SVERIGES RIKSBANK
WORKING PAPER SERIES
169

How Useful are Simple Rules for Monetary Policy? The Swedish Experience

Claes Berg, Per Jansson and Anders Vredin

AUGUST 2004

WORKING PAPERS ARE OBTAINABLE FROM

Sveriges Riksbank • Information Riksbank • SE-103 37 Stockholm
Fax international: +46 8 787 05 26
Telephone international: +46 8 787 01 00
E-mail: info@riksbank.se

The Working Paper series presents reports on matters in
the sphere of activities of the Riksbank that are considered
to be of interest to a wider public.
The papers are to be regarded as reports on ongoing studies
and the authors will be pleased to receive comments.

How useful are simple rules for monetary policy?

The Swedish experience

Claes Berg, Per Jansson, and Anders Vredin*

Sveriges Riksbank Working Paper Series

No. 169

August 2004

Abstract

Monetary policy is often analysed in terms of simple rules. Such rules may be useful for many purposes, even when they do not describe the actual monetary policy strategy exactly. This paper compares monetary policy in Sweden during the inflation-targeting regime 1993–2002 with the policies implied by certain simple instrument rules. Calibrated rules that are commonly used in theoretical analyses do not provide good approximations of Sveriges Riksbank's (the central bank of Sweden) policy, whereas rules with reaction coefficients that have been estimated using the bank's own (real-time) forecasts do capture policy behaviour quite well. There are different forecast-based rules – including different arguments and forecast horizons – that describe monetary policy about equally well. A close reading of various policy documents, e.g., Inflation Reports, minutes from the bank's Executive Board meetings, and speeches, shows that large deviations from the simple rules are associated with factors that are usually neglected in theoretical models of monetary policy. Examples of such factors are concerns for credibility and uncertainties about various economic relationships.

Keywords: monetary policy, inflation target, Taylor rule, forecast-based policy rules, transparency.

JEL classification: E31, E32, E52.

* Sveriges Riksbank, SE-103 37 Stockholm, Sweden. *E-mail*: claes.berg@riksbank.se; per.jansson@riksbank.se; anders.vredin@riksbank.se. This is a revised version of a paper that was originally prepared for the Workshop on Monetary Policy Rules, European Central Bank, March 11–12, 2002. Comments from Petra Geraats, Stefan Palmqvist, Lars Svensson, and Ulf Söderström are gratefully acknowledged. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Executive Board of Sveriges Riksbank.

1. Introduction

Monetary policy is clearly not a simple undertaking, but if explicit and fairly simple rules can describe typical policy actions quite well, such rules can be used for many purposes. Central banks can use them in their internal analyses, both in macroeconomic forecasting and in formal analyses of alternative policy strategies. The rules can also be used by central banks in their communication, i.e., to explain their strategies to outsiders.[1] The latter, in turn, can use estimated rules in evaluations of past policy (e.g., to separate systematic policy from "policy shocks") and in forecasts of future policy moves.[2] Against this background, it is meaningful to try to study the following questions in more detail: What is the role of monetary policy rules in the effective conduct of monetary policy? How does actual policy compare with the relatively simple rules discussed in the academic literature? In this paper we will study these issues against the background of the experience of implementing the inflation-target strategy in Sweden 1993–2002.

The demand for information about how monetary policy decisions are made has increased during the last decade, partly because of increased central bank independence and the use of more explicit targets for monetary policy. Transparency has also become an important objective for many central banks' communication, in particular banks with a high degree of political independence. Independence implies that transparency is necessary to hold the central bank accountable for its actions. At the same time, explicit targets facilitate transparency. Transparency is also needed to establish credibility for monetary policy on financial markets, which has become increasingly important as a result of higher international capital mobility. However, what central banks should be doing more exactly, to achieve an optimal degree of transparency, remains an open issue. Woodford (2001a) emphasises that transparency primarily is provided by a *systematic policy*:

---

[1] The Reserve Bank of New Zealand uses a simple policy rule to derive interest rate projections that are presented in the bank's Monetary Policy Statements.

[2] Atanasios Orphanides has shown how simple policy rules can be used to shed light on monetary policy in the US, see, e.g., Orphanides (2002). Similar studies of monetary policy in New Zealand and Sweden have been presented by Huang et al. (2001) and Jansson and Vredin (2003), respectively.

" … the goal of transparency should be to make the central bank's behavior more systematic, and to make its systematic character more evident to the public – not the exposure of 'secrets of the temple' as a goal in itself. … it is not clear that provision of the public with full details of the differences of opinion that may be expressed before the committee's eventual decision is reached really favors public understanding of the systematic character of policy. … A central bank should seek to minimize the extent to which the markets are surprised, but it should do this by conforming to a systematic rule of behavior and explaining it clearly… This points up to the fact that *policy should be rule-based.*"

In the academic literature on monetary policy in general, and inflation-targeting strategies in particular, two different models of rule-based monetary policy have been applied. One strand of the literature describes monetary policy in terms of *instrument rules*, the so-called Taylor rule (Taylor, 1993) being the most well known.[3] The other approach is to describe monetary policy in terms of the *objectives and constraints* the policy makers face. This, so-called "targeting-rules" approach has been advocated by Svensson (2001), on the grounds that it better captures the essence of monetary policy making in inflation-targeting countries (such as Canada, New Zealand, Sweden, and the UK). According to Svensson, and Bernanke et al. (1999), among others, the essence of inflation targeting is to formulate explicit objectives and to create institutional mechanisms in order to achieve those objectives.[4] Such a strategy may be difficult to capture in terms of simple instrument rules, like Taylor's.[5]

It is important to distinguish between the choice of a monetary policy *strategy* and central bank *communication*.[6] Using the quotation from Woodford above, one may define the monetary policy strategy as the "systematic rule of behavior" that is followed. Communication, on the other hand, is what the central bank does when "explaining it clearly". In this paper, our primary focus is on communication. The policy rules, or reaction functions, that we analyse and present are not intended to uncover the actual monetary policy strategy, let alone an optimal strategy. We will

[3] It should be emphasised that other instrument rules than the simple Taylor rule have commonly been applied. See, e.g., Leeper and Zha (2001) for a discussion and further references.
[4] Drawing on experiences from the US, Green (2001) also emphasises how institutional design matters for transparency, as a complement to the timing and format of public release of minutes of policy meetings.
[5] Kuttner (2003) uses some fairly simple rules to compare the monetary policies in New Zealand, Sweden, and the UK with monetary policy in the US.
[6] We are grateful to Petra Geraats for making the importance of this distinction clear to us.

focus on their usefulness for communication, in particular for identifying and explaining deviations from systematic behaviour.[7]

Since the Swedish inflation-targeting regime was introduced in January 1993, Sveriges Riksbank has repeatedly described its monetary policy in terms of a very simple rule of thumb. The following quotation is from the Inflation Report in October 1999, but similar formulations have been expressed both before and after that:

" …if the overall picture of inflation prospects (based on an unchanged repo rate) indicates that in twelve to twenty-four months' time inflation will deviate from the target, then the repo rate should normally be adjusted accordingly."

The Riksbank has also been willing to reveal what Woodford calls "secrets of the temple". Inflation forecasts have been published since 1996, and minutes from the Executive Board's meetings have been published (with only a few weeks' delay) since 1999. This increased transparency offers ways towards a better understanding of monetary policy. The published forecasts make it possible to assess how closely the Riksbank has followed the simple rule of thumb it has declared itself. Inflation Reports and minutes from policy meetings potentially provide additional information about policy objectives and systematic behaviour. Using this information, it is also possible to compare the Riksbank's policy with other policies, suggested by commonly used rules in the academic literature. When there is a collegial board which is responsible for setting interest rates, as is the case in Sweden, minutes from policy meetings also facilitate the principal's evaluation of individual board members. This suggests, somewhat in contrast to Woodford's arguments, that there are good reasons for central banks to reveal the "secrets of the temple", as a way to make the systematic character of their policies more evident to the public.

In this paper we will analyse the conduct of monetary policy in Sweden in great detail and use the Swedish experiences for a more general discussion of how useful different simple rules are in practice. We will show that monetary policy in Sweden since the introduction of the inflation target in 1993 can be described relatively well by simple rules which are estimated and relate the instrument rate (repo rate) to the Riksbank's (real-time) forecasts. The estimated forecast-based rules are

[7] Inflation-targeting central banks' communication has recently been criticised by Faust and Henderson (2004). The banks' Inflation Reports have been compared and evaluated by Fracasso et al. (2003).

consistent with the rule of thumb the Riksbank has claimed that it adheres to, but they differ from the usual Taylor rule(s) in important ways. The simple rules that can be used to describe the Riksbank's policy (i) contain parameters that have been estimated rather than calibrated; (ii) include real-time forecasts (of future inflation and possibly real output); and (iii) imply a substantial degree of interest rate smoothing. These results are in themselves not surprising, or even new, given earlier studies by, e.g., Jansson and Vredin (2003) and Kuttner (2003). But in this paper we go one step further and present other considerations that have affected interest rate decisions by the Riksbank, i.e., we provide explanations to the deviations from the simple rule(s). Our studies of various policy documents suggest that large deviations are due to problems that are not given much attention in standard models of monetary policy. In other words, a large part of monetary policy is possible to understand with the help of relatively simple rules, but in order to understand more than that, we have to consider aspects of monetary policy that are often neglected in standard theoretical models. This shows that comparisons of actual monetary policy with relatively simple rules are useful and constitute a way to form ideas for further research, especially since the sources of "policy shocks" that we can identify clearly are relevant for monetary policy also in other countries than Sweden.

The paper is organised in the following way. In the next section we present some explicit monetary policy rules that have been applied in the earlier literature. In Section 3 empirical analyses of simple rules based on Swedish data are presented. In Section 4 we take a closer look at the Riksbank's policy using various policy documents and use this information to discuss the deviations from the simple rules that we identify in Section 3.

2. Simple rules for monetary policy

Since the peak of inflation, which in many countries occurred around 1980, researchers, central bankers, and politicians have searched for principles for monetary policy that can create expectations of low and stable inflation. Many central banks have announced explicit inflation targets and have also achieved increased independence to achieve their goals. Transparency about monetary policy has also increased, in the

sense that central banks now provide much more information about their policy processes than they used to do. This development, in turn, has inspired further research about what central banks are actually doing.

