentions.

Figure 5
Repo rate and overnight forward rate curves, 1994-95

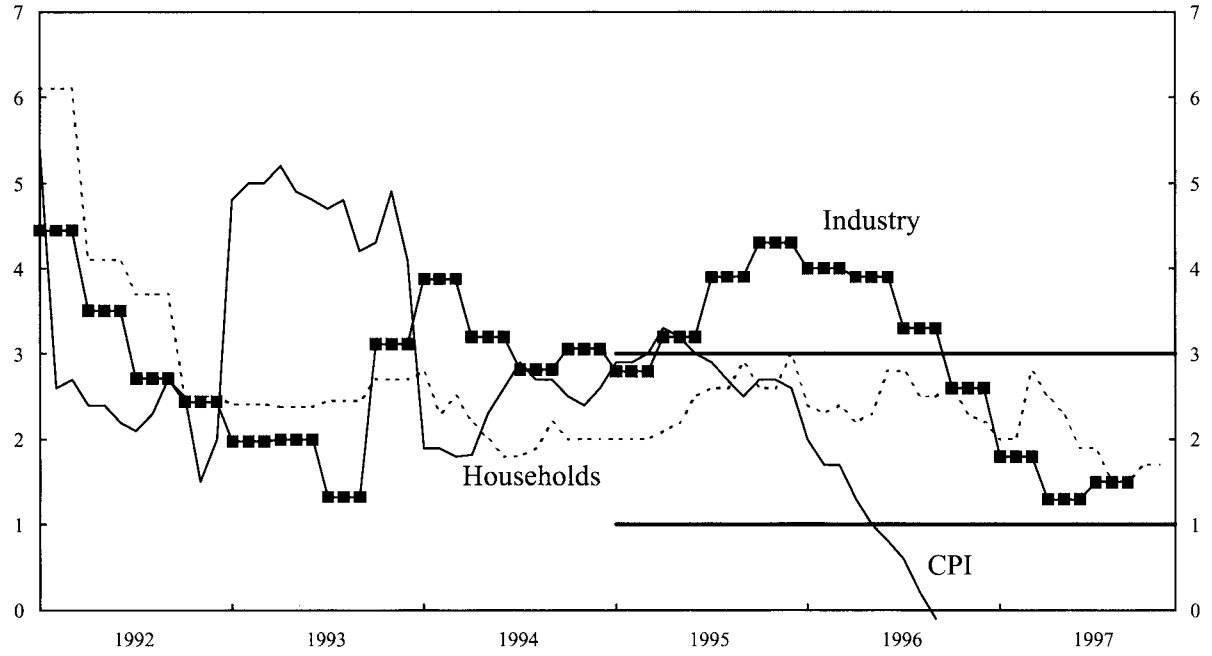


In 1994 there was a general lack of credibility in the ability to conduct an overall economic policy consistent with price stability. There was also a deep concern about the ability to consolidate government finances, which showed a deficit of 12% of GDP in 1993. These credibility problems resulted in a weak and volatile krona exchange rate, which created substantial difficulties in formulating the monetary policy. The volatility of the exchange rate implied that the Riksbank could not control the monetary conditions; that is, the weighted sum of real interest rates and the effective real exchange rate, in the short run. Hence, the so called Monetary Conditions index could not play the role of an operational target and was only used as an indicator of the monetary stance. The exchange rate was in practice treated as endogenous in the inflation forecast and made conditional on, for instance, an assumption of how market participants would react when the success of the budget consolidation became clearer. In such an environment, it is not always easy to be transparent and to give a clear picture of the monetary policy considerations. The best one can do is perhaps to try to focus the debate on fundamental issues.

The conditions for monetary policy changed during 1995. The krona appreciated by approximately 5% in effective terms from January to October 1995 and inflation expectations, according to surveys, came down significantly. The twelve-month rate of inflation was 2.7% in October 1995, which was a decrease of 0.6 percentage point compared with the peak in April 1995 (see Figure 6).[5]

[5] Implicit forward rates are estimated by extending the functional form of Nelson and Siegel (1987); see Svensson (1994).

Figure 6
CPI and inflation expectations of households and industry
Twelve-month changes, in percentages



Note: The curves for expectations have been shifted 12 months into the future, so that they coincide with the period to which the expectations refer.

