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Implementing and Communicating
Optimal Monetary Policy

by

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Implementing and Communicating Optimal Monetary Policy

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Abstract

The interest rate forecast plays a key role in the communication of monetary policy in Norges Bank. We give a comprehensive overview of the Bank's communication with focus on the interest rate forecast. The main arguments for publishing the interest rate forecast are discussed. The arguments are validated against two years of experience with interest rate forecasting. The paper describes the implementation of monetary policy in the Bank's models, in particular the use of optimal policy under commitment. It is argued that using optimal policy in a 'timeless perspective' is a useful normative benchmark to support a consistent reaction pattern that utilises the expectations channel appropriately. Comparing the interest rate forecasts with the market forward interest rates indicates that the bank's reaction pattern has been reasonably well anchored in the financial markets.

¹ The views expressed are the views of the authors, and not necessarily the views of Norges Bank.

1 Introduction

In November 2005 Norges Bank introduced endogenous interest rate forecasts in the monetary policy reports. Having previously used constant interest rate assumptions, or implied market rates as exogenous assumptions, the bank took ownership of the interest rate outlook. In this respect, the outlook can be considered an unconditional forecast of the key policy rate. In a stricter sense, the forecast is conditional upon the Bank's assessment of the current economic situation and its understanding of the transmission mechanism.

Publishing endogenous interest rate paths raises a number of issues. The first question is whether the use of an optimal interest rate path actually leads to a better monetary policy. Few central banks have implemented their own interest rate forecasts, so the international experience is limited. There is an issue that explicit interest rate forecasts obscure the true spectrum of risks and thus disturb the expectation formation. We argue that economic theory seems to favour transparency.

Second, a reasonable description of the central bank's preferences is required to be able to discriminate between different interest rate paths. Although, in principle, the optimal interest rate path can be drawn by hand, it is essential to formulate monetary policy in terms of an economic model to approach the optimality problem. This can be done either through a simple Taylor type reaction function or, more generally, in terms of a loss function. Macroeconomic models are paramount tools in developing the interest rate forecast. The optimal solution of a model with forward-looking expectations will depend on whether the central bank pursues discretion or commitment to a reaction pattern. In the latter case, the solution will depend on the form of commitment. We argue that commitment in a timeless perspective gives a reasonable description of Norges Bank's interest rate forecasts in the latest monetary policy reports.

Third, publishing an interest rate forecast is not sufficient to convey the central bank's full reaction pattern. The forecast itself may be helpful in anchoring expectations, but monetary policy would probably be even more effective if the

bank is able to indicate how it would react should economic developments be different from the forecast. In our view, optimal policy with a reasonable parametrization of the loss function ensures consistency in analyses of alternative assumptions of economic developments.

The paper discusses the pros and cons of choosing an endogenous interest rate path as the central bank's main forecast. We also summarize some experiences at the Norges Bank since the endogenous interest rate was introduced.

2 Transparency and communication – the academic debate

Transparency and communication have gained considerable attention in the academic literature in recent years. Transparency could have different types of effects on economic decisions. Geraats (2006) distinguishes between *information effects* and *incentive effects*. Information effects are direct effects of information disclosure, which implies that the public gets more information and the central bank loses a potential information advantage. Incentive effects are indirect effects where information disclosure alters the behaviour of the central bank.

The development towards greater transparency has to some degree reflected the development in monetary theory. The earlier view was that monetary policy could affect the real economy only to the extent the central bank could *surprise* the market participants. This view can be illustrated by the fact that before 1994, the Federal Reserve did not announce its target for the federal funds rate, and let it to the market participants to try to figure it out. Such a view could be rationalised by models based on the “Lucas supply curve”, where monetary policy could affect output and employment through unanticipated changes in inflation.

In the last decade, models based on policy surprise have been replaced by a new theoretical consensus based on the New Keynesian (New Neoclassical Synthesis) paradigm. Within this theoretical framework, monetary policy affects inflation and output mainly through expectations. By affecting private sector expectations, the central bank can achieve a better outcome of policy. Monetary policy has

become “management of expectations” (Woodford, 2003). Due to the important role of expectations within the New Keynesian framework, there has been enhanced focus on the role of commitment in monetary policy. Woodford (2005) highlights the benefits of commitment, and argues that in order to achieve these benefits, central banks should be transparent about its reaction pattern. By publishing the central bank’s own forecast of the interest rate, it will be easier for private agents to confirm that the central bank follows a commitment strategy. Svensson (2006a) applies similar arguments in favour of publishing the interest rate forecast. Rudebusch and Williams (2006) provide a more thorough analytical argument within a New Keynesian model, and confirm the views of Woodford and Svensson that publishing the forecast of the interest rate path makes the private agents’ estimate of the central bank’s reaction function more precise, which improves welfare.