A well known simple rule that is often used to describe monetary policy is the *Taylor rule*, which relates the nominal interest rate (the policy instrument), i_t, to the deviation between current inflation, π_t, and the inflation target, π^*, as well as to the gap between current output and some (possibly time-varying) target, $y_t - y_t^*$:

$$i_t = i_0 + \alpha(\pi_t - \pi^*) + \beta(y_t - y_t^*), \qquad (1)$$

where i_0 is the target level for the nominal interest rate. Taylor (1993) found this rule to describe US monetary policy quite well, and it has subsequently been argued both that this rule also can describe monetary policies in many other countries, and that it may be an almost optimal monetary policy rule.[8] Questions about optimal monetary policy strategies are, as pointed out above, outside the scope of the present paper. An observation that is more relevant here is that when the Taylor rule is estimated empirically, it is often found that it is necessary to include the lagged level of the policy instrument, i_{t-1}, to get a regression equation with acceptable statistical properties. Some interpret this as a sign that the monetary policy rule is mis-specified, others view this as a sign of deliberate interest rate smoothing by the central bank.[9]

Svensson (2001) argues that the simple Taylor rule (1) (whether it is augmented by a lagged interest rate or not) does *not* give the right insights about what inflation-targeting central banks are doing. Instead, he suggests specifying an objective function which describes the losses (costs) for the central bank in terms of the expected discounted deviations of inflation and output from their targets, a so-called *"general targeting rule"*. Then, the central bank's aim is to solve the following minimisation problem:

---

[8] In Taylor's original formulation, π_t = the rate of inflation (the GDP deflator) over the previous four quarters, $\pi^* = 2$, $i_0 = 4$ (= π^* + an estimate of the "equilibrium" real interest rate), and $y_t - y_t^*$ = the deviation between real GDP and a trend growing with 2.2 per cent per year. On the optimality of the Taylor rule, see Svensson (2001) and Woodford (2001b).

[9] See, e.g., Rudebusch (2002) and Söderström, Söderlind, and Vredin (2002).

$$\text{Min } E[\Sigma\, \delta^{\tau} L_{t+\tau}], \tag{2}$$

where the summation over τ is from zero to infinity. The "period loss function" L_t is typically given by

$$L_t = 0.5[\,(\pi_t - \pi^*)^2 + \lambda(y_t - y_t^*)^2]. \tag{3}$$

Here, λ measures the weight the central bank attaches to output fluctuations, relative to fluctuations in inflation. Svensson calls a loss function characterised by $\lambda = 0$ "strict inflation targeting", while $\lambda > 0$ is called "flexible inflation targeting". If we are willing to write down a simple enough model that describes the interdependencies between i_t, π_t, and y_t, we can derive the optimal policy that solves the minimisation problem in (2).[10] Svensson shows that in a standard forward-looking so-called New Keynesian model, optimal policy can be characterised by the following "*specific targeting rule*":

$$E(\pi_{t+s}) - \pi^* = -(\lambda/\gamma)\,[E(y_{t+s}) - E(y_{t+s-1})\,]. \tag{4}$$

That is, the interest rate should be set so that the forecasted deviations from the inflation target are proportional to the forecasted changes in the output gap. (Here, γ is the sensitivity of inflation to the output gap, i.e., the slope of the Phillips curve.)

Central banks with explicit inflation targets frequently emphasise that their policy is based on forecasts, and that they are not "strict" but "flexible" inflation targeters. For instance, Heikensten (1999) argues that the Riksbank's policy is based on an assessment of inflation one to two years ahead, but also that the development of the real economy matters for how fast the Riksbank wishes to bring inflation back to target. This is consistent with Svensson's "targeting rules", but also with the simple rule of thumb mentioned in the Riksbank's Inflation Reports. However, the inflation-targeting central banks seem to put more emphasis on a specific "target horizon" than

[10] The solution will be different depending on whether we assume that the central bank can credibly once and for all commit to a certain policy rule, or whether the central bank re-optimises in every period, i.e., follows a discretionary policy. Since binding commitments are typically not assumed to be a relevant policy alternative, most interest in the academic literature has been focused on the

what is justified by the intertemporal optimisation framework suggested by Svensson (an observation made also by Faust and Henderson, 2004). An alternative interpretation of what the inflation-targeting central banks are doing is thus to describe their behaviour in terms of a forecast-based instrument rule of the Taylor type, e.g.,

$$i_t = i_0 + \alpha(\pi^F_{t+s} - \pi^*) + \beta(y^F_{t+h} - y_t^*), \qquad (5)$$

possibly augmented by the lagged interest rate for reasons previously discussed. Here the notation x^F is used to denote the forecast that enters the central bank's reaction function. Note that (5) allows for different target horizons for inflation and the output gap, but assumes that both horizons are fixed.

The Riksbank has explicitly stated that it focuses on the forecast of inflation twelve to twenty-four months ahead, and that the forecast is conditioned on an unchanged interest (repo) rate. If the time index t denotes quarters and π_t measures the annual rate of inflation (the rate of increase in the price level between t and $t-4$), then this may be interpreted to mean that π^F_{t+s} in rule (5) should be equal to $\pi^F_{t+8} = E(\pi_{t+8} \mid i_{t+j} = i_{t-1})$, $j > 0$.[11] The choice of the forecast horizon for the output gap is less obvious, but given the standard view on the transmission mechanism of monetary policy it seems reasonable that $h < s$. One possibility is to assume $s = 0$, just like in the original Taylor rule. In practice, even the current output gap has to be forecasted, since neither the level of potential output nor that of actual output can be observed within the quarter (the former is unobservable and the latter is published with a considerable lag). These considerations lead to the following alternative approximation of the Riksbank's reaction function:

$$i_t = i_0 + \alpha(\pi^F_{t+8} - \pi^*) + \beta(y^F_t - y_t^*) + \rho i_{t-1}. \qquad (6)$$

---

discretionary solution. The ideal commitment policy is sometimes used as a benchmark; see, e.g., Nessén and Vestin (2000).

[11] Leitemo (1999) analyses, and criticises, another "constant-interest-rate" rule, where $E(\pi_{t+8} \mid i_{t+j} = i_t) = \pi^*$, $j = 0, 1, \ldots, 8$. See also Goodhart (2001), Honkapohja and Mitra (2003), and Vredin (2003) for discussions of such rules.

Rudebusch and Svensson (1999) have evaluated this policy rule and compared it with the Taylor rule (in a study using US data).[12] The forecasts in the Rudebusch-Svensson rule (6) are conditioned on an unchanged interest rate.

It is well known that central banks do not try to implement any relatively simple instrument rule exactly, but that they take many conditions into account when making decisions on monetary policy. In this sense, the "targeting rules" advocated by Svensson may, in principle, be more realistic. On the other hand, "targeting rules" may involve quite complex interest rate reaction functions. Such rules may therefore not be simple enough to be transparent and useful for the purpose of analysing policy. Some statements by central banks – like the explicitly stated rule of thumb of the Riksbank – do give the impression that the banks really try to stick to relatively simple instrument rules, while other descriptions – see, e.g., Archer (2003) – are closer to "targeting rules".

Against this background, instrument rules like (1), (5), (6), and the optimum condition (4) should all be viewed as possible descriptions of the policies by inflation-targeting central banks like the Reserve Bank of New Zealand, Bank of England, and Sveriges Riksbank. All these rules are based on the idea that the objective of monetary policy is to bring inflation and inflation expectations back to target, at a speed that depends on the level of activity in the economy. The differences between instrument rules and "targeting rules" should thus not be overstated.[13] In any case, the usefulness of different rules cannot be decided on theoretical grounds only. This leads us to our empirical analyses of some simple instrument rules.

[12] The coefficients in the optimal instrument rule depend on the central bank's preferences. Jansson and Vredin (2003) use $\alpha = 1.5$, $\beta = 0.5$ and $\rho = 0.6$. This is close to an optimal rule according to Rudebusch and Svensson (1999), if the weight on output stabilisation is the same as the weight on inflation stabilisation ($\lambda = 1$), and twice as large as the weight on interest rate smoothing.

[13] Furthermore, as shown by Svensson (2001), it is possible to derive Taylor-type rules as linear approximations of optimal targeting rules. This does not settle the questions about policy relevance, however.

3. Empirical analyses of simple rules

In this section we will examine empirically how well different simple rules are able to describe monetary policy in Sweden during the inflation-targeting regime 1993–2002. We will consider both instrument rules in the spirit of Taylor (1993) and forecast-based rules as suggested by, e.g., Rudebusch and Svensson (1999). The forecast-based rules use the official quarterly real-time forecasts made by Sveriges Riksbank since the introduction of the inflation target in 1993.[14] These forecasts are forecasts of the growth rates of GDP and CPI at the current-year, one-year, and two-year horizons.

The simplest rule that we will consider is Taylor's original calibrated instrument rule; that is, equation (1) with $\alpha = 1.5$ and $\beta = 0.5$. Compared with Taylor (1993) our calibration differs in two respects. First, we use the rule in differenced form rather than in levels. And, second, we use the Riksbank's current-year forecasts of the explanatory variables rather than their actual (ex post) values. The importance of using real-time rather than ex post data when estimating monetary policy reaction functions has been emphasised by Athanasios Orphanides in several papers, e.g., Orphanides (2002). To use a specification in differenced form is convenient because this eliminates the problem of calibrating the (constant) target level of the interest rate. Moreover, since the output gap is unobservable even ex post, it has to be estimated. Rather than using some econometric procedure to estimate potential output and the output gap we have chosen to use the Riksbank's forecasts of GDP growth together with an assumed potential growth rate of 2.2 per cent per year (as in Taylor, 1993, and Jansson and Vredin, 2003).