The situation was approaching a point where it should be feasible to ease monetary policy and lower the repo rate. But as the Riksbank still did not consider that inflation could fall below 2% 1-2 years ahead, there was no cause to alter the monetary stance and the repo rate was left unchanged at 8.91%.

Monetary policy was debated intensely around Christmas 1995, when a majority of observers considered that the Riksbank ought to lower the repo rate. Besides coming from a number of the most frequent domestic contributors to the economic policy debate, this view was heard from foreign stockbrokers and others. However, none of the more established observers or forecasters of the Swedish economy counted on the Riksbank fulfilling its inflation target in 1996 and 1997. At the Riksbank the inflation forecast was gradually revised towards the end of 1995. This was accompanied by an increased probability of an alternative where weaker economic activity pointed to lower inflation. The latter was also something to allow for in the decisions. As a rule, monetary policy decisions are not based on an isolated estimate of future inflation; a number of alternatives are studied and the decisions stem from an assessment of their respective probabilities. In January 1996 this led to the consideration that the time was ripe to start lowering the repo rate.

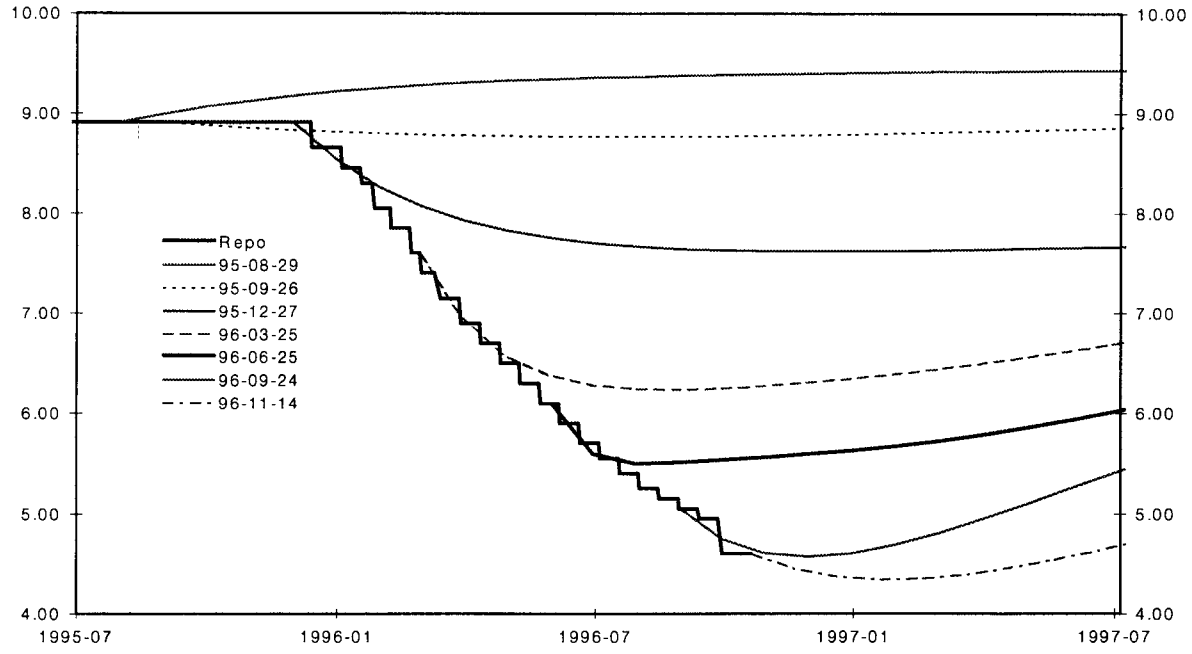
The tactics involved beginning with relatively large steps (25 basis points initially) at fairly regular intervals. As new, favourable information on inflationary pressure flowed in, the assessment of how far down the repo rate would be able to move was revised gradually. The interest rate corridor was adjusted accordingly and more repo rate cuts followed in somewhat smaller steps. In this process, the adjustments of the interest rate corridor were used as a tool to signal the future direction of the repo rate and the speed of adjustment.

