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Simple Rules for Monetary Policy?

Some Swedish Experiences.

by

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1. Introduction

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 1993-2001. We will argue that explicit and relatively simple rules, or reaction functions, may be useful in central bank's internal analyses and external communication. Such rules may thus also be useful when the principal or other outside observers evaluate monetary policy measures undertaken by the central bank. Although monetary policy is not a simple undertaking, explicit rules can describe typical policy actions quite well, and deviations from reaction functions that have been proposed in the academic literature can be used to identify unusual policy behavior that requires more careful analysis. However, practical experiences suggest that such deviations are related 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. Comparing actual monetary policy with relatively simple rules may thus be a way to form ideas for further research.

With increased central bank independence and the use of more explicit targets for monetary policy, the demand for information about how monetary policy decisions are made has increased. 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, the explicit targets facilitate transparency. Exactly what central banks should be doing to achieve an optimal degree of transparency however remains an open issue. Woodford (2001) suggests that transparency is provided by a *systematic policy*:

"... 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*."

It is important to distinguish between the choice of a monetary policy *strategy* (which “systematic rule of behavior” that is or should be followed) and central bank *communication* (what the central bank does or should do when “explaining it clearly”).¹ In this paper, our primary focus is on communication. The policy rules, or reaction functions, that we estimate and present are not intended to uncover the actual monetary policy strategy, let alone an optimal strategy. We will focus on their usefulness for communication. However, since the purpose of communication is to provide information about the strategy, the distinction is not always very easy to make in practice.

Since the inflation targeting regime was introduced in January 1993, Sveriges Riksbank has, in order to be transparent about its policy, repeatedly described monetary policy in terms of a simple rule of thumb. The following quotation is from the Inflation Report from 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.”

At the same time, the Riksbank has been willing to reveal “secrets of the temple”. Inflation forecasts have been published since 1996. This makes it possible to estimate the relevance of the explicit rule of thumb. Minutes from the Executive Board’s meetings have been published (with only a few weeks’ delay) since 1999. This makes it possible to investigate whether the minutes contain additional information compared with the simple rule of thumb.

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.² 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 (2001a), on the grounds that it better captures the essence of monetary policy making in inflation targeting countries (such as the UK, New Zealand and Sweden). According to Svensson and Bernanke *et al.* (1999), among others, the essence of inflation targeting is to formulate explicit

¹ We are grateful to Petra Geraats for making this distinction clear to us.

objectives and to create *institutional mechanisms* in order to achieve those objectives.³ Such behavior may be difficult to capture in terms of simple instrument rules, like Taylor's, but how different actual monetary policy really is from the rules prescribed by Taylor or Svensson, or from the simple rule of thumb expressed by the Riksbank (above) is an open issue.

The increased central bank transparency offers ways towards a better understanding of what central banks are trying to do. Inflation Reports contain qualitative information about policy behavior, published forecasts make it possible to estimate specific reaction functions, and minutes from policy makers' meetings potentially provide additional information about policy objectives and systematic behavior. All this information can be used to analyse the deviations between actual policy and the rules considered in the academic literature. When there is a collegial board which is responsible for setting interest rates, as is the case in Sweden, such information will also facilitate the principal's evaluation of individual board members. These are arguments for revealing "secrets of the temple" even when policy is rule-based. To analyze to what extent explicit rules can be used to describe actual policy is also of importance for central banks' internal work. Models that are used for forecasting and policy simulations are based on some simplifying assumptions about policy behavior, and the usefulness of the models hinges (among other things) on the relevance of such assumptions.

In this paper we will thus analyze the conduct of monetary policy in Sweden in great detail and use the Swedish experiences for a more general discussion of how useful different 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 a rule which relates the instrument rate (repo rate) to its own lag and the Riksbank's inflation forecasts. It will be shown that monetary policy as practised on most occasions adjusted the repo rate in the direction indicated by the rule(s). The estimated forecast-based rules are thus consistent with the rule of thumb the Riksbank has claimed that it adheres to, but they differ from the usual Taylor rule(s). The forecast-based rules however satisfy the so called Taylor principle, which implies that in the event of a sustained increase in the inflation rate by x per cent, the nominal interest rate will be raised by more than x per cent.

² It should be emphasized that other instrument rules than the simple Taylor (1993) rule have commonly been applied. See, e.g., Leeper and Zha (2001) for a discussion and further references.

³ Drawing on experiences from the US, Green (2001) also emphasizes how institutional design matters for transparency, as a complement to the timing and format of public release of minutes of policy meetings.

We will also discuss other considerations that have affected interest rate decisions by the Riksbank, i.e., that have caused deviations from the simple rule(s) of thumb. Can any specific reasons for the Riksbank not following the forecast-based rule of thumb it has declared itself on particular occasions be identified?⁴ Interpreting the deviations from the rule is of interest both for evaluations of monetary policy, and as a way to evaluate the standard models of monetary policy and get suggestions for future research. The sources of “policy shocks” that we can identify are clearly relevant for monetary policy also in other countries than Sweden. Some have to do with the central bank’s responsibility for the efficiency and stability of the payment system. Others are related to the fact that in practice there is often a collegial board setting interest rates, while in the academic literature on monetary policy rules it is normally assumed that there is only one single decision maker. The fact that the central bank is necessarily uncertain about the correct model of the economy is another important problem in practice, that has sometimes given rise to substantial deviations from the normal rule of thumb.⁵ We will give concrete examples of how problems like these affect policy decisions.

The paper is organized 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 estimates 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. We use this information to discuss the deviations from the simple rules that we present in section 3.

2. Arguments for and against simple rules

It is nowadays generally agreed that monetary policy should be based on some easily understood rules that are stable over time, and that one purpose of these rules should be to keep inflation low and stable. The primary task of the central bank should not be to pursue discretionary policies intended to stabilize the overall development of the economy in the short run. There are two lines of arguments behind these policy recommendations. The first is Friedman’s () classical arguments against fine tuning: monetary policy works with long and

⁴ Heikensten (1999) provides some arguments why the Riksbank may deliberately choose to deviate from its normal policy rule.

⁵ This problem has been given considerable attention in the academic literature; see, e.g., Brainard (1967), McCallum (1988,1999), Svensson (1999) and Söderström (2000).

variable lags, and the central bank has imperfect information about the state of the economy and the various transmission mechanisms. In order to avoid that monetary policy becomes a *source* of fluctuations rather than a remedy, the central bank should adhere to some well known and transparent rule.

The second, more "modern", argument is that discretionary policies that appear to be optimal at any given instant, may produce bad results on average. Kydland and Prescott (1977) and Barro and Gordon (1983) argued that there may be an "inflation bias" if central banks have high ambitions about production or employment and cannot make binding commitments to low inflation. This theory has been suggested as an explanation for the rise in inflation during the 1960s and 1970s.

Since the peak of inflation, which in many countries occurred around 1980, researchers, central bankers and politicians have thus searched for monetary policy rules that could make inflation targets credible. Many central banks have announced explicit inflation targets and have also achieved increased independence to achieve their goals.⁶ This development, in turn, has inspired further research, both positive analyses about what central banks are actually doing, and normative analyses about what they should be doing.