In practice it often turns out that actual monetary policy cannot be accurately described without allowing for some smoothing of the interest rate (see, e.g., Clarida et al., 2000). To deal with this, we also consider a calibrated Taylor rule that includes a lagged interest rate as an additional explanatory variable. For this rule, the coefficient on the lagged interest rate is set to 0.6 and the values of the other reaction coefficients are changed in such a way that Taylor's original parameterisation

[14] For a more detailed discussion of the data, see Jansson and Vredin (2003). The data set that is used in our analyses is an updated (and slightly revised) version of the data set used in Jansson and Vredin. The data are given in Tables 4 and 5.

is obtained as the static long-run solution.[15] In the general case, the calibrated versions of the Taylor rule that we will consider thus have the following form:

$$\Delta i_t = \rho \Delta i_{t-1} + \alpha_0 \Delta \pi^F_{t,0} + \beta_0 (\Delta y^F_{t,0} - 2.2), \qquad (7)$$

where i_t is (a log transformation of) the Riksbank's repo rate, and $\pi^F_{t,0}$ and $\Delta y^F_{t,0}$ the Bank's forecasts, made in quarter t, of CPI inflation and real GDP growth in the current year ("year 0").[16]

Instead of calibrating the policy rules it is of course also possible to estimate them. One advantage of using the reaction functions in estimated rather than calibrated form is that we can get rid of the problem of calibrating the growth rate of potential GDP and do not have to specify the rules in differenced form. The reason is that the estimation constant will implicitly capture both the growth rate of potential GDP and the target level of the policy rate, although leaving these quantities individually unidentified. The estimated reaction functions that we will consider are all of the following form:

$$\Delta i_t = c + (\rho - 1) i_{t-1} + \sum \alpha_i (\pi^F_{t,i} - 2) + \sum \beta_j \Delta y^F_{t,j} + e_t, \qquad (8)$$

where the summations, in the general case, are over the current year ("year 0"), one year ahead ("year 1"), and two years ahead ("year 2"). The interest rate on the left-hand side is in first differences in order to make the R^2s of the calibrated and estimated rules comparable.[17]

The simplest estimated policy rule that we will consider is a version of the Taylor rule that allows for interest rate smoothing, i.e. equation (8) estimated under

---

[15] For purposes of better assessing the individual contribution of interest rate smoothing we have estimated an AR(1) equation for the interest rate. This equation has a fit of 18 per cent in terms of R^2. Thus, while the lagged interest rate may be of some importance more information seems to be needed in order to get a good desciption of actual policy.

[16] The interest rate is defined as $i_t = 100 \ln(1 + r_t/100)$, where r_t is the repo rate, in per cent, at the end of quarter t.

[17] The specification in levels is $i_t = c^* + \rho^* i_{t-1} + \sum \alpha_i^* (\pi^F_{t,i} - 2) + \sum \beta_j^* \Delta y^F_{t,j} + e_t^*$. Specification (8) is obtained by adding and subtracting a lagged interest rate to this level form. The parameters and residuals of the level specification and (8) are related as follows: $c^* = c$, $\rho^* = \rho$, $\alpha_i^* = \alpha_i$, $\beta_j^* = \beta_j$, $e_t^* = e_t$. Hence, these two specifications are econometrically equivalent. The equivalence obtains as long as the level specification includes a lagged dependent variable.

the restriction $\alpha_1 = \alpha_2 = \beta_1 = \beta_2 = 0$.[18] Other rules that we will consider comprise calibrated and estimated versions of the instrument rule suggested by Rudebusch and Svensson (1999) (cf. equation (6)), an estimated version of the rule of thumb cited in the Riksbank's Inflation Reports, and a purely empirical rule derived using the so-called general-to-specific (GTS) methodology (see, e.g., Hendry, 1995).[19] The rule based on the GTS principle starts from a general model based on all available forecasts that the Riksbank has published (and also allowing for lags). The procedure then entails simplifying the general specification by excluding insignificant arguments while checking that each simplified model fulfils the criterion of being statistically well specified according to conventional error-term tests.

The details of the different rules are given in Table 1. As expected, when rules are estimated the lagged interest rate is highly significant. The coefficient value is around 0.7–0.8, implying substantial interest rate smoothing in Swedish monetary policy.[20] Furthermore, and also in line with what is expected, the inflation forecasts seem to be somewhat more important for policy than the output forecasts. The long-run response of the interest rate from an increase in forecasted inflation by 1 percentage point is roughly the same for all estimated rules, 2.2–2.4 percentage points. But the interest rate effect from a unit increase in expected output growth displays a greater dispersion: it is around 1.4 percentage points for the estimated Taylor rule, 0.7 percentage points for the GTS-based rule, and merely 0.25 percentage points for the estimated Rudebusch-Svensson rule.[21] In relation to the long-run responses of the calibrated rules, the estimated rules have larger responses on expected inflation in the case of the Taylor rules but smaller responses in the case of the Rudebusch-Svensson rule.

---

[18] Since Sweden is a small open economy one may also wish to experiment with rules that include exchange rate changes as a further source of policy reactions. However, exchange rate changes usually turn out to add very little to the performance of monetary policy. For example, an estimated Taylor rule (with smoothing) that excludes the exchange rate has a fit of 63 per cent in terms of R^2. This fit only improves marginally, to 64 per cent, when exchange rate changes are added. The finding that the exchange rate adds little is in line with previous research, see, e.g., Taylor (2001).

[19] For further details of the specifications, see Table 1.

[20] For the US, the typical estimate is similar but somewhat lower, see, e.g., Judd and Rudebusch (1998) and Kuttner (2003).

[21] We call the empirical counterparts of equation (6) "Rudebusch-Svensson rule" for purposes of simplicity. We are aware of the fact that many other researchers have suggested similar types of forward-looking rules.

Table 2 gives measures of goodness of fit and error-term diagnostics of the different rules. From these statistics three conclusions emerge quite clearly. First, without a lagged interest rate, the explanatory power is very low. This, of course, just underlines the above-mentioned finding that the lagged interest rate is empirically significant. Second, to get a satisfactory R^2, the values of the reaction coefficients need to be estimated rather than calibrated. Even with interest rate smoothing, the best calibrated rule (Taylor) merely explains half of the interest rate changes that have been made. Third, provided that the rule allows for smoothing and is estimated, the exact timing of forecast horizons and whether the policy rate responds to any output variable or not does not seem to be crucial. The R^2s of the estimated Taylor rule (with smoothing), Rudebusch-Svensson rule, and rule of thumb are all quite similar, in the neighbourhood of 0.6. But, as shown by the results for the GTS-based rule, including an empirically determined sequence of forecasts makes it possible to further improve on the fit. That the fit of the GTS-based rule is good is also confirmed by the fact that this rule is among the rules that generate residuals that pass all the diagnostic tests (at the conventional significance levels).

Another way of assessing the goodness of fit of our rules is to make comparisons with previous estimates of such relations. Judd and Rudebusch (1998) undertake estimates for the US, using various sub-samples and alternative measures of inflation and real activity over the period 1970–1997. All in all, they estimate 24 different rules for the changes in the federal funds rate. Their top-performing rule has an R^2 at 67 per cent. Most of their rules, however, have R^2s around 50 per cent. Thus, by this measure too, the explanatory power of our estimated rules (with interest rate smoothing) has to be judged to be relatively high. This applies in particular to the GTS-based rule, for which the R^2 is at 77 per cent.

While the GTS-based rule displays the best fit, it may still be that the implied policy behaviour and policy deviations (i.e., differences between actual and rule-based interest rate changes) generated by other rules are quite similar. To look into this issue we compute the contemporaneous correlations between the deviations from the rules. These are shown in Table 3. Focusing again on the GTS rule, it can be seen that the deviations from this rule correlate significantly with the deviations from the other estimated rules. The correlations with the calibrated rules are, on the other hand, rather low and insignificant. The deviations that correlate best with the

deviations from the GTS rule are those generated by the estimated Taylor rule (with smoothing) and the rule of thumb.

To shed some further light on the different implications of the various rules, graphical comparisons are undertaken in Figures 1 and 2. Figure 1 compares the deviations from the GTS rule with the deviations from the three calibrated rules. As can be seen, the calibrated rules imply a policy that is too aggressive, with interest rate swings that are larger and more erratic than in the case of the GTS rule. This holds true whether or not a smoothing mechanism is present (although obviously less pronounced in the case of smoothing). Figure 2 plots the deviations from the estimated rules. This figure confirms the relatively high degree of coherence between these rules, but also shows that their agreement depends (positively) on the size of the deviations. In particular, according to all four rules, sequences of positive deviations occur during 1995 and 1998 while a series of negative deviations are registered during 1996. Because these deviations are common to all the estimated rules they may be viewed as a robust feature of our descriptions of policy during the particular episode under consideration. In this case, it may also be appropriate to think of the deviations as representing significant *shocks* to monetary policy – no matter what (simple) rule that is used, certain interest rate decisions remain largely unexplainable.[22]

Although the deviations from the estimated rules are quite similar in general, occasions can be found on which they differ. To highlight the difference between a forward-looking policy and a policy that is determined solely on the basis of the current state of the economy we may compare the deviations from the rule of thumb (or Rudebusch-Svensson rule) with the deviations from the Taylor rule. The largest differences between the deviations occur during the fourth quarter 1994, the fourth quarter 1995, and the third and fourth quarters 1996. In 1994, the inflation target and the new policy regime still lacked credibility due to the accommodative economic policy that was conducted during the 1970s and 1980s.[23] This is one of the reasons why the inflation forecasts a couple of years ahead, at that time, were

[22] As can be seen from Figure 2, there is also some communality between the deviations during 2001. However, the size of these deviations is close to the residual standard deviation of the estimated rules (at roughly 0.3–0.35 percentage points). These deviations are therefore not judged to be genuine policy shocks.

[23] During these two decades Sweden basically had a fixed exchange rate but the currency was devalued on several occasions. Devaluations occurred in 1973, 1976, 1977 (two times), 1981, and 1982.

considerably higher than the target rate of 2 per cent. Therefore, the Riksbank's current-year forecast of inflation was lower than its forecasts for 1995 and 1996, generating a higher interest rate according to the forward-looking rule of thumb (or Rudebusch-Svensson rule) than the Taylor rule (and thus a positive difference between the residuals of the Taylor rule and the forecast-based rules, see Figure 2). After several interest rate increases, the inflation target successively gained credibility during 1995, which – among other things – contributed to a rather sharp appreciation of the exchange rate and lower public inflation expectations. These factors also contributed to lowering the Bank's inflation forecasts one and two years ahead, which during 1995 fell by around 1 percentage point. Thus, by the end of 1995 the Riksbank's current-year forecast of inflation was slightly higher than its one year ahead forecast. This generates a positive difference between the interest rate implied by the Taylor rule and the forecast-based rules. In 1996, credibility was further enhanced and during the autumn that year the inflation forecasts one and two years ahead were only marginally above target. At the same time, actual inflation fell quite dramatically due to a combination of lower interest rates and a subdued imported rate of inflation.[24] This was also reflected in the Bank's current-year forecasts, which dropped from around 2 per cent to roughly 1 per cent. This accounts for the positive difference between the deviations (residuals) from the Taylor rule and the forecast-based rules in the third and fourth quarters 1996.