The literature on transparency is, however, not unambiguous as regards the merits of transparency. Morris and Shin (2002) showed in a much debated article that transparency could under certain assumptions be harmful. The reason is that private agents might put too much weight on public information if this information is subject to errors. Svensson (2006b) showed, however, that with realistic parameter values, the Morris and Shin result is turned to pro transparency result. Walsh (2006) and Gosselin, Lotz, and Wyplosz (2006) have applied similar arguments within a New Keynesian model. Walsh shows that optimal transparency decreases with the degree of accuracy in the central bank’s forecasts of demand shock, while the optimal degree of transparency increases with the accuracy of the Bank’s forecasts of cost-push shocks. Gosselin, Lotz, and Wyplosz show that transparency can be harmful if the central bank’s forecasts of cost-push shocks are sufficiently noisy.

Despite the above cited arguments against (full) transparency, it seems to be consensus among researchers that central banks should be as transparent as possible about their objectives. With regard to the interest rate assumption behind the inflation forecasts, there is more disagreement. As mentioned above, Woodford (2005) and Svensson (2006a) advocate an endogenous interest rate path, while others are more sceptical. One commonly held view, e.g., by Mishkin

(2004) and Goodhart (2005), is that publishing the Bank's interest rate forecast might lead private agents to interpret the path as an unconditional promise and thereby put too much weight on the central bank's forecast.

Mishkin and Goodhart also give a more practical argument against publishing the interest rate path: It is difficult for a monetary policy committee to agree on a whole path of future interest rates. Blinder and Wyplosz (2004) argue that the choice of interest rate assumption could depend on the type of decision-making framework in the central bank. Agreeing on a specific interest rate path is particularly difficult, they argue, in individualistic committees like e.g., the MPC in Bank of England. Svensson (2006a) proposes that the MPC could vote on each point of the interest rate path, so that the path reflects the median voter, although the median voter may not be the same member across the path. We are not, however, aware of any central bank that follows such a decision procedure in practice.

Some have argued that policy makers themselves may put too much weight on the interest rate forecast when the forecast is published, in the sense that they may feel too constrained by the published interest rate path, particularly if publishing the interest rate path turns into prestige. If the central bank has vested interest in its forecast then it may be more difficult to adapt the interest rate to economic developments. We will show in Section 5, however, that our forecasts have been adjusted when economic developments have deviated from expectations. As the forecasts can be seen as a repeated game, the punishment would probably be huge if the central bank was believed to mislead the markets or fail to adjust to economic developments. The decomposition of changes in the interest rate forecast described below gives a framework for explaining in some detail why the interest rate trajectory has changed. The fan Figure around the forecast also indicates that such changes are likely to occur.

In addition to the theoretical and practical arguments against publishing the Bank's own interest rate forecast, there is an empirical argument. An often implicit assumption behind the rationale for providing such information, is that a clear communication of the central bank's interest rate intentions affects longer

term market interest rate. In other words, the expectations theory of the yield curve is assumed to work. However, the expectations theory has previously been rejected in econometric studies. (See, e.g., Shiller, Campbell, and Schoenholz (1983) and Bekaert and Hodrick (2001). However, based on identification of different types of shocks, Roush (2007) argues that when identifying different types of shocks, the results are more nuanced. For example, Roush finds that the expectations theory works for monetary policy shocks, while it fails for aggregate supply shocks. As long as it holds for monetary shocks, however, the assumption behind the rationale for an interest rate forecast seems valid. This finding also fits well with the experiences of Norges Bank, which we shall discuss in section 5.

We will expect that future academic work on transparency and communication will depend on the experiences central banks make in practice. The tendency towards greater transparency seems to continue, and the practice of publishing the central bank's own forecast of the interest rate seems to gain terrain both among researchers and practitioners.

3 Communication of monetary policy

The rationale of the central bank's communication is three-fold. First, it needs to anchor expectations. In order to achieve this, the central bank states its view of the current state of the economy and its view on the transmission mechanism. Given a credible reaction pattern, the mean forecasts of a broad range of economic variables follow.