The most well known simple instrument rule 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, $y_t - y_t^*$:

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

where i_0 is the target level for the nominal interest rate. Taylor (1993) found this rule to describe U.S. 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. When this 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

⁶ Theoretical arguments why an independent and "conservative" central banker may be able to achieve lower inflation have been presented by Rogoff (1985). It should be noted that there is a tension between the different arguments for a rule-based policy. Friedman favoured simple rules, while Kydland-Prescott and Barro-Gordon emphasized that such rules are not time consistent because central banks cannot make binding commitments. Rogoff's central banker thus pursues a discretionary policy, but it is "conservative" in the sense that it puts a relatively large weight on the inflation target.

policy rule is misspecified, others view this as a sign of deliberate interest rate smoothing by the central bank.⁷

Svensson (2001a) argues that the simple Taylor rule (1) (whether it is augmented by a lagged interest rate or not) is *not* the right way to describe what inflation-targeting central banks are, or should be, 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*", e.g.,

$$\text{Min } E[\sum_{\tau=0}^{\infty} \delta^{\tau} L_{t+\tau}], \quad (2)$$

where the "period loss function" L is typically given by

$$L_t = \frac{1}{2}[(\pi_t - \pi^*)^2 + \lambda(y_t - y_t^*)^2] \quad (3)$$

Here, λ measures the weight the central bank attaches to output fluctuations, relative to fluctuations in inflation. Svensson calls a loss function characterized by $\lambda = 0$ "strict inflation targeting", while $\lambda > 0$ is called "flexible inflation targeting". If we are willing to write down a model that describes the interdependencies between i_t , π_t , and y_t , we can derive the optimal policy that minimizes the loss function.⁸ Svensson shows that in a standard forward-looking so called New Keynesian model, optimal policy can be characterized by the following "*specific targeting rule*":

$$E(\pi_{t+s}) - \pi^* = -(\lambda/\alpha)[E(y_{t+s}) - E(y_{t+s-1})] \quad (4)$$

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, α is the sensitivity of inflation to the output gap, i.e., the slope of the Phillips curve.)

⁷ See, e.g., Rudebusch (2001) and Söderström, Söderlind and Vredin (2002).

⁸ 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-optimizes 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 discretionary solution. The ideal commitment policy is sometimes used as a benchmark; see, e.g., Nessén and Vestin (2000).

Central banks with explicit inflation targets, e.g., the Reserve Bank of New Zealand, Bank of England, and Sveriges Riksbank, frequently emphasize 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 – two years ahead, but also that the development of the real economy matters for how fast the Riksbank wants to bring inflation back to target. This is consistent with Svensson’s “targeting rules”, and so is the rule of thumb mentioned in Riksbank’s Inflation Reports (see page 3 above), except for the fact that actual policy makers seem to put more emphasis on a specific “target horizon” than what is justified by the intertemporal optimization framework suggested by Svensson. An alternative interpretation of what the inflation targeting central banks are doing is thus to describe their behavior in terms of a forecast-based instrument rule of the Taylor type, e.g.,

$$i_t = i_0 + \alpha(\pi_{t+s}^F - \pi^*) + \beta(y_{t+h}^F - y_t^*) \quad (5)$$

possibly augmented by the lagged interest rate for reasons discussed above. Here the notation x^F is used to denote the forecast that enters the central bank’s reaction function, which may not necessarily be the optimal forecast (mathematical expectation) $E(x)$. Note also that (3) allows for different target horizons for inflation and the output gap.

The Riksbank has explicitly stated that it focuses on the forecast of inflation one – two years ahead, and that the forecast is conditioned on no change in the interest rate. This may, e.g., be interpreted to mean that $\pi_{t+s}^F = E(\pi_{t+6} \mid i_{t+j} = i_{t-1}, j > 0)$, i.e., if the time index t denotes quarters and “one – two years ahead” is interpreted as six quarters ahead.⁹ This brings us close to the following instrument rule studied by Rudebusch and Svensson (1999):

$$i_t = i_0 + \alpha(\pi_{t+8}^F - \pi^*) + \beta(y_{t-1}^F - y_t^*) + \rho i_{t-1} \quad (6)$$

where forecasts are conditioned on no change in the interest rate. In simulations of a model of the US economy, Rudebusch and Svensson show that the instrument rule (6) performs better (generates smaller losses) than the Taylor rule (given that the coefficients in (6) are chosen optimally).

⁹ Leitemo () analyzes, and criticizes, another “constant-interest-rate” rule, where $E(\pi_{t+8} \mid i_{t+j} = i_t, j = 0 - 8) = \pi^*$. See also Goodhart (2001a).

There are some obvious disadvantages of instrument rules like the Taylor rule (1) or the forward-looking rules (3) and (4). (We are talking here about disadvantages from a positive perspective, not a normative, since our paper is focused on the role of rules for monetary policy communication. See Svensson (2001a) for more detailed criticism of instrument rules). First, it is reasonable to assume (like Kydland-Prescott and Barro-Gordon) that central banks cannot commit to specific instrument rules. Second, it is well known that central banks do not try to implement any relatively simple instrument rules 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 be more realistic. On the other hand, “targeting rules” involve quite complex and discretionary behavior, and may therefore not be very transparent. Some statements by central banks – like the explicitly stated rules of thumb, with their fixed target horizons – do give the impression that they really try to stick to relatively simple instrument rules, probably for the reasons given by Friedman (). The relevance of loss functions like (3) can also be questioned. Explicit objective functions are not part of central bank laws. There is a variety of problems with both establishing and minimizing a loss function in practice.¹⁰

In principle, both instrument rules like (1), (5) and (6) and the more complex optimum condition (4) are 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 formulas 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.¹¹ The rules presented above should all be seen as approximations of actual central bank behavior. The policy rules are indeed intended to increase our understanding of monetary policy, but this objective cannot be met without simplifications. This also means that all kinds of rules presented above may be useful approximations for some purposes.¹²

In our view, it is not possible to interpret the information given by central banks (in Inflation Reports, speeches, etc.) as providing any strong signals about whether they

¹⁰ For a discussion of those problems see Goodhart (2001b) and Svensson (2001b).

¹¹ Furthermore, as shown by Svensson (2001a), 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.

¹² This point is illustrated by the fact that many theoretical macro models are based on the assumption that monetary policy can be described as an exogenous process for the nominal money stock. Although this is a very unrealistic assumption, it does not render all conclusions from such models meaningless.

attempt to follow instrument rules or "targeting rules".¹³ One reason for that may be that many important problems that central banks are dealing with in practice arise both with instrument rules and "targeting rules". One type of question concerns the appropriate definitions of inflation and the inflation target. Is the relevant inflation concept, e.g., the consumer price index or should some measure of "core inflation" be used? Should the central bank have any target for output, and if so, what target? If the central bank has some responsibility for financial stability, what are the implications for monetary policy? Are there any reasons for interest rate smoothing? If the central bank changes its instrument, what are the effects on inflation and output over time?