An important issue is of course how robust our results are with respect to reasonable alterations of the specification of the various rules. To investigate this we have undertaken a number of additional sensitivity tests. These involve (i) measuring the policy rate as a quarterly average rather than as an end-of-quarter value; (ii) using forecasts of so-called underlying inflation instead of headline inflation;[25] (iii) using

[24] During the course of 1996 the Riksbank lowered the repo rate by approximately 5 percentage points, from around 9 per cent to approximately 4 per cent. The reason why this puts downward pressure on the CPI (in the short run) is that CPI includes house mortgage interest expenditures, which correlate positively with the repo rate. The low imported inflation rate was a consequence of the appreciating exchange rate.

[25] This may be interpreted as an alternative (or complementing) way of acknowledging the possibility that not only the inflation target in terms of the CPI matters for monetary policy. Because measures of underlying inflation are smoothed, they imply that certain movements in headline CPI are not counteracted by policy measures. In so far as these movements are not due to shocks to aggregate demand, looking at underlying rather than headline inflation thus implicitly contributes to also

consecutive twelve-monthly inflation figures rather than end-of-year figures; (iv) undertaking the estimations on different sub-samples; and (v) using alternative methods of estimation.[26]

The conclusion from these robustness exercises is that the results, as given in Figures 1 and 2, are markedly – and indeed surprisingly – robust to the alterations. This is an interesting observation in itself. One conceivable reason why different simple rules imply very similar policy behaviour is that forecasts of inflation and output at different horizons are strongly correlated. This should be a general result that should be kept in mind when formulating and interpreting the communication of forecast-targeting central banks.[27] In the next section we will scrutinise various real-time policy documents – in particular the Minutes from the Riksbank's Executive Board's meetings – to see whether additional information can be gained for purposes of better understanding the robust deviations from the policy rules (significant policy shocks) that have been identified.

4. Understanding the deviations from the simple rules

In order to understand the deviations between the best performing rules (the estimated rules that are based on real-time data and allow for interest rate smoothing) and actual monetary policy decisions, it is necessary to give a background to the implementation and communication of monetary policy. In our analyses of the Riksbank's policy after the introduction of the inflation target in January 1993, we have found it useful to describe the inflation-targeting regime in terms of three different phases. During the *first* phase, 1993–1995, the primary objective was to *establish credibility* for the new regime. The inflation target was adopted in January 1993, but was

---

stabilising the real economy. For a theoretical analysis of the concept of "core inflation" and its relation to monetary policy, see Nessén and Söderström (2001).

[26] The specification choices that underlie the different rules are of course enforced by the information that we have at our disposal. For example, for the period 1992–1996 the Riksbank has only published its end-of-year forecasts of headline CPI inflation. In order to be able to use the forecasts of underlying inflation or consecutive twelve-monthly figures (both available from 1997 and onwards only), we thus need to pool two different types of information, which introduces a further source of uncertainty.

[27] Similar results have been reported for New Zealand by Huang et al. (2001).

set so as to be achieved from 1995 and onwards.[28] The Riksbank thus gave itself a lead-time of two years. There were several reasons for this. Monetary policy was operating in a completely different framework than under the fixed exchange rate regime that had been in place throughout the post-war period. The macroeconomic crisis was also severe. On the one hand, there was little inflationary pressure through capacity utilisation since the economy was in a deep recession. On the other hand, the collapse of the fixed exchange rate was associated with a steep depreciation of the krona that was considered a major risk for future inflation.

Between 1993 and 1995 long-term (five year) inflation expectations of agents on the money market fell from above 4 per cent to 3 per cent, i.e., to the upper bound of the Riksbank's tolerance interval; cf. Figure 3. The median inflation forecast two years ahead by external forecasters was however around 3 per cent already in the beginning of 1993 and it dropped to between 2.5 and 3 per cent in first half of 1994 (see Jansson and Vredin, 2001). The picture of the inflation target's credibility thus differs depending on whether one looks at survey data or official forecasts.

In the *second* phase, 1996–1998, credibility problems were less pressing, which opened the possibility for so-called *flexible inflation targeting* with some attention paid also to output stabilisation. Inflation-forecast targeting was gradually introduced. The Riksbank's own inflation forecasts were given more weight in communication of monetary policy in 1996 and 1997. Explicit paths for future inflation, surrounded by uncertainty intervals derived using forecast distributions were published for the first time in the second quarter of 1998.[29] This served to illustrate that the inflation forecast is inherently uncertain and that this is something that needs to be taken into account when deciding on policy. During this phase inflation expectations five years ahead fell from 3 per cent to around 2 per cent or less.

In the *third* phase, from 1999 and onwards, monetary policy decisions were taken by a more *independent* Riksbank. The responsibility for monetary policy was transferred from the Governing Board, which is appointed by the Parliament, to a new body, the Executive Board, consisting of six full-time members (one Governor and five

[28] In a Press Release on January 15, 1993, it was stated that "[t]he Riksbank specifies that the objective of monetary policy is to limit the annual increase in the consumer price index in 1995 and onwards to 2 per cent, with a degree of tolerance of ± 1 [percentage point]".

Deputy Governors) appointed by a General Council (previously the Governing Board). The amendments to the Riksbank Act, and the Constitution, were designed to ensure central bank independence as required by the Maastricht Treaty. Accountability and transparency increased further, by the publication of minutes from the monetary policy meetings of the Executive Board, in addition to Inflation Reports.[30]

In this section we will, based on our reading of Inflation Reports and both official and internal minutes, try to better understand the "robust" policy deviations that were identified in Section 3. In particular, we will comment on the relatively large deviations that seem to have occurred in 1995, 1996, and 1998.

4.1 Phase 1 (1993–1995): Gaining credibility

During 1993 the estimated rules describe actual policy surprisingly well, given the transitional problems after the regime shift. Explicit inflation forecasts were not at the centre of the discussion in monetary policy meetings with the Governing Board during the first years of inflation targeting. Although inflation forecasts were constructed within the Riksbank, they were not communicated outside the Bank, neither in public reports nor in speeches by the Governor. The main concern for monetary policy was that the inflation target lacked credibility, in the sense that inflation expectations were too high and exceeded the upper interval of the target range. In this situation, the Riksbank seemed to attach a lot of importance to the development of the exchange rate, long-term interest rates, and inflation expectations.

After the depreciation of the krona in November 1992, the Riksbank initiated a cautious reduction of the repo rate. Given the weak krona, the Bank feared that excessively large interest rate cuts might cause inflation expectations to rise or create doubts concerning the seriousness of the anti-inflationary policy.[31] There were also concerns for a deepening crisis in the financial sector. The foreign currency debt

---

[29] See Blix and Sellin (1999, 2000) for a description of a method that can be used to construct uncertainty intervals based on judgmental forecasts.

[30] If there are dissenting views on the inflation outlook within the Board, it is the majority view which is presented in the Inflation Report. The minutes were first published with a time lag of six to eight weeks but this lag was later reduced to around two weeks. The minutes include reservations by individual members to the majority decision regarding the inflation outlook and the repo rate.

held by small and mid-sized firms was still relatively high, and a further weakening of the exchange rate could have aggravated the financial position of these firms, which then, in turn, could have had a negative impact on the balance sheets of the commercial banks. A weaker exchange rate would also increase the amount of capital in the banks needed to meet their 8 per cent capital adequacy limits.[32]

One reason for the continuing downward adjustment of the instrument rate in 1993 was the interest rate cuts implemented by other European central banks, most notably the Bundesbank.[33] The main argument for lowering the repo rate in October 1993 was an assessment of low immediate inflationary pressure and the development of long-term interest rates and the exchange rate.[34]

In January 1994 Urban Bäckström replaced Bengt Dennis as the Governor of the Riksbank. Mr Dennis had been the Governor since 1982 and was a stern defender of the fixed exchange rate regime, until it was abandoned in November 1992. During the first year of the inflation-targeting regime, Mr Dennis gave speeches in which he explicitly stated that the floating exchange rate regime was a temporary solution. A return to a fixed exchange regime would be a more favourable long-term solution for a small open economy like Sweden, according to Mr Dennis. This is probably one further reason why the exchange rate and the long-term interest rate were the prime indicators when interest rate decisions were contemplated during 1993.

The new Governor, Mr Bäckström, in his early speeches outlined a framework for conducting monetary policy in a forward-looking fashion. Although serious imbalances in public sector finances and a lack of credibility for the inflation target were still major concerns for policy makers in 1994–1995, inflation forecasts gradually became more important in the internal monetary policy discussions. The decisions on the policy rate seem to have been influenced not only by concerns for future inflation, but also by concerns for low GDP growth and by the reduction of European interest rates.[35]

---

[31] Separate Minutes of the Governing Board meeting on January 14 and February 25, 1993.
[32] Separate Minutes of the Governing Board meeting on February 25, 1993.
[33] Separate Minutes of the Governing Board meetings on April 23, April 28, May 13, and July 1, 1993.
[34] Separate Minutes of the Governing Board meeting on October 21, 1993.
[35] Separate Minutes of the Governing Board meetings on February 24, May 5, and May 26, 1994.

During the spring and summer of 1994 inflation pressure increased. Therefore the Riksbank started to raise the repo rate, beginning in August 1994. An important issue in 1993–1995 was the effect increased interest rates would have on the stability of the financial system. Simulation results were discussed in the Bank's monetary policy group, at which various interest rate and inflation scenarios were contemplated before the Governing Board met on August 11, 1994. At that point, the staff inflation forecast for the annual increase of the CPI in 1995 was 3.8 per cent, given a constant weak exchange rate. Even though the inflation forecast was clearly above the upper tolerance interval, concerns for overall macroeconomic and financial stability explain why more aggressive interest rate increases were avoided during 1994.