It is conceivable that the new information would have warranted cuts in larger steps. However, larger steps could have induced the market to expect lower rates than those that could be implemented with certainty. There was also a general concern about the credibility of the inflation target. The sequence of broadly uniform cuts therefore became relatively long. If today's picture had been completely clear from the start, a couple of larger reductions during the spring might have

seemed natural. At the same time it should be emphasised that there are no ties to any particular pattern. The tactics are always subordinate to the objective of fulfilling the inflation target; new information about inflationary pressure in the economy can always justify a reassessment of the tactics.

On the whole, the actions taken seem to have been intelligible. During the spring and summer 1996 the market's picture of how much the interest rate might be lowered was revised to about the same extent as the Riksbank adjusted its assessment. A picture of how the perceived potential for cuts changed can be derived from the path of the repo rate in relation to the development of the overnight forward curve. For instance, at the end of March the market envisaged that the repo rate would be lowered to just over 6%. That was also approximately the Riksbank's position at that time (see Figure 7).

Figure 7
Repo rate and overnight forward rate curves, 1995-96



From January to October 1996 the policy was successful in the sense that the repo rate could be lowered by more than four percentage points without leading to a weaker krona or higher bond rates. In fact, the opposite occurred: the krona was stronger and bond rates lower in October 1996 than in the beginning of the year. The favourable development of bond rates was even clearer in terms of the differential against German rates and the total effective appreciation of the krona since its weakest position in April 1995 was about 15%. In the inflation report that was published in September 1996 it was concluded that the inflation rate would be in line with the 2% target during 1997 as well as in the first half of 1998.

To conclude, the repo rate has been adjusted gradually in fairly small steps. This pattern is more a result of corresponding changes in the assessment of future inflation than of preferences for interest rate stability. Transparency and clearness have also become an important element of the Riksbank's monetary tactics and are considered necessary to gain credibility and support for the inflation target. The ambition to be transparent and clear together with the inflation target implies that our public assessments of future inflation should have an impact on the short-term market rates. However, market expectations are also influenced by the actual magnitude and frequency of repo rate adjustments together with the Governing Board's decisions to alter the interest rate corridor. Empirical

tests of how speeches, inflation reports and changes in instrumental rates affect market interest rates are presented in the next section.

3 Impact of monetary announcements on market interest rates

3.1 Impact of inflation reports and speeches

In Table 2 we report the impact of inflation reports and speeches by the Governor and Deputy Governors on market interest rates. We have controlled for changes in the repo rate and the interest rate corridor (captured by changes in the lending rate), which in some cases took place on the same day.[6] The estimated model is

$$\Delta r_{it} = \beta_0 + \beta_1 \Delta r_{i,t-1} + \beta_2 REPORT_t + \beta_3 SPEECH_t + \beta_4 \Delta R_t + \beta_5 \Delta R_{t-1} + \beta_6 \Delta L_t + u_t,$$

$$u_t | I_{t-1} = N(0, h_t), \tag{1}$$

$$h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 h_{t-1},$$

where $i \in \{3\text{-month bills, 2-year bonds}\}$, ΔR_t is the change in the repo rate, ΔL_t is the change in the interest rate corridor, the variable $REPORT_t$ ($SPEECH_t$) is a dummy variable that takes the value 1 (-1) if the inflation report (speech) was interpreted (by us) as foreboding monetary tightening (easing) and the value 0 if the report (speech) was neutral. Out of 56 speeches, 12 were seen as foreboding tightening, 9 as foreboding easing, and the rest as neutral or touching subjects other than the inflation outlook and the prospects for monetary policy. The ten inflation reports were coded in the same way: 3-5-2.[7] According to Table 2, the inflation reports have no significant intra-day effect on the 3-month bill rate or the 2-year bond rate, but the coefficients are positive as expected. The problems of finding significant intra-day effects from the inflation reports are not surprising. On some occasions the instrumental rates were changed just before the publishing of a report. The Riksbank thereby revealed, at least implicitly, the conclusions of the reports in advance. Speeches have an effect of approximately two basis points on the 3-month bill rate, which is significant at the 10% level. We will discuss the impact of instrumental rate changes in the next section.