The fact that many central banks are unwilling, or unable, to explain whether their behavior is mainly governed by instrument rules or "targeting rules" also illustrates why all rules considered in this paper must be viewed as approximations. Hence, the relevance of these rules cannot be decided on theoretical grounds only. This leads us to examine to what degree Swedish monetary policy can be interpreted with the help of a relatively simple instrument rules.

3. Empirical analysis of simple rule(s)

In this section we will examine in some detail how well different simple rules are able to describe monetary policy in Sweden during the inflation-targeting regime 1993–2001. By simple rules we mean both instrument rules in the spirit of Taylor (1993) and more complicated 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 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

¹³ Some may interpret this statement as saying that central banks have not been sufficiently transparent. Such a conclusion would however be based on the assumption that policy makers' information is perfect, so that the ideal policy can easily be calculated, implemented, and explained.

¹⁴ For the precise sources of the data and a discussion of various problems see Jansson and Vredin (2001).

their actual values. 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 undertake the estimation we have chosen to use the Riksbank's forecasts as our estimate of the output gap.¹⁵

In practice it often turns out that actual monetary policy cannot be accurately described without allowing for some smoothing mechanism. The reason is that rules of the type suggested by Taylor imply a policy that is too aggressive compared to what is observed in reality (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 reaction coefficients on α and β are changed in such a way that Taylor's original parameterisation is obtained as the static long-run solution, i.e. $\alpha^* = \alpha/(1 - 0.6) = 1.5$ and $\beta^* = \beta/(1 - 0.6) = 0.5$, where α^* and β^* are the reaction coefficients on inflation and the output variable respectively.¹⁶

Instead of calibrating the policy rules it is of course also possible to estimate them. By construction, leaving everything else unchanged, estimated rules must provide a better fit to actual policy than calibrated rules. An estimated version of the Taylor rule (with smoothing) thus provides a further rule that may be considered.¹⁷

The (more complicated) forecast-based 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. In order to make the different rules comparable, all specifications are in terms of the first difference of the interest rate. The rule based on the

¹⁵ The estimate that we use is thus the difference between the Riksbank's forecasts of the actual and potential growth rate of GDP. The potential growth rate of GDP is set to 2.2 percent per year, see Jansson and Vredin (2000) for details.

¹⁶ For purposes of better assessing the individual contribution of the interest-rate smoother we estimate an AR(1) equation for the interest rate. This equation has a fit of 18 percent 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 description of actual policy.

¹⁷ 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 turn out to add very little to the performance of monetary policy. For example, an estimated Taylor rule (with smoothing) that leaves the exchange rate out has a fit of 63 percent in terms of R^2 . This fit only improves marginally, to 64 percent, 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).

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.¹⁸ Furthermore, and also in line with what is expected, the inflation forecasts seem to be somewhat more important for policy than the output forecasts. Also, 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, 2.2–2.5 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 and GTS-based rules but only 0.2 percentage points for the estimated Rudebusch-Svensson rule.¹⁹ 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 (1.5) but smaller responses in the case of the Rudebusch-Svensson rule (3.75). The estimated responses on output growth are, however, more in line with the calibrated ones (0.5 for the Taylor rules and 1.25 for the Rudebusch-Svensson rule).

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 an acceptable fit, 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 too crucial an issue. This is highlighted by the fact that the R^2 s of the estimated Taylor rule (with smoothing), Rudebusch-

¹⁸ For the US, the typical estimate is around 0.6–0.7. Our lower coefficient value accords well with the casual observation that actual monetary policy is changed more aggressively in the US than in many other countries, including Europe.

Svensson rule, and rule of thumb are all quite similar, in the interval 0.58–0.65. 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 the best is also confirmed by the fact that this is the only specification for which the residuals easily pass all the diagnostic tests.

While the GTS-based rule displays the best fit, it may still be that policy shocks generated by other rules are quite similar. To look into this issue we compute the contemporaneous correlations between the shocks of the different rules. These are shown in Table 3. Focusing again on the GTS rule, it can be seen that the shocks from this rule correlate significantly with the shocks from the other estimated rules. The correlations with the calibrated rules are, on the other hand, low and insignificant. The shocks that correlate best with the shocks from the GTS rule are those generated by the rule of thumb.

To shed some further light on the similarity between the shocks, graphical comparisons are undertaken in Figures 1 and 2. Figure 1 compares the shocks from the GTS rule with the shocks 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 very erratic and large. This holds true whether or not a smoothing mechanism is present (although somewhat less pronounced in the case of smoothing). Figure 2 plots the shocks of the estimated rules. This figure confirms the relatively high degree of coherence between shocks based on estimated rules, but also shows that their agreement depends (positively) on the size of shocks. In particular, according to all four rules, sequences of positive shocks occur during 1995 and 1998 while a series of negative shocks are registered during 1996. Because these shocks are common to all the estimated rules they may be viewed as a robust feature of policy during the episode under consideration.

An important issue is of course the robustness of these results 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;²⁰ (iii) using consecutive 12-monthly

¹⁹ We call the empirical counterparts of equation (6) “Rudebusch-Svensson rule” for purposes of simplicity. We are of course aware of the fact that many other researchers have suggested similar types of forward-looking rules.

²⁰ 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

inflation figures rather than end-of-year figures; (iv) using “truncated” samples and a different dating of the arguments in the rules; and (v) using (where appropriate) instrumental-variable estimates rather than ordinary least squares.²¹

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 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.²² 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) shocks that the Riksbank has chosen to make.

4. Why has the Riksbank deviated from the simple rule(s)?

In order to understand the deviations between the best performing rules (the estimated rules) 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 set to be achieved as from 1995 and onwards. The Riksbank thus gave itself a lead time of two years. There were several reasons for this. Monetary policy was now operating in a completely different framework than the fixed exchange rate regime that had been in place throughout the post-war period. A great deal of analysis would have to be conducted for a full understanding of the new situation. The macroeconomic crisis was also severe. On the one hand, there was little

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 stabilising the real economy. For a theoretical analysis of the “core inflation” concept and its relation to monetary policy, see Nessén and Söderström (2000).

²¹ 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 12-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.

²² Similar results have been reported for New Zealand by Huang *et al.* (2001).

inflationary pressure through capacity utilization 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 bond investors' long term (five year) inflation expectations 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)). Then the median forecasted inflation increased to 3.5 per cent in the beginning of 1995 and decreased to 2.5-3 per cent in the end of 1995. 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 the forecast distributions were published for the first time in the second quarter of 1998. This served to illustrate that the inflation forecast is inherently uncertain. During this phase bond investors' 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 (and most other Riksbank issues) 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 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 both inflation reports and minutes from the monetary policy meetings of the Executive Board.²³

²³ 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 eventual reservations by individual members to the majority decisions regarding the inflation forecast and the repo rate.

In this section we will, based on our reading of Inflation Reports and both official and internal minutes, try to understand why the rules estimated in the previous section do not fully capture the Riksbank's policy decisions. In particular, we will comment on the relatively large policy deviations that seem to have occurred in 1995, 1996, 1998 and 2000, according to the estimates of the simple rules presented in the previous section.