Second, to fulfil the Taylor principle and fully determine monetary the central bank needs to state its reaction pattern. This can be achieved in several ways. In principle, the central bank could publish its preferred interest rate rule. As most policy makers in practice regularly would deviate from a simple rule, publishing such a rule would not necessarily be clarifying. Alternatively, the bank could publish its loss function with the desired weights on deviation from the inflation target, the output gap, the degree on interest rate smoothing etc. In practice, it is rather resource demanding to translate a loss function into informative reaction patterns and very few external observers would be able to do this. Woodford

(2007) suggests that a target criterion that is satisfied at all times suffices to determine monetary policy. He points out that a target criterion will depend on fewer details about the current economic environment than would a desirable specification of a reaction function. Furthermore, he argues that a target criterion is a more robust specification of the appropriate goal of policy than the reaction function or the loss function. Norges Bank has to some extent applied a set of target criteria, see below. Still, the bank has found that the most reliable way to convey its reaction pattern is by illustrating reactions in alternative shift scenarios. This gives an indication on how the general public should adjust their expectations should actual developments in the economy differ from the forecast.

Third, most central banks seek to explain their monetary policy actions ex post to comply with certain legal requirements on accountability. In practice, this is related to explaining the reaction pattern ex ante and could be seen as a credibility check that the bank's actions are in accordance with its announced reaction pattern.

The sections below give an overview of Norges Bank's communication along the dimensions described above.

3.1 The forecasts

The main panel of Figures in the Norges Bank monetary policy report displays the forecast of four important variables under flexible inflation targeting, headline inflation (CPI), a measure of core inflation² (headline inflation adjusted for taxes and energy prices CPI-ATE), the output gap and the interest rate. In addition, the bank provides a similar forecast of the import weighted exchange rate.

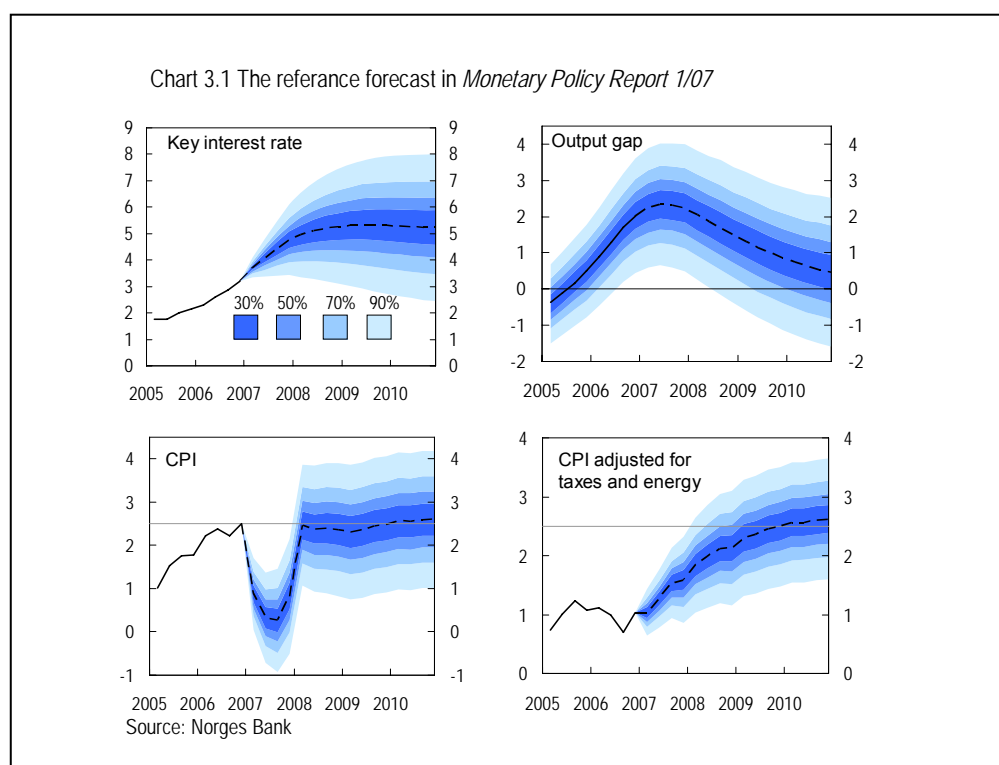
The reference scenario expresses the mean of the probability distributions and it is assumed that the distribution is symmetric. This implies that the reference scenario has already taken into account the full risk spectrum. Consequently, when the forecast is settled, the mean is adjusted so that particular risks on either

² CPI-ATE is one of several measures of core inflation. The bank gives an overall assessment of current core inflation in its regular press statements after the interest rate meetings, normally in terms of an interval.

side of the forecast in the end are reasonably well balanced. In principle, the probability distributions of the forecasts could be thought of as skewed whereas the bank could still publish the mean. There are, however, arguments that a full range of skewed probability density functions in the forecasts may become overly complicated.