3.2 Impact of key rate changes

Cook and Hahn (1989) examine the influence of monetary policy on interest rates by estimating the effect of changes in the federal funds rate target on market interest rates. They found that changes in the target caused large movements in short-term rates and smaller but significant movements in intermediate- and long-term rates. Also, the magnitude of the effect on the short 3-, 6- and 12-month rates were very similar. Dale (1993), studying the UK market, extended their analysis to take into account the time elapsed between changes and asymmetric responses to those changes as well as turning points in the direction of key rate changes. His results are very similar to those of Cook and Hahn. In addition he finds a significant turning point effect. However, he finds no evidence that the response of market rates to a change in the key rate depends on the time elapsed since the previous key rate change – the duration of the no change period. Nor does he find any evidence that

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6 If the speech was held after 4.00 p.m. the day after the speech is considered as the announcement date, since we use closing market rates quoted at 4.00 p.m.

7 A list of the key rate change announcements and the dates of the inflation reports together with the classification are in Appendix A and B, respectively.

Table 2
Impact on market rates from Sveriges Riksbank inflation reports and speeches by the Governor and Deputy Governor of the Riksbank

Variable	3-month T-bill	2-year T-bond
Mean equation intercept	-0.004 (2.385)	-0.008 (2.986)
$\Delta r_{i,t-1}$	0.067 (1.907)	0.046 (1.307)
$REPORT_t$	0.016 (0.766)	0.001 (0.019)
$SPEECH_t$	0.022 (1.824)	0.014 (1.064)
ΔR_t	0.104 (2.496)	0.087 (1.956)
ΔR_{t-1}	0.084 (2.123)	0.037 (0.773)
ΔL_t	0.032 (1.111)	0.072 (2.145)
Variance equation intercept	0.0001 (3.014)	0.0007 (4.522)
u_{t-1}^2	0.063 (5.399)	0.173 (6.683)
h_{t-1}	0.911 (70.175)	0.753 (23.980)

Notes: t-values are reported within parentheses. The variable $REPORT_t$ ($SPEECH_t$) is a dummy variable that takes the value 1 (-1) if the inflation report (speech) was interpreted (by us) as foreboding monetary tightening (easing) and the value 0 if the report (speech) was neutral.

market rates respond asymmetrically to positive and negative changes or non-linearly to big and small changes in the key rate.

We estimate the following equation for the change in a market interest rate with maturity i on the day of the key rate change announcement:

$$(2) \qquad \Delta r_{it} = \beta_0 + \beta_1 \Delta R_t + \beta_2 (D_t - D_{t-1}) \cdot S_t + \beta_3 \Delta L_t + \beta_4 TP_t \cdot S_t + u_t,$$

where $i \in$ {rates on 3-month bills, 6-month bills, 12-month bills, 2-year bonds, 5-year bonds, 10-year bonds}, $t \in$ {day of key rate change announcement}, ΔR_t is the change in the repurchase rate, D_t is the duration of the no change period, measured as the number of calendar days since the previous repo rate change (not counting the announcement days), S_t is a dummy variable for the sign of the repo

Table 3
Impact on market rates from key rate changes

Panel A: Impact on announcement day

Variable	3-month	6-month	12-month	2-year	5-year	10-year
ΔR_t	0.216 (5.253)	0.159 (3.004)	0.137 (2.423)	0.117 (1.875)	0.097 (1.625)	0.049 (0.854)
$(D_t - D_{t-1}) \cdot S_t$	-0.001 (4.408)	-0.001 (3.758)	-0.001 (2.975)	-0.001 (3.304)	-0.001 (2.483)	-0.001 (2.013)
ΔL_t	0.027 (0.833)	0.059 (1.397)	0.013 (0.306)	0.054 (1.084)	0.041 (0.856)	0.030 (0.653)
$TP_t \cdot S_t$	0.282 (5.687)	0.454 (7.100)	0.500 (6.651)	0.382 (5.279)	0.309 (4.444)	0.493 (6.507)
R^2	0.601	0.598	0.284	0.533	0.423	0.321
DW	1.888	2.230	2.347	2.115	2.366	2.202