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 center of the discussion in monetary policy meetings with the Governing Board during the first year of inflation targeting. Although inflation forecasts were constructed within the Riksbank, they were not communicated outside the central 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 exceeded the upper interval of the target. In this situation, the Riksbank seemed to pay most attention 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 instrumental rate. Given the weak krona, the Riksbank feared that excessively large interest rate cuts might cause inflation expectations to rise or create doubts concerning the seriousness regarding the anti-inflationary policy.²⁴ There were also concerns for a deepening crisis in the financial sector. The foreign currency debt held by small and mid-sized firms was still relatively high, and a further weakening of the exchange rate could aggravate their financial position which could then have 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.²⁵

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.²⁶ The main argument for lowering the repo rate in October 1993 was an

²⁴ Separate Minutes of the Governing Board meeting on 14 January and 25 February 1993.

²⁵ Separate Minutes of the Governing Board meeting on 25 February 1993.

²⁶ Separate Minutes of the Governing Board meetings on 23 April, 28 April, 13 May and 1 July 1993.

assessment of low immediate inflationary pressure and of long term interest rates and the exchange rate.²⁷

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 framework. Although serious imbalances in public sector finances and a lack of credibility for the inflation target were still major concerns for policy makers in 1994-95, 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.²⁸

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, when various interest rate and inflation scenarios were contemplated before the Governing Board met on 11 August 1994 and decided to raise interest rates. In August, the internal inflation forecast for the annual increase of CPI inflation in 1995 was 3.8 per cent, given a constant weak exchange rate. Even though the inflation forecast was clearly above the upper tolerance intervall, concerns for overall macroeconomic and financial stability explain why more aggressive interest rate increases were excluded during 1994.

The acute banking crisis towards the end of 1992 was partly triggered by macroeconomic instability related to the defense of the fixed exchange rate regime. The recovery in the banking sector was also partly due to the economic recovery from 1993

²⁷ Separate Minutes of the Governing Board meeting on 21 October 1993.

²⁸ Separate Minutes of the Governing Board meetings on 24 February, 5 May and 26 May 1994.

onwards.²⁹ 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 two percentage points would reduce bank's results by around 10 billion kronor in 1994, leading to a loss of the same amount.³⁰ However, there was no evident risk that the capital ratios of the major bank groups would fall below 8 per cent in 1994.³¹

In 1995, in particular in the second half of 1995, our estimates of the simple rules provide indications of relatively large positive monetary policy deviations (cf. Figure 2). The repo rate thus seems to have been raised relatively much during the first six months and then kept at a level higher than suggested by the simple rules. This is somewhat puzzling, at least for the rule of thumb, when considering that the inflation forecasts on the one and two year horizons were 4 and 4.4 per cent in the first half of 1995. The discussions in Governor speeches and monetary policy meetings do not indicate that the repo rate was raised aggressively in order to bring back inflation rapidly to the target. The discussion was more focused on establishing credibility for monetary policy by implementing a gradual tightening of the policy stance, signalling that the inflation target would not be abandoned and give time for further consolidation of fiscal policy.

In May 1995, various projections for future inflation were discussed at the board meeting. Given unchanged exchange rates, the inflation forecast pointed to around 4.5 per cent inflation at the end of 1996. Various policy options were discussed. Leaving the repo rate unchanged would risk giving the impression that the inflation target was abandoned. An aggressive monetary tightening was nevertheless considered inappropriate, as there was still uncertainty regarding whether or not appropriate measures in other policy areas would be undertaken or not. Instead, a more gradual tightening was considered appropriate, as it would make clear that the inflation target was not abandoned and also give some time for other confidence-building economic policy measures to be carried out.³²

The exchange rate's negative trend was broken in the summer of 1995; this presumably reflected increased confidence in the consolidation of government finance, the

²⁹ 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).

³⁰ Lind och Marlor (1994).

³¹ One bank, which already had a low capital ratio, was an exception, but was not considered to pose a problem for financial systemic stability. The simulations showed that higher interest rates than the benchmark scenario also during 1995 would risk leading to a capital ratio below 8 per cent in one more bank.

³² Governor Bäckström's report 2 May 1995.

improvement in the budget outcome and an end to the unrest in international markets during the winter and spring. The tightening of monetary policy came to an end during the summer in 1995.

The discussion above indicates that, given the internal forecasts for future inflation, the interest rate was deliberately not increased as much as deemed necessary in order to bring back inflation to two per cent in the 1-2 year horizon. It is therefore difficult to find evidence in speeches, inflation reports and internal reports which motivates the existence of the positive policy deviations in the first half of 1995 visible in Figure 1. One possible solution to the puzzle may be that the estimated rule overstates the case for a positive deviation, as it is estimated on a longer period including later data from a period when credibility of monetary policy had been established. In order to study this issue we split the sample in two periods. When estimating the rules on the period from 1993:1-1997:1, the positive deviations in the first six months of 1995 are much smaller (or disappears) than when estimating the rule on the full sample.

In the second half of 1995 the positive policy deviations do not disappear, however. 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 in 1995 the inflation forecast was reduced by 1 percentage points, to 2.9 per cent at the end of first year and to 3.4 per cent at the end of the second year.³³ The repo rate, however, was kept unchanged at 8.91 from mid 1995 until the beginning of 1996. The fact that the inflation forecast was reduced by 1 percentage point, while the instrumental rate was still unaltered is the main reason why there is such a clear indication of a positive deviation in the data during the autumn of 1995. This, however, begs the question why the Governing Board did not lower the repo rate during this period. One interpretation is therefore that the data reflects an increased emphasis during the autumn on bringing back the inflation forecast and, in particular, inflation expectations closer to two percent before an easing was deemed possible. Another interpretation is that there was a growing discrepancy between different opinions within the Riksbank on the outlook for GDP-growth and inflation.

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

In a Press Release on 9 January 1996 the Riksbank informed that "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 easing of monetary policy during 1996, which caused the short interest rate differential to decrease, the krona strengthened and the long bond rates fell markedly. 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 for "underlying" inflation (CPI adjusted for tax effects) was somewhat above 2 per cent. Furthermore, it was more and more clear that the domestic and international demand was becoming weaker than earlier expected. 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 1996.³⁴

The main argument for the easing of monetary policy in 1996 was thus the assessment by the Riksbank management that inflationary pressure was alleviating. The possibility of meeting the inflation target in 1996 and 1997 was considered high. In relation to the main scenario in the staff forecasts, the management's assessment was more pessimistic in its assessment of GDP growth.³⁵ A forward-looking view on the determinants for inflation underscored that temporary fluctuations in the exchange rate were not considered a problem when deciding on an easing of monetary policy.

During 1996 the estimated monetary policy rules suggest that the actual policy rate was lower than the interest rate implied by the rules. The negative policy deviation during 1996 can be interpreted as a consequence of the management and the Governing board basing their repo rate decisions on somewhat lower inflation and GDP assessments than the staff forecasts used when estimating the simple rules.³⁶ The inflation forecasts in the data set both

³³ In the second quarter of 1995 the inflation forecast was 4 per cent at the end of the first year and 4.4 per cent at the end of the second year. In the fourth quarter these forecasts were reduced to 2.9 and 3.4 per cent, respectively.