The risks to the forecasts are illustrated by fan Figures. The fan Figure is technically calculated by imposing stochastic shocks to the IS-curve, the Phillips-curve and the UIP equation in a simple new-Keynesian macroeconomic model.³ The standard deviations of the shocks are estimated from 1995 to 2005. The width of the fan Figures is increasing with time and stabilises at its unconditional variance.

A table of annual growth rates is also included in the report. The table includes a few more variables than the fan Figure, among them an explicit view on the growth rate of potential output.



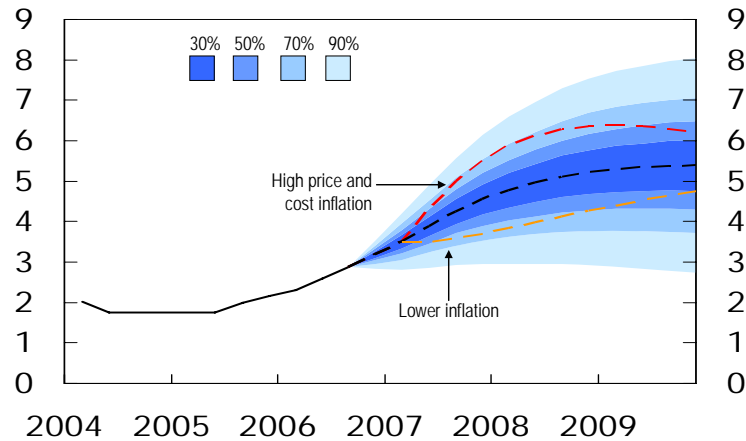
³ See Norges Bank Staff Memo 3/2004

3.2 The uncertainty analysis

Monetary policy becomes more effective if market participants can react adequately to economic news occurring between the monetary policy reports. The central forecast is not sufficient to disclose the Bank's reaction pattern in the case of unexpected disturbances to the economy. In order to convey a broader reaction pattern, the monetary policy report therefore indicates how the bank would react should certain disturbances occur. Consequently, the report includes several shift scenarios with an explicit monetary policy reaction to different developments in inflation and output.

The monetary policy response in the shifts is consistent with the preferences underlying the reference scenario. Implementing such shifts in a forward-looking model raises some challenges as to whether the shocks, and the bank's reaction to them, can be expected by economic agents. The shifts in the Report are normally rigged so that all agents in the economy assume that the bank has committed to its reaction pattern. As it becomes evident that the economy has entered a different track, the interest rate forecast is adjusted and private sector expectations are changed equivalently, maintaining the assumption of commitment. Figure 3.2 illustrates the interest rate reactions to a set of alternative inflation developments (also illustrated in the Monetary Policy Reports).

Figure 3.2. Alternative interest rate paths with lower inflation and with high price and cost inflation. *Inflation Report 3/06*