Panel B: Combined impact on announcement day and day after

Variable	3-month	6-month	12-month	2-year	5-year	10-year
ΔR_t	0.346 (5.499)	0.265 (3.210)	0.279 (3.181)	0.227 (2.352)	0.188 (2.091)	0.117 (1.350)
$(D_t - D_{t-1}) \cdot S_t$	-0.001 (4.038)	-0.002 (3.335)	-0.001 (2.490)	-0.002 (3.076)	-0.001 (2.206)	-0.001 (1.774)
ΔL_t	0.066 (1.312)	0.116 (1.764)	0.064 (0.991)	0.147 (1.907)	0.141 (1.971)	0.169 (2.438)
$TP_t \cdot S_t$	0.493 (6.507)	0.694 (6.974)	0.335 (2.486)	0.753 (6.484)	0.540 (4.994)	0.397 (3.792)
R^2	0.649	0.606	0.308	0.558	0.458	0.363
DW	2.368	2.275	2.380	2.047	2.227	2.031

Panel C: Combined "impact" over the two days prior to a key rate change

Variable	3-month	6-month	12-month	2-year	5-year	10-year
ΔR_t	0.432 (5.604)	0.313 (4.518)	0.254 (2.458)	0.223 (2.410)	0.196 (1.956)	0.170 (1.586)
R^2	0.370	0.281	0.143	0.111	0.097	0.078
DW	1.457	1.547	1.399	1.855	1.871	1.746

rate change (i.e. $S_t = 1$ if $\Delta R_t > 0$ and $S_t = -1$ if $\Delta R_t \leq 0$), ΔL_t is the change in the interest rate corridor, TP_t is a dummy variable for turning points in the key rate change variable (i.e. $TP_t = 1$ if the sign of ΔR_t is different from the sign of ΔR_{t-1} and = 0 otherwise).

In Table 3 Panel A, the impact on market rates from a change in the repo rate is seen to be small on the announcement day. Only 21.6% of the change is impounded in the 3-month rate on that day. The impact is monotonically decreasing in maturity. For the 10-year bond rate the impact is only 4.9%. Taking into account the day after the announcement increases the impact to 34.6% for the 3-month bill rate and 11.7% for the 10-year bond rate. There thus seems to be some delay in the market's reaction to a repo rate change. This impact can be compared to those found for the same maturities by Cook and Hahn (1989) for the United States and Dale (1993) for the United Kingdom. Cook and Hahn found impacts of around 50% , while Dale found impacts of 20-30% for the 3-, 6- and 12-month maturities on the announcement day. Thus, the impact is much smaller on the announcement day in Sweden. We will come back to the reasons for this below.

A lengthening of the duration of the no change period is seen to have a negative effect on market rates (the coefficients of -0.001 are significant at the 5% level for all maturities). Hence, a lengthening of the duration between repo rate changes by ten days decreases the impact on market rates by one basis point. The market seems to interpret a lengthening in the duration as a signal that the trend of repo rate changes has been weakened. Changes in the interest rate corridor have positive signs for all maturities, but are not statistically significant on the announcement day. However, if the day after the announcement is included the impact is bigger and significant at the 5% level for the longer maturities. The turning point coefficient estimates are quite big as we would expect.

Could the low impact on market rates be due to the repo rate changes having been anticipated by the market? We address this question in Panel C, where we have used as regressand the change in market rates over the two days preceding a repo rate change. It is seen that the changes in the repo rate were to a large extent expected by the market. 43.2% of the change in the repo rate is reflected in the 3-month rate over the two days prior to the announcement. We also note that the "impact" is monotonically decreasing in maturity. For the 10-year bond rate the "impact" is 17%. The Figures in Panel C are much higher than the 15-20% reported by Dale (1993) for the United Kingdom.