³⁴ Report by Governor Bäckström and Deputy Governor Heikensten January 1996.

³⁵ Separate Minutes of the Governing Board meetings on 22 February, 21 March, 23 May and 20 June 1996.

³⁶ The forecasts in the data set were based on the Economics Departments forecasts from 1993. From 1996 and onwards forecasts were published and reflect the assessments of the Governing Board. Approximate numerical inflation and GDP-growth forecasts (for calendar years) were published during 1996. During the end of 1997 and

at the end of the first year and the second year are clearly above two per cent during 1996. However, prospects for both the international and Sweden's economy weakened. Growth prospects on the one year and the two year horizon were revised successively downwards in the first three quarters of 1996. There were also signs that the economy had become less inflation prone in other respects as well. It was noted in the March Inflation Report that a given demand situation in the economy seemed to generate lower inflation than before. The staff therefore presented many alternative scenarios, based on various assumptions regarding potential GDP or the size of the output gap. It was concluded that the risk for a weaker growth development than in the main scenario, justified a further easing of monetary policy.³⁷ In November it was noted that the inflation propensity had been reduced and that the condition for meeting the inflation target in the coming years had increased, even after the quite substantial monetary easing. In conclusion, the negative monetary policy deviations in 1996 seem to be explained by the discrepancy between the staff forecasts in the main scenario and the risks for more subdued inflation and growth associated both with general business cycle conditions and uncertainty about fundamental relations as judged by management and board.(e.g., the Phillips curve).

The estimated policy rules result in positive policy deviations in the second and third quarter in 1998. There seems to be two reasons for this. First, the situation was unusually difficult to assess with initial signs of deflationary effects from the Asian crisis counteracted by slowly rising resource utilization in Sweden 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 on the one year horizon which was revised downwards, to levels clearly below target.³⁸ The forecasts for the two year horizon, on the other hand, were more in line with the target. The instrumental rate was therefore left unchanged during the spring.³⁹ During the late spring and early summer, the assessment was gradually revised; it was now foreseen that inflation one to two

the beginning of 1998 approximate annual inflation forecasts appeared on a quarterly basis. Numerical forecasts of inflation and GDP growth using one decimal digit were introduced the Inflation Reports in March 1998 and March 1999 respectively. From 1999 and onwards, forecasts in data set reflects forecasts by the Executive Board.

³⁷ Separate Minutes of the Governing Board meetings on 25 April and 20 June 1996.

³⁸ In the data set the inflation forecast for the next year was revised down from 2.1 in the first quarter to 1.4 in the second quarter and 1.3 in the third quarter of 1998, while the corresponding forecasts for the year after next year was 2.1 in the first quarter, 1.8 in the second quarter and 2 per cent in the third quarter.

years ahead would be below the target. The Riksbank chose to lower the instrumental rate in June 1998.

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, possibly also consequences for financial stability, and there were three repo rate cuts totalling 0.7 percentage points. These interest rate cuts brought the repo rate down to 3.40 per cent, a level in line with the interest rate suggested by the simple rules.

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. Further downward adjustments were made to forecast inflation compared with the assessments during 1998. Against this background, the Riksbank lowered the repo rate on two occasions, by a total of 0.5 percentage points, to 2.90 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. In the formation of monetary policy, the Riksbank thus considers both the main scenario (the most probable outcome) and the spectrum of risks. In the middle of 1999, both international and domestic economic prospects shifted in a positive direction. 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 utilization, it was judged that inflation

³⁹ With hindsight, it is clear that the repo rate could have been reduced earlier, given the actual inflation figures for 1999 and 2000.

one to two years ahead would be above the target. This caused the Riksbank to raise the repo rate 0.35 percentage points in November 1999.

During 2000 there are signs of a negative deviation in the second quarter and in the third quarter (cf. Figure 2). Interestingly, there were many arguments raised in the discussions within the Executive Board during 2000 pointing in the direction of a higher repo rate.

In the monetary policy meeting in February it was noted that increasing import and domestic prices pointed to an inflationary pressure and risks for inflation above the target. There had been a continuation of the already favourable economic trend in Sweden as well as internationally and there seemed to have been some improvement in growth prospects since the December Inflation Report. A gradual realignment to less expansionary conditions was considered necessary. The repo rate was raised by 0.50 percentage points. But the repo rate was then kept unchanged between March and October 2000.

In June the 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. The risk spectrum pointed to somewhat higher inflation at the end of the forecast period, however. The repo rate was nevertheless left unchanged. One Board member, however, advocated an immediate repo rate 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 assumed earlier. Five Board members were of the opinion that these inflation forecasts favoured leaving the repo 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 period 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 repo rate increase.

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.

4.3 Conclusions

Our analyses of Swedish monetary policy 1993 – 2001 have shown that the Riksbank's policy is, on average, well approximated by a simple forecast-based rule. But there have also been deliberate deviations from rule. On the one hand, this may be interpreted as supporting the view that the Riksbank has tried to follow an optimal targeting rule in Svensson's (2001a) sense. On the other hand, it seems to be the case that monetary policy has been influenced, to an important extent, by considerations that are usually neglected in models of monetary policy rules.

At times, the relative weight for the inflation forecast was lower due to concerns for credibility and the fact that other targets than inflation have been important. Exchange rate stability and financial stability were important objectives during the early years of the inflation targeting regime. This may also be the explanation for the relatively large policy deviations (deviations from a simple rule) in 1998. The positive policy deviation in the second half of 1995 may be due to an increased emphasis on the two per cent inflation target and/or a growing discrepancy between different opinions within the Riksbank on the outlook for future inflation. 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 may explain the policy deviations in 1998. The actual monetary policy decisions in 2000 also seem to be related to this type of interest rate smoothing, which is not captured by the lagged interest rate in a Taylor type rule. The policy deviations during 1996, however, seem to be due to the choice of data we have decided to put into the rule(s). This year there seem to have been deviations between the forecasts made by the staff and those of the management and the Riksbank's Board. This source of "policy shocks" should have disappeared since forecasts started to be published.

5. Summary and conclusions

TO BE WRITTEN

Table 1: Empirical simple rules for the Riksbank

Rule	Smoothing			Inflation		Output gap	
	ρ	α_0	α_1	α_2	β_0	β_1	
Taylor, calibrated			1.50		0.50		
Taylor, calibrated, smoot.	0.60	0.60			0.20		
Taylor, estimated, smoot.	0.80***	0.44***			0.28***		
R&S, calibrated	0.60			1.50	0.50		
R&S, estimated	0.74***			0.62***	0.04		
Rule of thumb	0.66***		0.46***	0.30*			
General to specific	0.73***	0.20**	0.48***		0.14**	0.25**	

Notes: α_i and β_j ($i = 0, 1, 2, j = 0, 1$) denote the respective reaction coefficients on the forecasts of inflation and the output gap at the annual forecast horizons i and j ; 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 percent levels. R&S is the Rudebusch-Svensson instrument rule. A log transformation has been applied to the interest rate, i.e. $i_t = 100(1 + r_t/100)$, where r_t is the repo rate in percent. The sample period is 1993:1–2002:1.