3.3 The interest rate account

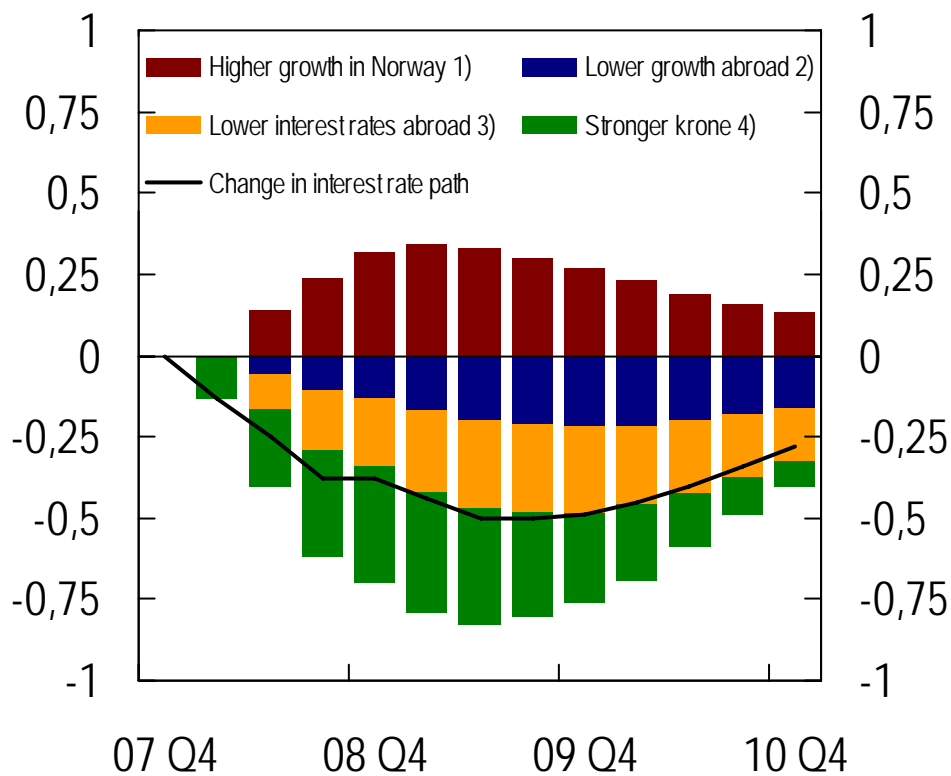
The third ingredient of the communication is the interest rate account. It complements the shift scenarios as its aim is to decompose the Bank's reaction to the economic news since the previous Monetary Policy Report. The forecast in the Monetary Policy Report incorporates the bank's overall judgement. Thus, the interest rate account is a technical model-based illustration of how the change in the interest rate forecast from the previous report can be decomposed by different exogenous shocks to the model. The illustration shows how changes in the assessment of international and domestic economic variables as well as changes in the shock processes have affected the interest rate trajectory, using a simple economic model to study the effects.⁴

If the economy develops as expected, the interest rate forecast should be adhered to unless the Bank has gained new knowledge about the transmission mechanism. Consequently, the interest rate decomposition is calculated under the assumption

⁴ See Norges Bank Staff Memo 3/2004

of commitment. Paragraph 4 provides more details on the applied commitment strategy.

Figure 3.3 Factors behind changes in the interest rate path from MPR 2/07 to MPR 3/07. Percentage points. Quarterly figures. 07 Q4 – 10 Q4
The interest rate account in MPR 3/07



¹⁾ Reflects effects of the unexpectedly high output growth in 2007 and the consequences thereof.

²⁾ Reflects effects of lower expected growth in the global economy.

³⁾ Reflects effects of expectations of lower key policy rates among trading partners, through effects on the krone exchange rate.

⁴⁾ Reflects effects of the appreciation of NOK this autumn over and above the effects of changed interest rate expectations abroad.

Source: Norges Bank

4 Deriving the explicit interest rate path

Despite the challenge for a committee in deciding a whole interest rate path, our experience is that it is indeed possible.⁵ At Norges Bank, the Executive Board does not vote on each point of the path, as suggested by Svensson (2006).

Somewhat simplified, the process is as follows: 1) the Board discusses important premises for the interest rate path. Such premises include judging the current state of the economy, in particular the size of the output gap, the rate of underlying inflation, conditions in the foreign exchange market etc, and various risk scenarios. 2) Based on the Board's judgments on the premises, the staff produces forecasts, where the interest rate forecast is based on a reaction pattern consistent with earlier policy and preferences. 3) The Board discusses the forecasts and might ask for adjustments based on their judgments. The staff then produces revised forecasts, and this iteration process ends up in a forecast that reflects both the staff's judgments and modelling work, and the Board's judgments and preferences.

We will describe the two stages in more detail, and start with the Board's assessments of the forecasts, since the starting point of the staff's modelling work is to "guess" the Board's judgments and preferences regarding the interest rate path. However, in addition to producing forecasts based on the Board's judgments and preferences, the staff is also asked to give an independent policy advice to the Governor. The staff's role is thus twofold: to give policy advice and to produce forecasts based on the Boards judgments and preferences.⁶

4.1. The Board's general assessments: Criteria for an appropriate interest rate path

When the Boards assesses the interest rate forecast, the overriding considerations are fulfilments of the objectives of monetary policy as stated in the mandate given by the Government. In the assessments, it is useful to have some criteria for

⁵ Recently, the Riksbank has also shown that it is possible for a monetary policy committee to reach a decision on an interest rate path.