The acute banking crisis towards the end of 1992 was partly triggered by macroeconomic instability related to the defence of the fixed exchange rate regime. The recovery in the banking sector was also partly due to the economic recovery from 1993 onwards.[36] Lower interest rates and increasing exports benefited the banks by raising their operating income and reducing loan losses as the solvency of borrowers improved. In one scenario it was estimated that an increase in short-term interest rates by 2 percentage points would reduce profits in the banking system by around 10 billion kronor in 1994 (Lind and Marlor, 1994). However, there was no evident risk that the capital ratios of the major bank groups would fall below 8 per cent in 1994.[37]

During 1995 (in particular the second half of the year) our estimates of the policy rules record a sequence of positive deviations (cf. Figure 2). During this period, the Riksbank thus chose to keep the repo rate at a higher level than suggested by the rules. Looking at the macroeconomic situation at that time, economic activity slowed down during the second half of 1995, mainly due to the recession in Central Europe. From the second quarter to the fourth quarter 1995 the inflation forecast was reduced by around 1 percentage point, to 2.9 per cent at the end of the first year and to 3.4 per cent at the end of the second year. The estimated rules therefore suggest an easening of monetary policy. The repo rate, however, was kept unchanged at 8.91 per

[36] The management of the bank crisis included a bank support guarantee approved by the parliament, openness and information to the general public, and the establishment of a Bank Support Authority; see Ingves and Lind (1996).

[37] One bank, which already had a low capital ratio, was an exception, but was not considered to pose a problem for overall financial stability. The simulations showed that higher interest rates than the

cent from mid 1995 to the beginning of 1996. At this point in time, it seems possible that the Riksbank chose to undertake a relatively careful easening of policy because of credibility concerns. Inflation expectations, as measured in surveys and implicit in long-term interest rates, were still clearly above the inflation target. Another factor that seems to be important is the rather low estimate of the equilibrium interest rate implied by the rules. Because the actual interest rate is at a much higher level than the equilibrium rate, the rules suggest a quicker easening of policy than actually occurred (over and above the influence from the lower inflation forecasts).

4.2 Phase 2 (1996–1998): Flexible inflation targeting

In a Press Release on January 9, 1996 the Riksbank wrote: "Inflationary pressure in the economy has eased. There is therefore an increased probability that in the coming years the rate of inflation will be in line with the price stability target." Altogether the Riksbank lowered the repo rate by almost 5 percentage points in 1996. Despite the easening of monetary policy during 1996, which caused the short interest rate differential to decrease, the krona strengthened and the long bond rates fell markedly. In addition, inflation expectations kept falling; cf. Figures 3 and 4.

In January, the inflation forecast by the staff for 1996 and 1997 was around 2.5 per cent in terms of headline CPI. Indirect taxes were assumed to contribute around 0.2–0.4 percentage points to the annual increase in CPI. The management therefore concluded that the forecast of ”underlying” inflation (CPI adjusted for, among other things, tax effects) was somewhat above 2 per cent. Furthermore, it gradually became apparent that domestic and international demand conditions were becoming worse. Therefore the discussion in the Board focused on the probabilities for alternative growth and inflation scenarios, giving more weight to a scenario in which the economy would grow at less than the potential rate in 1996.[38]

The main argument for the easening of monetary policy in 1996 was thus the assessment by the Riksbank’s management that inflationary pressure was alleviating. The possibility of meeting the inflation target in 1996 and 1997 was

---

benchmark scenario also during 1995 would risk leading to a capital ratio below 8 per cent in one more bank.

considered high. In relation to the main scenario in the staff forecasts, the management's assessment was more pessimistic regarding GDP growth.[39] At the same time, exchange rate developments had become a less important indicator for monetary policy. A forward-looking view on the determinants of inflation underscored that temporary fluctuations in the exchange rate were not considered a problem when deciding on a less contractionary policy.

During 1996 we observe yet another sequence of deviations from the estimated policy rules (cf. Figure 2). In contrast to the situation in 1995, the actual interest rate is here below the rule-based estimate (i.e., the policy shocks are negative). To understand these deviations it is helpful to know that the Riksbank's procedures of relating the forecast to policy evolved gradually during these years. Up to 1997–1998 the discussion in the Inflation Report was mainly qualitative, mostly referring to forecasts that were rounded to the closest quarter or half percentage point. In the background there was a detailed staff forecast but it was not exactly clear whether the forecast represented the official position of the policy makers. Indeed, in 1996, unpublished internal documents show that the inflation and GDP-growth assessments of the Riksbank's policy makers were lower than those of the staff. The reason for this seems to be that the policy makers of the Riksbank had a more pessimistic view regarding growth prospects (in Sweden and other countries) and believed that the staff analyses were based on relationships that made the Swedish economy too prone to inflation. Therefore, according to the policy makers, the staff analyses were underestimating the conditions for meeting the inflation target. Because it is the staff's forecasts that are used in our database for the period 1993–1998, this gives rise to negative policy shocks during this particular year.[40]

---

[38] Report by Governor Bäckström and Deputy Governor Heikensten January 1996.

[39] Separate Minutes of the Governing Board meetings on February 22, March 21, May 23, and June 20, 1996.

[40] In 1999, as the Executive Board was appointed, it was explicitly clarified that the forecasts in the Inflation Report reflect the view of the policy makers (the Executive Board). Also, from that year on both the inflation and GDP-growth forecasts in the Inflation Report were reported using one decimal digit (rather than being rounded to the closest quarter or half percentage point). As a consequence, the data set that we use consists of forecasts by the staff for the period 1993–1998 and by the Executive Board for the period 1999–2002. However, judging from internal documents and other sources, it is only in 1996 that any important differences occurred between the staff's and the policy makers' assessments.

In conclusion, the negative monetary policy deviations in 1996 seem to be due to the discrepancy between the staff forecasts in the main scenario, that enter the simple rules, and the risks for more subdued inflation and growth, as seen by policy makers. These risks had to do both with uncertainty about general business cycle conditions, i.e. what theorists call "additive uncertainty", and uncertainty about fundamental relations, i.e. "model uncertainty" (e.g., the shape of the Phillips curve).

The next deviations from the estimated policy rules occur in the second and third quarters 1998. There seem to be two reasons for the positive policy shocks recorded during these quarters. First, the situation was unusually difficult to assess with initial signs of deflationary effects from the Asian crisis counteracted by slowly rising domestic resource utilisation and a weak exchange rate. In this uncertain situation, the Riksbank chose to await further information. Second, even though inflation prospects seemed to be somewhat more subdued again, it was mainly the forecast one year ahead which was revised downwards, to levels clearly below target. The forecast two years ahead, on the other hand, was more in line with the target.[41] The instrumental rate was therefore left unchanged during the spring. During the late spring and early summer, the assessment was gradually revised; it was now foreseen that both inflation one and two years in the future would be below the target. Against this background the Riksbank chose to lower the repo rate in June 1998. But the cut was not sizeable enough to fully offset the positive deviation from the estimated policy rules.

In the early autumn of 1998 it was judged that inflation one to two years ahead would be in line with the target. The risk spectrum featured, as earlier, weaker international prospects on the one hand, and, on the other, a risk that a more persistently weak exchange rate could lead to higher prices. General elections were also held during the autumn, which probably influenced the timing of policy decisions. In the late autumn the global financial crisis was expected to have more sizeable consequences for future inflation, and possibly also for financial stability. There were three repo rate cuts totalling 0.7 percentage points during that period. These interest rate cuts brought the repo rate down to 3.4 per cent, a level in line with

[41] The inflation forecasts one year ahead in the first, second, and third quarters 1998 were 2.1, 1.4, and 1.3 per cent respectively. The corresponding forecasts two years in the future were 2.1, 1.6, and 1.9 per cent.

the interest rate suggested by the simple rules. The policy deviations in 1998 thus seem to be associated with a cautious attitude to interest rate changes.

4.3 Phase 3 (1999–): Monetary policy under central bank independence

During 1999, the first year after the new legislation came into effect, the instrumental rate set by the Riksbank was relatively close to the rate implied by the simple policy rules. The international economic outlook went on deteriorating in the early part of 1999 and this meant that international inflation prospects were revised gradually downwards. Against this background, the Riksbank lowered the repo rate on two occasions, by a total of 0.5 percentage points, to 2.9 per cent.

Since spring 1998 a risk spectrum (”fan chart”) is presented in the Inflation Report showing the distribution of conceivable inflation outcomes. Although various scenarios had been used earlier in the risk analysis, this was a method whereby alternative scenarios could be weighed together and presented in a more systematic way (Blix and Sellin, 1999, 2000). In the formation of monetary policy, the Riksbank thus considers both a main scenario (the most probable outcome) and the spectrum of risks. In the middle of 1999, both international and domestic economic prospects shifted. The risk spectrum for inflation one to two years ahead shifted from a downside risk early in 1999 to an upside risk at the end of the year. With the altered risk spectrum and increased capacity utilisation, it was judged that inflation one to two years ahead would be above the target. This caused the Riksbank to raise the repo rate by 0.35 percentage points in November 1999.

During 2000 there are signs of negative policy deviations according to the GTS rule and the estimated Taylor rule (cf. Figure 2). However, the rule of thumb and the Rudebusch-Svensson rule do not support the idea that monetary policy was too expansionary. In fact, the discussions within the Executive Board also reflected a split view on the monetary policy stance during 2000. In February the repo rate was raised by 0.5 percentage points, but was then kept unchanged until December. During this period arguments were raised pointing in the direction of a higher repo rate.

In June, successively rising activity was expected to cause pressure on domestic prices. Compared with the earlier forecast, however, the acceleration was now judged to be somewhat slower, although the risk spectrum still pointed to

somewhat higher inflation at the end of the forecast period. The repo rate was left unchanged, but one Board member advocated an immediate increase.

In the meeting in October 2000 the picture of a strong economic upswing in Sweden, with rising resource utilisation, was still valid. The reason why inflation was not forecast to be higher, even though the upswing was continuing and the forecast horizon had shifted ahead, was partly that the initial amount of unutilised resources in the economy (the size of the output gap) was now judged to be somewhat larger than previously assumed. Five Board members were of the opinion that the inflation forecasts favoured leaving the policy rate unchanged. But all five underscored that the clear picture of a strong economic upswing implied that the unutilised resources would be brought into production successively, and that a repo rate increase might be necessary in the future. A sixth Board member attached greater weight to the risk of rising inflation beyond the two-year horizon and the risk that a late curbing of such a tendency would entail a more marked downward effect on output. This member therefore advocated an immediate increase of the interest rate.

In December 2000 a decision was taken by five Board members to raise the repo rate by 0.25 percentage points to 4.0 per cent. A sixth Board member did not share the skewed risk spectrum and entered a reservation against the decision.