Table 4

Expectations of key rate changes in 1996 compared to the 1992-95 period: combined "impact" over the two days prior to a key rate change

Variable	3-month	6-month	12-month	2-year	5-year	10-year
ΔR_t, $t = 1,..,34$	0.471 (4.584)	0.312 (3.479)	0.231 (1.427)	0.201 (1.583)	0.183 (1.313)	0.153 (1.029)
ΔR_t, $t = 35,..,61$	0.174 (0.853)	0.248 (1.158)	0.399 (1.813)	0.178 (0.721)	0.106 (0.405)	0.102 (0.351)

In Section 2 we discussed the efforts by the Riksbank to conduct a transparent monetary policy, especially in the most recent period. This should be reflected in the markets better anticipating changes in the repurchase rate. However, the evidence seems to point in the opposite direction in Table 4. There we report the results for two sub-periods. The same model presented in Panel C of Table 3 has been estimated for the two sub-periods 3rd December 1992 to 4th July 1995 and 9th January 1996 to 24th October 1996 but only the coefficients for the repo rate change variable are reported. The "impact" on the two days prior to an announcement is 17.4% for the most recent sub-period compared to 47.1% for the earlier period. However, this result only says how much expectations were revised over the two days prior to an announcement and does not, for instance, exclude the possibility that expectations in the longer term were more in line with the repo rate in the latter period. We therefore also tested the predictive ability of the overnight forward rate on a 3-month horizon depicted in Figure 4, comparing the 1996 period with the previous period. This is simply

done by regressing the forward rate on the repo rate. The predictive ability is quite high for both periods, the coefficient estimates are 0.97 and 1.02 respectively. The difference is significant at the 1% level according to a formal Chow test. This gives a more satisfying verdict on the transparency of recent monetary policy than the results presented in Table 4.

Table 5
Non-linear impact on market rates

Panel A: Impact on announcement day

Variable	3-month	6-month	12-month	2-year	5-year	10-year
ΔR_t^b	0.199 (4.301)	0.129 (2.195)	0.126 (1.890)	0.065 (0.957)	0.053 (0.818)	0.013 (0.207)
ΔR_t^s	0.140 (0.969)	0.085 (0.463)	0.127 (0.688)	0.340 (1.600)	0.308 (1.511)	0.305 (1.559)
R^2	0.616	0.623	0.280	0.588	0.491	0.392
DW	1.882	2.207	2.376	2.025	2.210	2.017
F (prob.)	0.159	0.816	0.997	0.211	0.226	0.150

Panel B: Combined impact on announcement day and day after

Variable	3-month	6-month	12-month	2-year	5-year	10-year
ΔR_t^b	0.328 (4.564)	0.224 (2.422)	0.292 (2.858)	0.168 (1.554)	0.145 (1.449)	0.081 (0.835)
ΔR_t^s	0.261 (1.161)	0.278 (0.960)	0.412 (1.482)	0.432 (1.280)	0.406 (1.297)	0.378 (1.250)
R^2	0.657	0.624	0.317	0.587	0.489	0.385
DW	2.228	2.179	2.375	1.961	2.042	1.835
F (prob.)	0.771	0.856	0.674	0.446	0.417	0.340

Panel C: Combined "impact" on the two days prior to a change

Variable	3-month	6-month	12-month	2-year	5-year	10-year
ΔR_t^b	0.477 (5.701)	0.335 (4.364)	0.287 (2.309)	0.227 (2.148)	0.203 (1.763)	0.177 (1.451)
ΔR_t^s	0.652 (2.489)	0.509 (2.118)	0.278 (1.000)	0.292 (0.883)	0.244 (0.679)	0.207 (0.542)
R^2	0.437	0.323	0.155	0.111	0.087	0.063
DW	1.536	1.665	1.458	1.891	1.924	1.835
F (prob.)	0.516	0.482	0.976	0.848	0.911	0.939

We have also estimated equation (2) with the ΔR_t variable split into big and small repo rate changes to see if there is a non-linear impact. We have defined a small change to be a change which is greater than or equal to 20 basis points; a big change thus exceeds 20 basis points. The results are given in Table 5, where only the coefficients of the repo rate changes are reported. The hypothesis of a linear impact cannot be rejected in formal F-tests. Thus, there is no evidence that big and small changes in the repo rate have different impacts on market rates. For instance, about one fifth of a repo rate change is reflected in the 3-month rate, irrespective of the size of the change.