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

Rule	Fit	Diagnostics		
	R ²	Autocorr.	Normality	ARCH
Taylor, calibrated	0.29	0.07	0.04	0.09
Taylor, calibrated, smoot.	0.49	0.00	0.00	0.07
Taylor, estimated, smoot.	0.63	0.02	0.89	0.33
R&S, calibrated	0.40	0.01	0.22	0.79
R&S, estimated	0.58	0.06	0.09	0.01
Rule of thumb	0.65	0.05	0.01	0.23
General to specific	0.80	0.17	0.67	0.72

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 monetary policy shocks from 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***	0.36**	0.32*	0.07	-0.05	0.20
Taylor (c, s)		1.00	0.50***	0.45***	0.19	-0.01	0.27
Taylor (e, s)			1.00	0.14	0.54***	0.45***	0.73***
R&S (c)				1.00	0.30*	0.01	0.15
R&S (e)					1.00	0.87***	0.69***
Rule of thumb						1.00	0.76***
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.

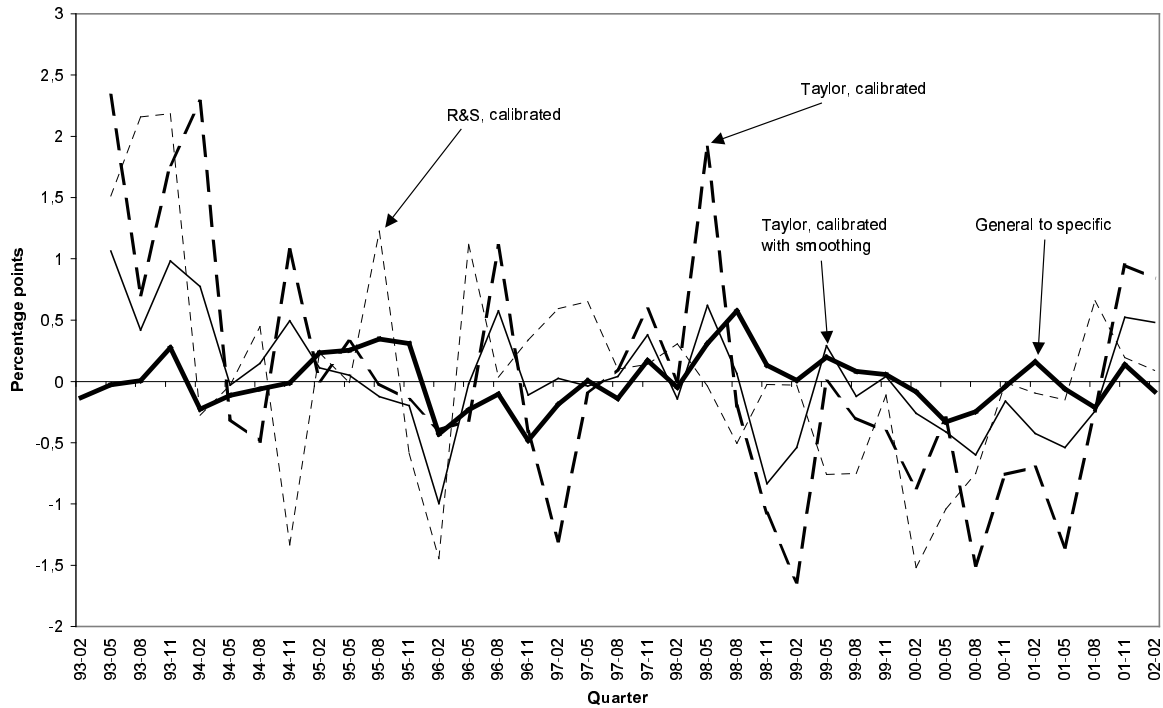
Table 4. Actual CPI inflation and forecasts by Sveriges Riksbank.

Forecast derived at time:	Forecast for year:										
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1992: Dec	5,0	3,5									
1993: Mar		3,4	3,5								
1993: Jun		3,4	3,5								
1993: Sep		3,3	3,3								
1993: Dec		3,3	3,3								
1994: Mar			3,1	3,3							
1994: Jun			2,9	3,3							
1994: Sep			3,6	3,3							
1994: Dec			4,1	4,4							
1995: Mar				4,0	4,4						
1995: Jun				4,0	4,4						
1995: Sep				3,6	3,5						
1995: Dec				2,9	3,4						
1996: Mar					2,6	3,5					
1996: Jun					2,3	2,7					
1996: Sep					2,3	2,7					
1996: Dec					2,4	2,5					
1997: Mar						2,3	2,5				
1997: Jun						1,9	2,2				
1997: Sep						2,2	2,2				
1997: Dec						2,3	2,5				
1998: Mar							2,1	2,1			
1998: Jun							1,4	1,8			
1998: Sep							1,3	2,0			
1998: Dec							1,2	1,4			
1999: Mar								1,1	1,4		
1999: Jun								1,1	2,0		
1999: Sep								1,3	2,4		
1999: Dec								1,4	2,3		
2000: Mar									2,0	2,9	
2000: Jun									1,9	2,7	
2000: Sep									1,6	2,5	
2000: Dec									1,8	2,1	
2001: Mar										1,8	2,0
2001: Jun										1,9	2,1
Actual	4,1	2,6	2,4	0,1	1,9	-0,6	1,2	1,4			

Table 5. Actual real GDP growth and forecasts by Sveriges Riksbank.