5. Summary and conclusions

Monetary policy is often described in terms of simple rules, for different purposes. In textbooks in economics, but also in models used for research, it is necessary to make simplifying assumptions about monetary policy. Central banks can also use simple monetary policy rules for pedagogical purposes. If there is a simple rule that actually approximates monetary policy well, it can be used by the central bank both in its internal policy process (as part of model analyses, e.g.), and as a way to communicate policy decisions to people outside the central bank who want to better understand or forecast monetary policy. Finally, simple rules may serve a purpose as benchmarks when the central bank's principal (the government or the parliament) wants to evaluate policy. Holding the central bank accountable for its actions has become more important, because central banks have become more independent. Independence has

to be balanced with careful evaluation, and comparing actual monetary policy with some easily understood rules may be a useful way to start the policy evaluations. It should be emphasised that simple rules may be useful for all these purposes even if they literally are misrepresentations of monetary policy, as long as they are good empirical approximations. That is, simple rules may be useful when discussing and explaining monetary policy even when the actual monetary policy strategy does not exactly follow such rules.

In this paper we have compared monetary policy in Sweden with the policies implied by certain simple rules. This provides both an analytical description of the Riksbank's interest rate decisions, and an illustration of the usefulness of simple rules for monetary policy analysis. We report several interesting (but perhaps not so surprising) results. First, relatively simple instrument rules can approximate monetary policy in Sweden under the inflation-targeting regime quite well. This suggests that instrument rules can be used in analyses of monetary policy under inflation targeting, even if there are good reasons to believe that more complicated rules (e.g., the "targeting rules" advocated by Lars Svensson) capture important aspects of policy that simple instrument rules do not take into account.

Second, if simple rules are to describe actual monetary policy well, they have to be estimated on actual data. Calibrated rules that are commonly used in theoretical models are not good approximations of actual policy. In particular, the Swedish Riksbank (and other central banks) pursues a much less aggressive monetary policy than that implied by commonly applied calibrated rules.

A third result is that there are different estimated rules that approximate monetary policy about equally well, and hence provide similar estimates of the "policy shocks". In particular, a rule which relates the interest rate to the forecast of inflation one and two years ahead and allows for smoothing of the policy rate (the Riksbank's rule of thumb), implies a policy that comes rather close to that of a rule where the interest rate responds to current inflation, current output, and the forecasts of inflation and output one year ahead (and again allows for smoothing). Exactly what forecast horizon that is used in the simple rule, and whether output is included or not, does thus not seem to be very important, from a practical point of view.

It deserves to be emphasised that these results have been obtained using the Riksbank's own forecasts, i.e., genuine real-time data. It is the fact that such data are

published that makes it possible to formally evaluate both theoretical models of policy behaviour and actual monetary policy. Making real-time data available is thus an important aspect of central bank transparency.

Finally, interesting results have been obtained by comparing the deviations between the actual interest rate path and those implied by the simple rules. On certain occasions, policy seems to have been more "expansionary" or "contractionary" than what is implied by most relevant simple rules. We have used policy documents such as Inflation Reports and minutes from policy meetings to search for explanations for such policy deviations. We find that the Riksbank from time to another deviates from the simple rules for reasons that are usually neglected in models of monetary policy. At times, the reaction to the inflation forecast has been relatively small due to concerns for other targets than inflation. Securing credibility was an important objective during the early years of the inflation-targeting regime. Furthermore, when uncertainty about the macroeconomic conditions has been perceived to be unusually large, a cautious policy has been followed and the repo rate has been left unchanged despite changes in the expected rate of inflation. This seems to explain the policy deviations in 1998, and the decisions in 2000 also seem to be related to this type of gradualism, which apparently is not captured by the lagged interest rate in an instrument rule.

These findings show that central bank transparency requires more than publishing real-time data and declaring simple principles for policy. In order to make meaningful evaluations of monetary policy possible, central banks also have to reveal "secrets of the temple" that are relevant for an understanding of why the monetary policy strategy may change over time.

We believe that these results are quite general, and would hold for other countries as well. They also suggest areas where further research about monetary policy is needed, in particular, the connection between monetary policy and various kinds of uncertainties, and the nature of, and reasons for, interest rate smoothing.

Table 1: Empirical simple rules for the Riksbank

	Smoothing	Inflation			Output
Rule	ρ	α_0	α_1	α_2	β_0
Taylor, calibrated		1.50			0.50
Taylor, calibrated with smoot.	0.60	0.60			0.20
Taylor, estimated with smoot.	0.81***	0.42***			0.27***
R&S, calibrated	0.60			1.50	0.50
R&S, estimated	0.72***			0.66***	0.07
Rule of thumb	0.66***		0.48**	0.27	
General to specific	0.71***	0.23***	0.48***		0.20***

Notes: α_i (i = 0, 1, 2) and β_0 denote reaction coefficients on forecasts of inflation and output growth at annual forecast horizons; for example, α_2 is the reaction coefficient on the two years ahead forecast of inflation. ρ is the AR coefficient on the lagged interest rate. *, **, and *** indicate significance at the 10, 5, and 1 per cent levels. R&S is the Rudebusch-Svensson instrument rule. The sample period is 1993:1–2002:1. A log transformation has been applied to the interest rate, i.e. $i_t = 100\ln(1 + r_t/100)$, where r_t is the repo rate in per cent. The estimated rules are of the form: $\Delta i_t = c + (\rho - 1) i_{t-1} + \sum\alpha_i(\pi^F_{t,i} - 2) + \sum\beta_j\Delta y^F_{t,j} + e_t$, where $x^F_{t,s}$ denotes a s year ahead forecast of variable x undertaken during quarter t. The calibrated rules are: $\Delta i_t = \rho\Delta i_{t-1} + \alpha_i\Delta\pi^F_{t,i} + \beta_j(\Delta y^F_{t,j} - 2.2)$. π denotes CPI inflation while Δy is the growth rate of GDP.

Table 2: Goodness of fit and error-term diagnostics of empirical simple rules

	Fit	Diagnostics		
Rule	R^2	Autocorr.	Normality	ARCH
Taylor, calibrated	0.28	0.27	0.37	0.09*
Taylor, calibrated, smoot.	0.49	0.18	0.83	0.97
Taylor, estimated, smoot.	0.63	0.02**	0.85	0.35
R&S, calibrated	0.38	0.19	0.30	0.75
R&S, estimated	0.60	0.09*	0.03**	0.01**
Rule of thumb	0.63	0.03**	0.01**	0.02**
General to specific	0.77	0.16	0.75	0.59

Notes: Autocorr. provides an F test against serial correlation based on an AR(3) model under the alternative. Normality is the Doornik-Hansen $\chi^2(2)$ test. ARCH is Engle's χ^2 test against conditional heteroskedasticity (based on 3 ARCH terms under the alternative). For details of the tests see Doornik and Hendry (1997). The test results are given as p values. For further details see the notes to Table 1.

Table 3: Correlations between policy deviations (residuals) from empirical simple rules

	Taylor (c)	Taylor (c, s)	Taylor (e, s)	R&S (c)	R&S (e)	Rule of thumb	GTS
Taylor (c)	1.00	0.87***	0.34**	0.38**	0.09	–0.06	0.22
Taylor (c, s)		1.00	0.49***	0.52***	0.21	–0.02	0.32*
Taylor (e, s)			1.00	0.21	0.57***	0.46***	0.80***
R&S (c)				1.00	0.28*	–0.07	0.17
R&S (e)					1.00	0.86***	0.74***
Rule of thumb						1.00	0.79***
GTS							1.00

Notes: (c) means that the rule is calibrated. (c, s) means that the rule is calibrated and includes a lagged interest rate. (e) means that the rule is estimated. (e, s) means that the rule is estimated and includes a lagged interest rate. GTS is the instrument rule derived using the general-to-specific methodology. The standard error of the correlations is approximated by the formula $1/(T^{0.5})$, where T is the sample size. For further details see the notes to Table 1.

Table 4: Actual CPI inflation and forecasts by Sveriges Riksbank

	92	93	94	95	96	97	98	99	00	01	02	03	04
92:12		5.0	3.5										
93:03		5.3	3.4	3.5									
93:06		4.3	3.4	3.5									
93:09		4.7	3.3	3.3									
93:12		4.7	3.3	3.3									
94:03			2.9	3.1	3.3								
94:06			2.9	2.9	3.3								
94:09			3.4	3.6	3.3								
94:12			3.0	4.1	4.4								
95:03				3.3	4.0	4.4							
95:06				3.3	4.0	4.4							
95:09				3.4	3.6	3.5							
95:12				3.1	2.9	3.4							
96:03					2.5	2.6	3.5						
96:06					2.1	2.3	2.7						
96:09					0.9	2.3	2.7						
96:12					0.8	2.4	2.5						
97:03						1.7	2.3	2.5					
97:06						1.9	1.9	2.2					
97:09						1.9	2.2	2.2					
97:12						1.9	2.3	2.5					
98:03							1.8	2.1	2.1				
98:06							0.2	1.4	1.6				
98:09							0.1	1.3	1.9				
98:12							–0.3	1.2	1.4				
99:03								1.0	1.1	1.4			
99:06								0.9	1.1	1.6			
99:09								1.0	1.3	2.0			
99:12								1.1	1.4	2.3			
00:03									1.4	2.0	2.1		
00:06									0.9	1.9	1.9		
00:09									1.2	1.6	2.0		
00:12									1.3	1.8	2.1		
01:03										1.7	1.8	1.9	
01:06										2.6	1.9	2.2	
01:09										2.9	2.0	2.1	
01:12										2.6	2.0	2.1	
02:03											2.4	2.3	2.4
Act.		4.1	2.6	2.4	0.1	1.9	–0.6	1.2	1.4	2.9			