3.2 Impact of key rate changes on interest rate volatility

In this section we consider the impact of key rate changes on the volatility in market rates. We estimate the model:

$$(3) \qquad \ln\sigma_{it} = \omega_0 + \omega_1 \ln\sigma_{i,t-1} + \omega_2\left|\Delta R_t\right| + \omega_3\left(D_t - D_{t-1}\right) + \omega_4\left|\Delta L_t\right| + \omega_5 TP_t + u_t,$$

where again $t \in \{\text{day of key rate change announcement}\}$. The volatility is defined as the standard deviation of daily interest rate changes in the days following an announcement:

$$\sigma_{it} \equiv \left[\frac{1}{\min\{10, D_{t+1}-2\}} \sum_{s=1}^{\min\{10, D_{t+1}-2\}} \left(\Delta r_{it_s}\right)^2\right]^{1/2} \quad \text{where} \quad t < t_1 < t_2 < \cdots < t_{D_{t+1}} < t+1.$$

We have not considered a period of more than ten business days after a key rate change in computing the standard deviation. The reason is that we think it is doubtful that the impact would be felt for a longer period, considering that many other things will have happened in the meantime. We also stop two days before the next key rate change announcement if the announcements come that close together. This results in the sample size being reduced to 31 observations.

Table 6
Impact on volatility from key rate changes

Variable	3-month	6-month	12-month	2-year	5-year	10-year
intercept	0.005 (0.436)	0.013 (1.125)	0.234 (1.628)	0.045 (2.578)	0.052 (2.565)	0.053 (2.547)
$\ln\sigma_{i,t-1}$	0.217 (1.402)	0.326 (2.510)	-0.078 (0.393)	0.410 (3.566)	0.399 (2.899)	0.439 (3.162)
$\left\|\Delta R_t\right\|$	0.150 (2.903)	0.085 (2.143)	-0.432 (0.846)	-0.014 (0.290)	-0.035 (0.621)	-0.055 (0.965)
$D_t - D_{t-1}$	-0.0002 (1.088)	-0.0002 (1.729)	-0.0004 (0.272)	-0.0005 (3.256)	-0.0004 (2.394)	-0.0004 (1.961)
$\left\|\Delta L_t\right\|$	0.041 (0.938)	0.046 (1.233)	0.010 (0.021)	0.066 (1.372)	0.069 (1.245)	0.086 (1.533)
TP_t	0.087 (2.885)	0.105 (4.042)	0.249 (0.723)	0.162 (4.702)	0.131 (3.256)	0.118 (2.889)
R^2	0.571	0.620	0.053	0.710	0.602	0.605

In Table 6 there is strong evidence of persistence in volatility, even with the timing conventions we have used in this analysis. The absolute value of a repo rate change has a significantly positive effect only on the volatilities of the 3-month and 6-month interest rates. The absolute value of a change in the interest rate corridor has the expected positive sign, but is not statistically significant at the 5% level. However, the point estimates suggest that the effect is strongest on the longer maturities. We also note the high volatility in connection with a turning point in the direction of key rate changes (keep in mind though that there are only two observations on turning points in the sample). There is also some evidence that lengthening the duration of the no-change period has a dampening effect on volatility in the days after a key rate change.

Conclusions

In this paper we have explained the current system of interest rate policy instruments in Sweden, which was introduced in 1994 as a response to the move to a flexible exchange rate. The tactics of policy rate adjustments and the need for transparency and information disclosure with an explicit inflation target were discussed. The repo rate, the Riksbank's primary instrumental rate, has been adjusted gradually in fairly small steps. This pattern is more a result of corresponding changes in the assessment of future inflation than of preferences for interest rate stability.

The Riksbank has tried to be more transparent in its monetary policy considerations since the shift to the explicit inflation target. However, it is not always easy to interpret the considerations behind monetary policy decisions when there is turbulence in the markets and the overall picture of the state of the economy is blurred. Improved credibility and a more stable situation in the economy during 1996 made it easier in this respect. The communication of the assessments of future inflation and conclusions for monetary policy have run more smoothly and the markets seem to have understood where the Riksbank has been aiming. This view is supported by the position of the overnight forward rate curve, which reflects expectations about future repo rates, at different points in time.