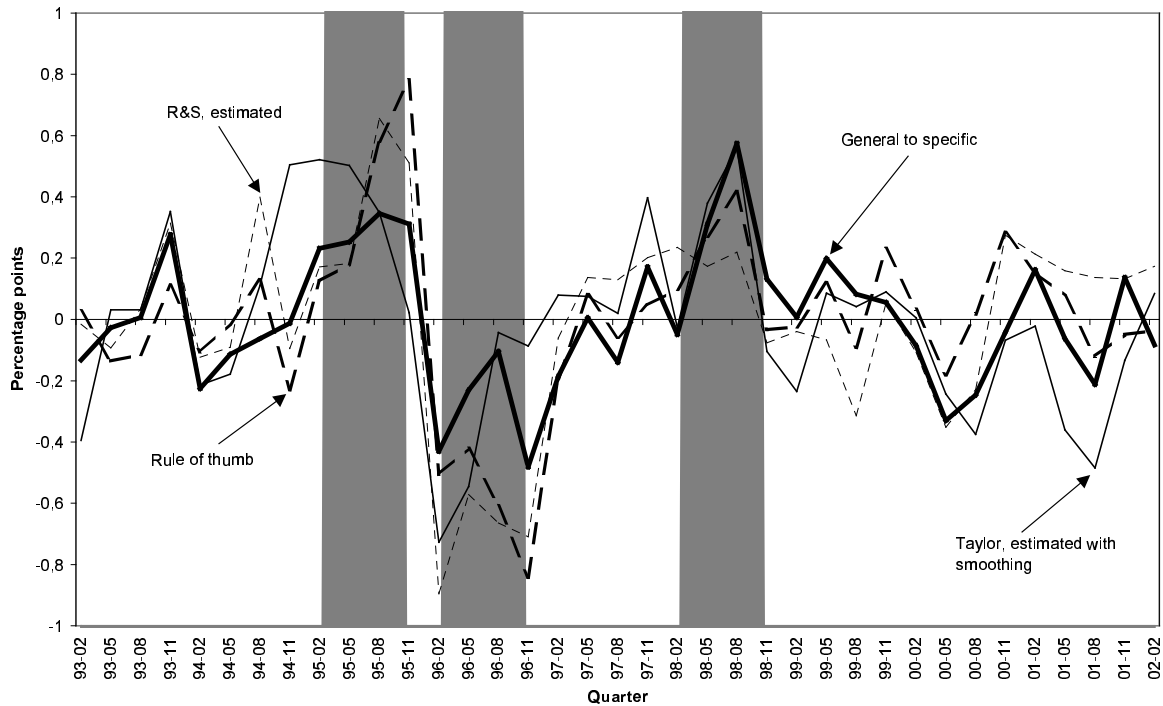
Forecast derived at time:	Forecast for year:											
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1992: Dec	-1,4	-1,5	1,7									
1993: Mar		-1,3	2,3	2,8								
1993: Jun		-1,3	2,3	2,8								
1993: Sep		-1,8	2,2	2,9								
1993: Dec		-1,8	2,2	2,9								
1994: Mar			2,1	2,7	2,9							
1994: Jun			2,2	2,7	2,4							
1994: Sep			2,2	2,7	2,4							
1994: Dec			2,0	2,7	2,3							
1995: Mar				2,4	2,6	2,3						
1995: Jun				2,4	2,6	2,3						
1995: Sep				2,4	2,6	2,3						
1995: Dec				3,4	3,1	2,6						
1996: Mar					2,0	2,3	2,6					
1996: Jun					1,6	1,8	2,6					
1996: Sep					1,6	1,8	2,6					
1996: Dec					1,5	2,5	2,8					
1997: Mar						2,1	3,1	2,8				
1997: Jun						1,8	3,1	3,6				
1997: Sep						2,0	3,0	3,4				
1997: Dec						1,5	2,8	3,2				
1998: Mar							2,5	2,9	3,0			
1998: Jun							2,7	3,0	2,9			
1998: Sep							2,9	2,8	2,6			
1998: Dec							2,7	2,1	2,3			
1999: Mar								2,1	2,5	2,3		
1999: Jun								2,5	3,0	3,0		
1999: Sep								2,5	3,0	3,0		
1999: Dec								3,4	3,7	3,3		
2000: Mar									4,0	3,5	2,6	
2000: Jun									4,3	3,5	2,9	
2000: Sep									4,3	3,5	2,9	
2000: Dec									3,9	3,4	2,9	
2001: Mar										2,4	2,4	2,7
2001: Jun										2,2	2,5	2,9
Actual	-1,7	-1,8	4,1	3,7	1,1	2,1	3,6	4,5	3,6			

Fig. 1: Monetary policy shocks from calibrated simple rules and simple rule derived using the general-to-specific principle



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

Fig. 2: Monetary policy shocks from estimated simple rules



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

Figure 3. CPI and long term inflation expectations.
Per cent

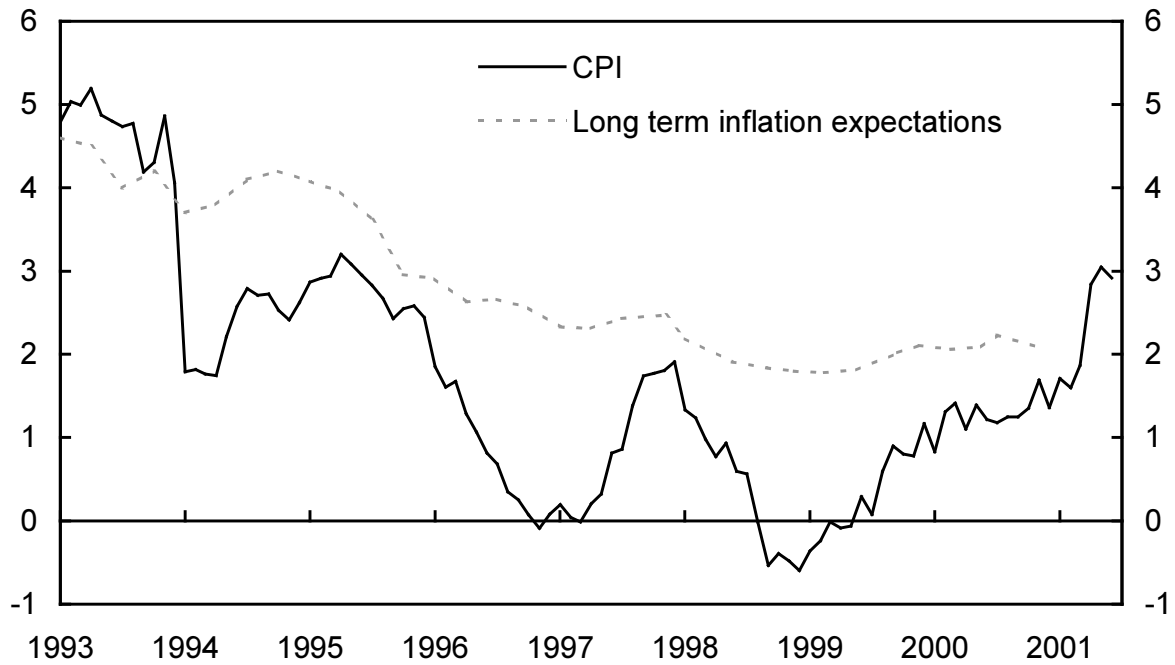
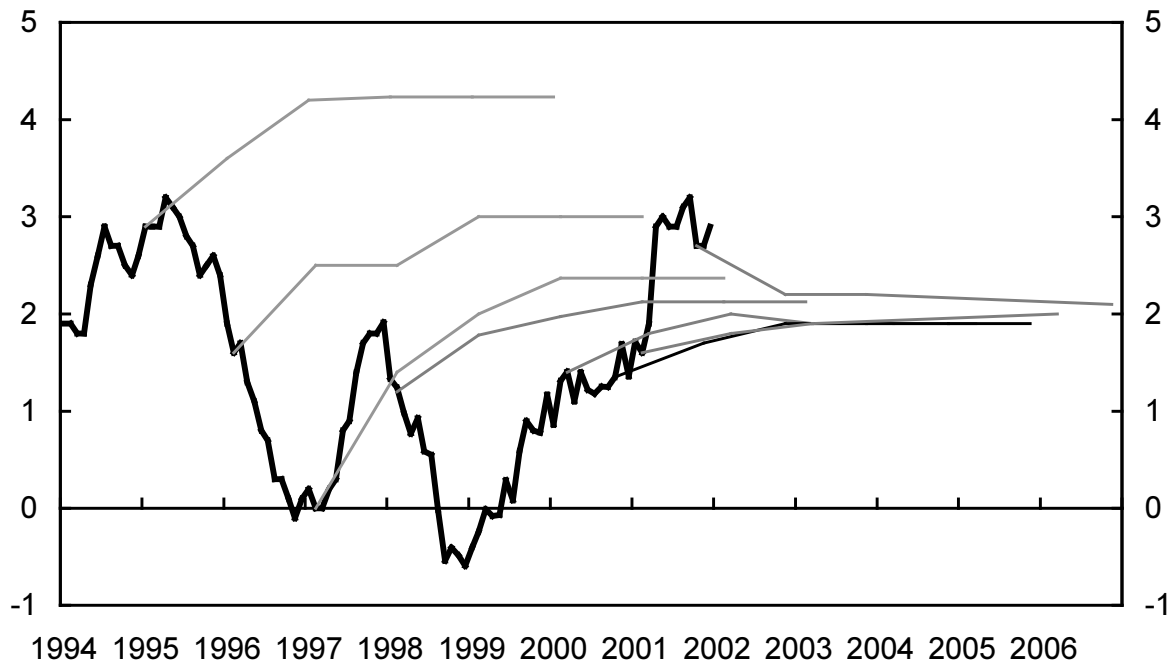