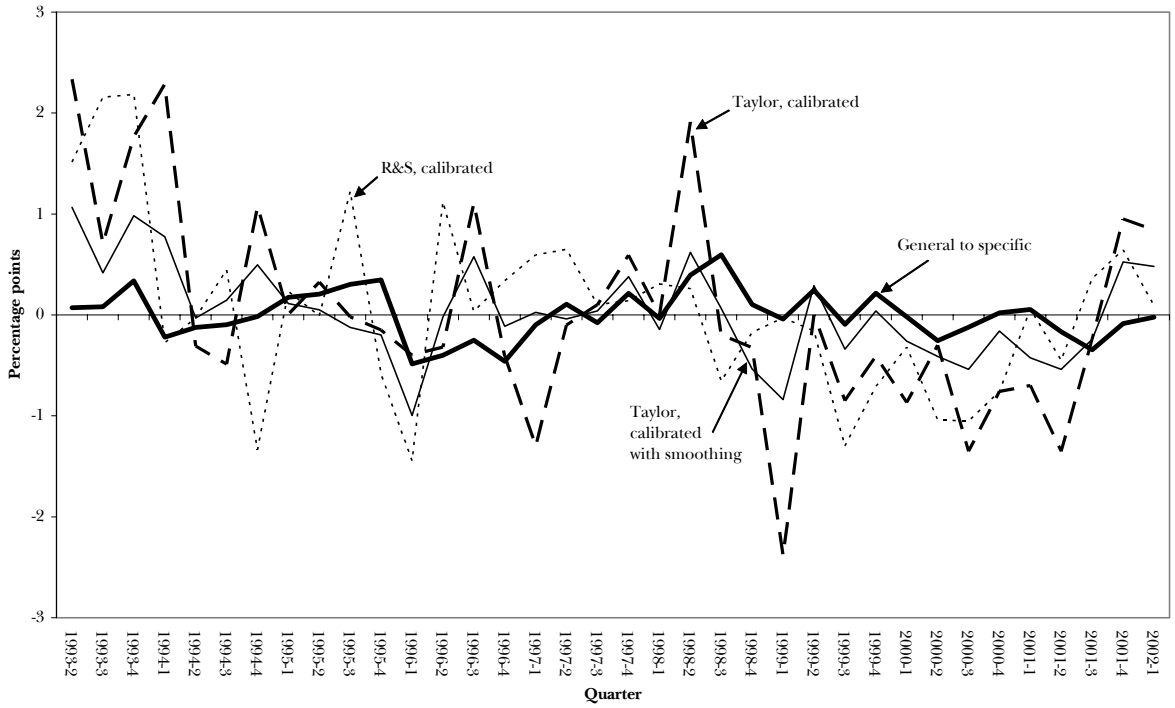
Notes: Entries of the table are inflation forecasts (CPI) for the year indicated by each column. The forecasted inflation is usually the price increase between December year t and December year $t + 1$. In some cases, the forecast horizon is shorter and no end-of-year forecast exists two years ahead. In those cases, we use the forecast of the twelve-monthly figure that comes closest (in time) to this end-of-year forecast. The dates of the rows are the dates when the forecasts are derived. In the case no new forecast is available in a quarter, the most recent available forecast has been used. The last row gives the actual values of CPI inflation.

Table 5: Actual GDP growth and forecasts by Sveriges Riksbank

	92	93	94	95	96	97	98	99	00	01	02	03	04
92:12	–1.4	–1.5	1.7										
93:03		–1.3	2.3	2.8									
93:06		–1.3	2.3	2.8									
93:09		–1.8	2.2	2.9									
93:12		–1.8	2.2	2.9									
94:03			2.1	2.7	2.9								
94:06			2.2	2.7	2.4								
94:09			2.2	2.7	2.4								
94:12			2.0	2.7	2.3								
95:03				2.4	2.6	2.3							
95:06				2.4	2.6	2.3							
95:09				2.4	2.6	2.3							
95:12				3.4	3.1	2.6							
96:03					2.0	2.3	2.6						
96:06					1.6	1.8	2.6						
96:09					1.6	1.8	2.6						
96:12					1.5	2.5	2.8						
97:03						2.1	3.1	2.8					
97:06						1.8	3.1	3.6					
97:09						2.0	3.0	3.4					
97:12						1.5	2.8	3.2					
98:03							2.5	2.9	3.0				
98:06							2.7	3.0	2.9				
98:09							2.9	2.8	2.6				
98:12							2.7	2.1	2.3				
99:03								2.1	2.5	2.3			
99:06								2.5	3.0	3.0			
99:09								3.6	3.8	3.0			
99:12								3.4	3.7	3.3			
00:03									4.0	3.5	2.6		
00:06									4.0	3.7	3.0		
00:09									4.3	3.5	2.9		
00:12									3.9	3.4	2.9		
01:03										2.4	2.4	2.7	
01:06										2.2	2.5	2.9	
01:09										1.3	2.2	2.8	
01:12										1.2	1.8	2.4	
02:03											1.6	3.0	2.6
Act.	–1.7	–1.8	4.1	3.7	1.1	2.1	3.6	4.5	3.6	1.2			

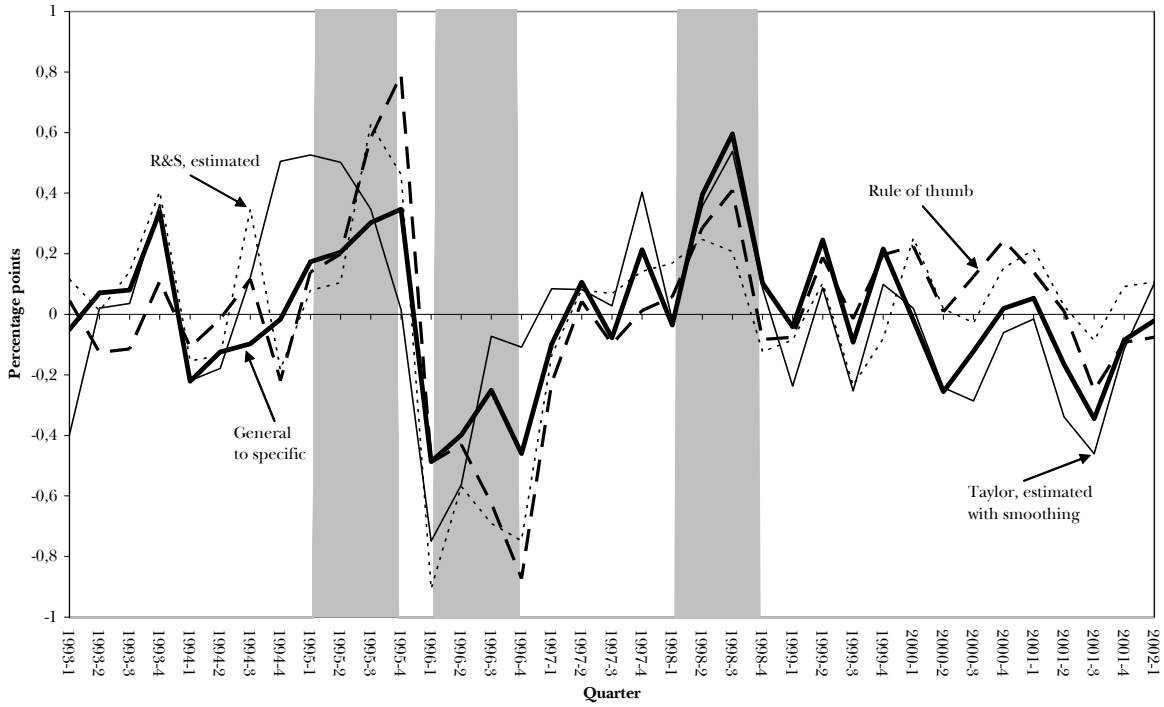
Notes: Entries of the table are forecasts of GDP growth for the year indicated by each column. The dates of the rows are the dates when the forecasts are derived. In the case no new forecast is available in a quarter, the most recent available forecast has been used. The last row gives the actual values of GDP growth.

Fig. 1: Policy deviations (residuals) from calibrated simple rules and estimated simple rule derived using the general-to-specific principle



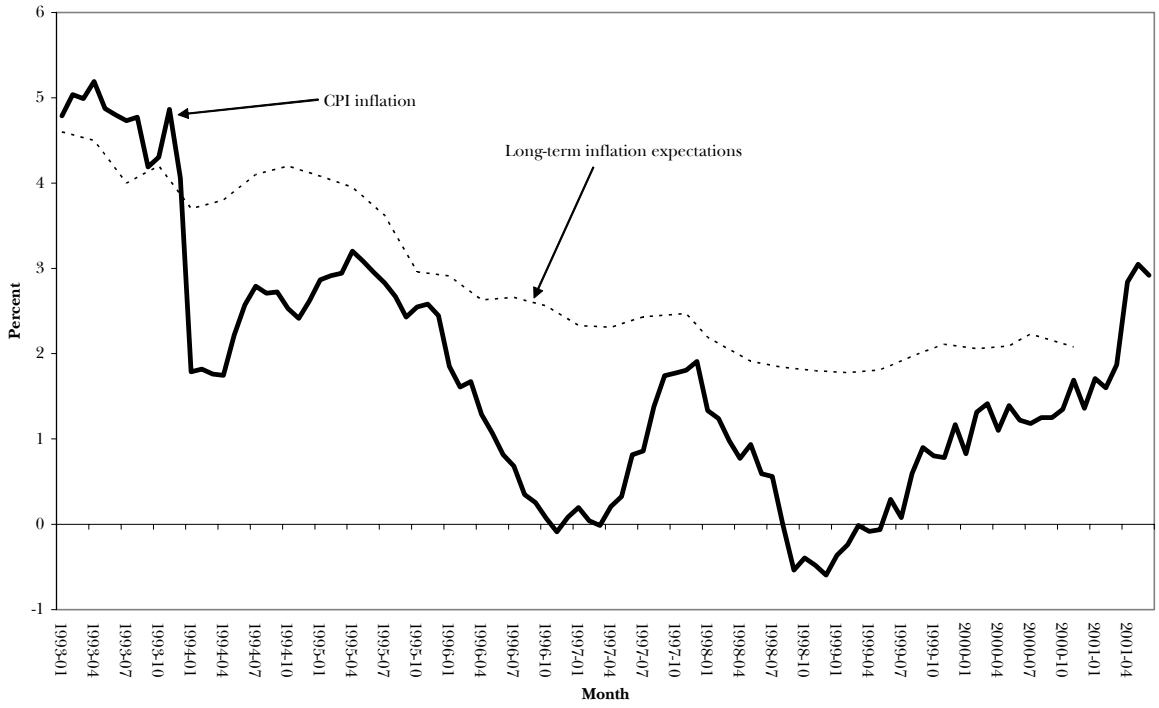
Notes: The deviations are the errors of the policy rules given in Table 1.