We examined the influence of monetary policy announcements on interest rates by estimating the effects of speeches, inflation reports and changes in the instrumental rates on market interest rates. First, speeches by the Governor and the Deputy Governors influence short-term market interest rates in the way they are intended. For instance, short-term market rates tend to increase when the Governor express worries about the inflation pressure in the economy. Second, changes in the repo rate were to a large extent anticipated by the market, as evidenced by changes in market rates on the two days preceding the announcement of a repo rate change. A third observation is that the impact on the announcement day is monotonically declining in the maturity of the bond. Moreover, a lengthening of the duration between repo rate changes had a dampening effect on the impact of a repo rate change. Finally, a key rate change led to higher volatility on the days following the announcement of the change.

Appendix A

Key rate changes, December 1992 to October 1996

Obs	Announcement	Repo rate	Repo rate change	Deposit rate change	Lending rate change
1	1992-12-03	11.50	-1.00		
2	1992-12-14	11.00	-0.50		
3	1992-01-05	10.50	-0.50		
4	1993-02-05	9.75	-0.75		
5	1993-04-23	9.50	-0.25		
6	1993-04-29	9.25	-0.25		
7	1993-05-13	9.00	-0.25		
8	1993-05-19	8.75	-0.25		
9	1993-07-01	8.50	-0.25		
10	1993-08-05	8.25	-0.25		
11	1993-08-12	8.00	-0.25		
12	1993-10-21	7.75	-0.25		
13	1994-01-20	7.50	-0.25		
14	1994-02-17	7.25	-0.25		
15	1994-05-05	7.00	-0.25		
16	1994-05-26	6.95	-0.05		
17	1994-06-14	6.92	-0.03		
18	1994-08-11	7.20	0.28	0	0.50
19	1994-11-01	7.40	0.20		
20	1994-12-13	7.60	0.20		
21	1995-02-09	7.80	0.20	0.50	0.50
22	1995-02-21	7.83	0.03		
23	1995-02-28	7.90	0.07		
24	1995-03-07	8.05	0.15		
25	1995-03-14	8.10	0.05		
26	1995-03-21	8.15	0.05		
27	1995-03-28	8.20	0.05		
28	1995-04-04	8.27	0.07		
29	1995-04-11	8.34	0.07		
30	1995-04-12			1.00	0.50
31	1995-04-18	8.41	0.07		
32	1995-06-06	8.66	0.25		
33	1995-06-29			0.50	0.50
34	1995-07-04	8.91	0.25		
35	1996-01-09	8.66	-0.25		
36	1996-01-30	8.45	-0.21		
37	1996-02-13	8.30	-0.15		
38	1996-02-22	8.05	-0.25	-0.50	-0.50
39	1996-03-05	7.85	-0.20		
40	1996-03-19	7.60	-0.25		
41	1996-03-21			-0.75	-0.75
42	1996-03-26	7.40	-0.20		
43	1996-04-09	7.15	-0.25		
44	1996-04-23	6.90	-0.25		
45	1996-04-25			-0.75	-0.75
46	1996-05-07	6.70	-0.20		

Key rate changes, December 1992 to October 1996 (cont.)

Obs	Announcement	Repo rate	Repo rate change	Deposit rate change	Lending rate change
47	1996-05-21	6.50	-0.20		
48	1996-06-04	6.30	-0.20		
49	1996-06-18	6.10	-0.20		
50	1996-06-20			-0.75	-0.75
51	1996-07-02	5.90	-0.20		
52	1996-07-16	5.70	-0.20		
53	1996-07-30	5.55	-0.15		
54	1996-08-13	5.40	-0.15		
55	1996-08-15			-0.50	-0.50
56	1996-08-27	5.25	-0.15		
57	1996-09-10	5.15	-0.10		
58	1996-09-24	5.05	-0.10		
59	1996-10-08	4.95	-0.10		
60	1996-10-22	4.85	-0.10		
61	1996-10-24	4.60	-0.25	-0.50	-0.50

Appendix B

Inflation Reports

Inflation report publication date	Code	Repo rate change	3-month rate change	2-year rate change
1993-10-29	-1		-0.01	-0.01
1994-03-14	-1		-0.06	-0.09
1994-06-14	0	-0.03		
1994-10-18	1		+0.01	+0.02
1995-02-28	1	+0.07	+0.08	+0.01
1995-06-20	1		-0.01	0
1995-11-16	0			
1996-03-04	-1		0	+0.10
1996-06-05	-1		-0.08	-0.02
1996-09-24	-1	-0.10	0	+0.02

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