Figure 4. CPI and money market agents' inflation expectations.
Percentage 12-month change



References

- Apel, Mikael and Per Jansson, "System Estimates of Potential Output and the NAIRU", *Empirical Economics* 24: 373 – 388, 1999a.
- — and — —, "A Theory-Consistent System Approach for Estimating Potential Output and the NAIRU", *Economics Letters* 64: 271 – 275, 1999b.
- Barro, Robert and David Gordon, "A Positive Theory of Monetary Policy in a Natural rate Model," *Journal of Political Economy*, 91, 589-610, 1983.
- Berg, Claes, "Inflation Forecast Targeting: The Swedish Experience," *Sveriges Riksbank Quarterly Review*, 40-66, 3/1999.
- Blix, Mårten and Peter Sellin, "Inflation Forecasts with Uncertainty Intervals", *Sveriges Riksbank Quarterly Review*, 12 – 28, 2/1999.
- — and — —, "A Bivariate Distribution for Inflation and Output Forecasts", Sveriges Riksbank, Working Paper No. 102, 2000.
- Brainard, William, "Uncertainty and the Effectiveness of Policy," *American Economic Review* 57, Papers and proceedings, 411-425, 1967.
- Britton, E., P. Fisher and J. Whitley, "The Inflation Report Projections: Understanding the Fan Chart", *Bank of England Quarterly Bulletin*, 1998.
- Christiano, Lawrence and Massimo Rostagno, "Money Growth Monitoring and the Taylor Rule", NBER Working Paper 8539, 2001.
- 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.
- Faust, Jon and Lars E.O. Svensson "Transparency and Credibility: Monetary Policy with Unobservable Goals", *International Economic Review*, 42, 369-397, 2001.
- Goodhart, Charles, "Monetary Transmission Lags and the Formulation of the Policy Decisions on Interest Rates," *Federal Reserve Bank of St. Louise Review*, 165-181, July/August 2001
- Heikensten, Lars, "The Riksbank's Inflation Target – Clarification and Evaluation," *Sveriges Riksbank Quarterly Review*, 5-17, 1/1999

- Heikensten, Lars and Anders Vredin (1998), "Inflation Targeting and Swedish Monetary Policy – Experience and Problems", *Sveriges Riksbank Quarterly Review*, 5-33, 4/1998.
- Hendry, David, *Dynamic Econometrics*, Oxford University Press, 1995.
- 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.
- Jansson, Per and Anders Vredin, "Forecast-Based Monetary Policy in Sweden 1992-1998: A View from Within," Sveriges Riksbank, Working Paper No. 120, 2000.
- Kydland, Finn and Edward Prescott, "Rules Rather Than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy* 85, 473-490, 1977.
- Leitemo, Kai and Ulf Söderström, "Simple Monetary Policy Rules and Exchange Rate Uncertainty", Sveriges Riksbank, Working Paper No. 122, 2001.
- Lind, Göran and Felice Marlor, "Analys av räntekänslighet", Sveriges Riksbank, Memorandum, 1994
- McCallum, Bennett T., "Robustness Properties of a Rule for Monetary Policy," *Carnegie-Rochester Conference Series on Public Policy* 29, 173-204, 1988.
- McCallum, Bennett T., "Issues in the Design of Monetary Policy Rules," in J.B. Taylor and M. Woodford, eds., *Handbook of Macroeconomics*, vol. 1C, Amsterdam: North-Holland, 1999.
- Nessén, Marianne and Ulf Söderström, "Core Inflation and Monetary Policy", Sveriges Riksbank, Working Paper No. 110, 2000. Forthcoming, *International Finance*.
- Nessén, Marianne and David Vestin, "Average Inflation Targeting", Sveriges Riksbank, Working Paper No. 119, 2000.
- Orphanides, Athanasios and John Williams, "Imperfect Knowledge, Inflation Expectations, and Monetary Policy", manuscript, Board of Governors of the Federal Reserve System, 2002.
- Rogoff, Kenneth, "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics* 100, 1169-1190, 1985.
- Rudebusch, Glenn D., and Lars E.O. Svensson, "Policy Rules for Inflation Targeting," in J.B. Taylor, ed., *Monetary Policy Rules*, Chicago: University of Chicago Press, 1999.

- Svensson, Lars E.O., "Inflation Targeting: Some Extensions," *Scandinavian Journal of Economics* 101 3: 337-361, 1999.
- —, "What is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules," unpublished, Princeton University, 2001a.
- —, "The Inflation Forecast and the Loss Function", unpublished, Princeton University, 2001b
- —, and Michael Woodford, "Implementing Optimal Policy through Inflation -Forecast Targeting," unpublished, Princeton University, November 1999.
- — and — —, "Indicator Variables for Optimal Policy," NBER Working Paper no. 7953, October 2000.
- ----- and — —, "Indicator Variables for Optimal Policy under Asymmetric Information," NBER Working Paper no. 8255, April 2001.
- Söderström, Ulf, "Monetary Policy with Uncertain Parameters," Sveriges Riksbank, Working Paper No. 83, 1999.
- Söderström, Ulf, "Targeting Inflation with a Prominent Role for Money", Sveriges Riksbank, Working Paper No. 123, 2001.
- Taylor, John B., "Discretion versus Policy Rules in Practice," *Carnegie Rochester Conference Series on Public Policy* 39: 195-214, 1993.
- Taylor, John B., "The Role of the Exchange Rate in Monetary-Policy Rules", *American Economic Review, Papers and Proceedings* 91: 263-267, 2001.
- Woodford, Michael, "Monetary Policy in the Information Economy", manuscript, August 2001.