Fig. 2: Policy deviations (residuals) from estimated simple rules



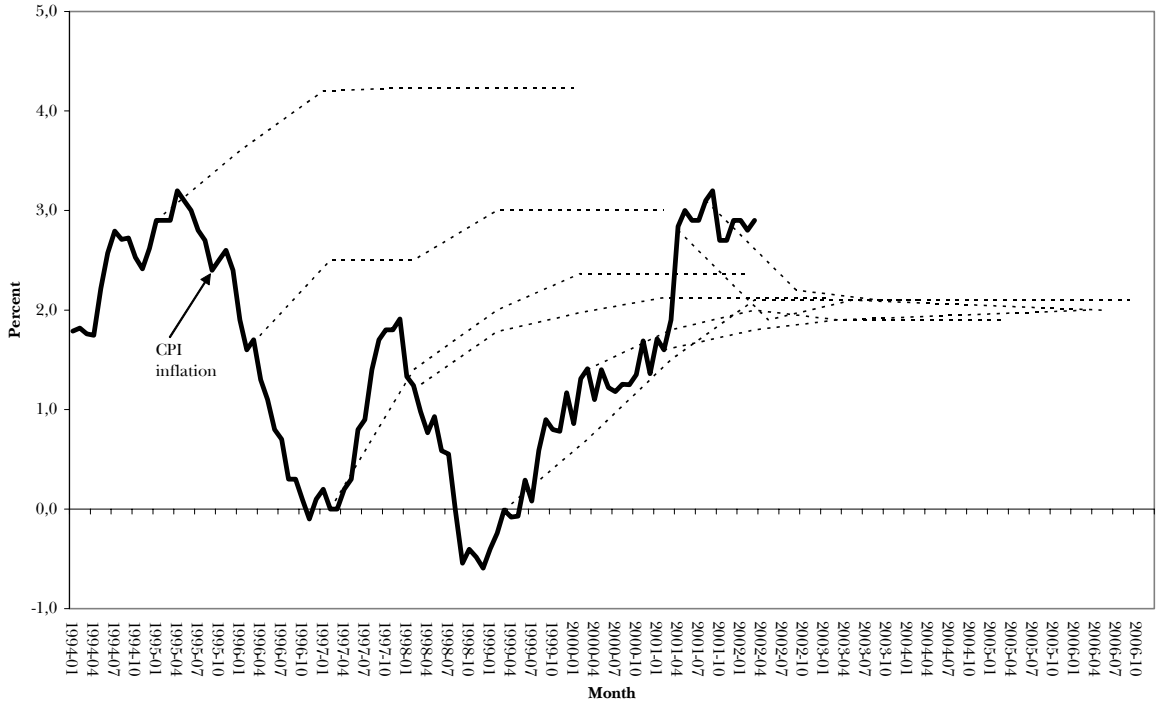
Notes: The deviations are the errors of the policy rules given in Table 1.

Fig. 3: CPI inflation and long-term inflation expectations



Notes: CPI inflation is measured at a consecutive twelve-monthly rate. Inflation expectations are the five years ahead price increases expected by agents on the money market. These expectations are based on surveys undertaken by Aragon Fondkommission. For this series, the horizontal axis indicates the dates on which the surveys were undertaken.

Fig. 4: CPI inflation and inflation expectations at various horizons



Notes: CPI inflation is measured at a consecutive twelve-monthly rate. Inflation expectations are the annual price increases expected by money market agents one, two, three, four, and five years in the future. These expectations are based on surveys undertaken by Prospera Research AB and Statistics Sweden. For these series, the horizontal axis indicates the dates on which the outcomes were expected to occur.

References

Archer, David, "Are the policy rules proposed in the literature good enough for practical use?", unpublished manuscript, Reserve Bank of New Zealand, 2003.

Barro, Robert, and David Gordon, "A Positive Theory of Monetary Policy in a Natural rate Model," *Journal of Political Economy* 91: 589–610, 1983.

Bernanke, Ben, Thomas Laubach, Frederic Mishkin, and Adam Posen, *Inflation Targeting: Lessons from the International Experience*, Princeton University Press, 1999.

Blix, Mårten, and Peter Sellin, "Inflation Forecasts with Uncertainty Intervals", *Sveriges Riksbank Quarterly Review*: 12–28, 2/1999.

Blix, Mårten, and Peter Sellin, "A Bivariate Distribution for Inflation and Output Forecasts", Sveriges Riksbank Working Paper Series No. 102, 2000.

Clarida, Richard, Jordi Gali, and Mark Gertler, "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory", *Quarterly Journal of Economics* 115: 147–180, 2000.

Doornik, Jurgen, and David Hendry, *Modelling Dynamic Systems Using PcFiml 9.0 for Windows*, International Thomson Business Press, 1997.

Faust, Jon, and Dale Henderson, "Is Inflation Targeting Best-Practice Monetary Policy?", unpublished manuscript, Federal Reserve Board, 2004.

Fracasso, Andrea, Hans Genberg, and Charles Wyplosz, "How Do Central Banks Write?", Geneva Reports on the World Economy Special Report 2, CEPR, ICMB and Norges Bank, 2003.

Friedman, Milton, *A Program for Monetary Stability*, Fordham University Press, 1960.

Goodhart, Charles, "Monetary Transmission Lags and the Formulation of the Policy Decisions on Interest Rates", *Federal Reserve Bank of St. Louis Review* 83: 165–181, July/August 2001.

Green, Edward, "Central Banking and the Economics of Information", in A. Santomero, S. Viotti, and A. Vredin, eds., *Challenges for Central Banking*, Kluwer Academic Publishers, 2001.

Heikensten, Lars, "The Riksbank's Inflation Target – Clarification and Evaluation", *Sveriges Riksbank Quarterly Review*: 5–17, 1/1999.

Hendry, David, *Dynamic Econometrics*, Oxford University Press, 1995.

Honkapohja, Seppo, and Kaushik Mitra, "Performance of Inflation Targeting Based on Constant Interest Rate Projections", paper presented on workshop on "Expectations, Learning, and Monetary Policy" organized by Deutsche Bundesbank and CFS, 2003. Forthcoming, *Journal of Economic Dynamics and Control*.

Huang, Angela, Dimitri Margaritis, and David Mayes, "Monetary Policy Rules in Practice: Evidence from New Zealand", Bank of Finland, Discussion Papers No. 18, 2001.

Ingves, Stefan, and Göran Lind, "The Management of the Bank Crisis – In Retrospect", *Sveriges Riksbank Quarterly Review*: 5–18, 1/1996.

Ireland, Peter, "Does the Time-Consistency Problem Explain the Behavior of Inflation in the United States?", *Journal of Monetary Economics* 44: 279–291, 1999.

Jansson, Per, and Anders Vredin, "Forecast-Based Monetary Policy: The Case of Sweden", *International Finance* 6: 349–380, 2003.

Judd, John, and Glenn Rudebusch, "Taylor's Rule and the Fed: 1970–1997", *Federal Reserve Bank of San Francisco Economic Review* 3: 3–16, 1998.

Kuttner, Kenneth, "The Role of Policy Rules in Inflation Targeting", unpublished manuscript, Federal Reserve Bank of New York, 2003.

Kydland, Finn, and Edward Prescott, "Rules Rather Than Discretion: The Inconsistency of Optimal Plans", *Journal of Political Economy* 85: 473–490, 1977.

Leitemo, Kai, "Targeting Inflation by Constant-Interest-Rate Forecasts", *Journal of Money, Credit and Banking* 35: 609–626, 2003.

Leeper, Eric, and Tao Zha, "Assessing Simple Policy Rules: A View from a Complete Macro Model", *Federal Reserve Bank of St. Louis Economic Review* 83: 83–110, July/August 2001.

Lind, Göran, and Felice Marlor, "Analys av räntekänslighet", Sveriges Riksbank, unpublished manuscript (in Swedish), 1994.

Nessén, Marianne, and Ulf Söderström, "Core Inflation and Monetary Policy", *International Finance* 4: 401–439, 2001.

Nessén, Marianne, and David Vestin, "Average Inflation Targeting", Sveriges Riksbank Working Paper Series No. 119, 2000.

Orphanides, Athanasios, "Monetary Policy Rules and the Great Inflation", *American Economic Review* 92, Papers and proceedings: 115–120, 2002.

Rogoff, Kenneth, "The Optimal Degree of Commitment to an Intermediate Monetary Target", *Quarterly Journal of Economics* 100: 1169–1190, 1985.

Rudebusch, Glenn, "Term Structure Evidence on Interest Rate Smoothing and Monetary Policy Inertia", *Journal of Monetary Economics* 49: 1161–1187, 2002.

Rudebusch, Glenn, and Lars Svensson, "Policy Rules for Inflation Targeting", in J. Taylor, ed., *Monetary Policy Rules*, Chicago: University of Chicago Press, 1999.

Svensson, Lars, "What is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules", *Journal of Economic Literature* 41: 426–477, 2003.

Söderström, Ulf, Paul Söderlind, and Anders Vredin, "Can a Calibrated New-Keynesian Model of Monetary Policy Fit the Facts?", Sveriges Riksbank Working Paper Series No. 140, 2002.

Taylor, John, "Discretion versus Policy Rules in Practice", *Carnegie-Rochester Conference Series on Public Policy* 39: 195–214, 1993.

Taylor, John, "The Role of the Exchange Rate in Monetary-Policy Rules", *American Economic Review* 91, Papers and Proceedings: 263–267, 2001.

Williams, John, "Simple Rules for Monetary Policy", Finance and Economics Discussion Series 1999-12, Board of Governors of the Federal Reserve System.

Woodford, Michael, "Monetary Policy in the Information Economy", NBER Working Paper No. 8674, 2001a.

Woodford, Michael, "The Taylor Rule and Optimal Monetary Policy", *American Economic Review* 91, Papers and Proceedings: 232–237, 2001b.

Vredin, Anders, "Comments on 'Problems in Inflation Targeting Based on Constant Interest Rate Projections' by Seppo Honkapohja and Kaushik Mitra", presented on workshop on "Expectations, Learning, and Monetary Policy" organized by Deutsche Bundesbank and CFS, 2003.

Earlier Working Papers:

Sveriges Riksbank
Visiting address: Brunkebergs torg 11
Mail address: se-103 37 Stockholm

Website: www.riksbank.se
Telephone: +46 8 787 00 00, Fax: +46 8 21 05 31
E-mail: registratorn@riksbank.se

ISSN 1402-9103 Riksbank Printing Office Stockholm 2004