⁶ Every economist at the Monetary Policy Division has to give an independent policy advice to his/her superior.

assessing the interest rate path. For a *committee*, such criteria provide an agenda for discussion. These agenda points are all different aspects of the same problem. In practice, it may therefore be useful to have some simple points of reference that can help to evaluate whether an interest rate path seems reasonable in relation to the monetary policy objective. In other words, the theoretical results on policy design needs to be translated from mathematics into practical guidelines, or criteria, which are easy to discuss in meetings. For external communication and transparency purposes, it is also an advantage that the criteria are easy to understand.

The Board currently uses a set of criteria in order to decide if an interest rate path “looks good”. The five criteria can be summarized as follows:

1. Achievement of the inflation target

The interest rate should be set with a view to stabilising inflation close to the target in the medium term. The horizon will depend on disturbances to which the economy is exposed and the effects on the prospects for the path for inflation and the real economy.

2. Reasonable balance between the inflation gap and the output gap

Norges Bank conducts flexible inflation targeting, which implies that stabilising inflation around the target should be weighted against stability in the real economy. The chosen interest rate path should therefore imply a reasonable balance between the objectives if there is a conflict between in the short term between stabilizing inflation around the target and stabilizing the real economy. What is meant by a “reasonable” balance is obviously a matter of judgment and is an important element in the Board discussions.

In the assessment, potential effects of asset prices, such as property prices, equity prices and the krone exchange rate on the prospects for output, employment and inflation are also taken into account. Assuming the criteria above have been satisfied, the following additional criteria are useful:

3. Robustness

Interest rate developments should result in acceptable developments in inflation and output also under alternative, albeit not unrealistic assumptions concerning the economic situation and the functioning of the economy. Designing a robust policy is clearly a challenging task, and the literature on robustness does not provide any clear guidance. Even if some results in the literature, in particular the part applying robust control techniques, find the policy should be more aggressive under uncertainty, most policymakers would probably apply a more cautious policy, in line with the Brainard (1967) principle. This approach follows Blinder's (1998) description of a good monetary policy, where central banks should calculate the change in policy required to "get it right" and then do less. An important exception is when there is uncertainty about the credibility of the policy regime.

4. Gradualism and consistency

Interest rate adjustments should normally be gradual and consistent with the Bank's previous response pattern. Gradualism may have several interpretations. First, although gradualism is not exactly the same as Brainard attenuation, gradualism could be interpreted as a way of operating within an uncertain terrain. Second, gradualism may also be motivated by financial stability concerns. Large shifts in the interest rate could lead to large movements in asset prices and higher risks of financial instability. This relationship is, however, not unambiguous, as a (very) gradual policy might in some cases not prevent build-up of financial imbalances. Third, a gradual approach is consistent with the "history-dependence" which characterises optimal policy under commitment. We shall come back to this issue in section 4.2.

It is frequently debated in the literature what could be the reason for interest rate smoothing. Rudebusch (2006) argues that the apparent weight on interest rate smoothing in estimated reaction functions may be a result of an estimation bias due to missing variables rather than reflecting true interest rate smoothing. We will not go deeply into the debate about how the apparent gradualism in interest rate setting should be interpreted, but rather ascertain that policymakers seem to prefer interest rate paths that do not include large shifts in the interest rate.

5. Cross-checking

It is important to cross-check the Board's judgments on the interest rate path against other information. One natural cross-check is the market expectations about the future interest rate, as represented by implied forward interest rates (adjusted for risk and term premia). In addition, simple interest rate rules like the Taylor rule and other variants suggested in the literature provide potentially useful cross-checks.

When specifying the criteria, there is a trade-off between precision and robustness. The criteria should be sufficiently precise to add value to the discussions, but at the same time not put excessive constraints on the Board members' judgments. For example, it may be argued that criterion 2, which says that there should be a "reasonable" balance between the inflation gap and the output gap, is quite vague. Until the end of 2006, there was an additional "sign restriction" in criterion 2, namely that the two gaps "should normally not be positive or negative at the same time".⁷ The intuition was that, if for instance inflation was below target and the output gap was negative in the forecasting horizon, monetary policy would not have been sufficiently tight, as a higher interest rate path would bring both variables closer to their desired values. Although the old criterion is arguably more precise than the new version, it proved to be less robust than intended, in particular within a context of optimal policy under commitment. We shall return to this below.

Giannoni and Woodford (2002) show how more specific criteria can be formulated. Although their optimal criterion is shown to be robust to changes in some parameters, for example the degree of inertia in "cost-push" shocks, the optimal criterion is still model dependent. Woodford (2007) has therefore suggested that central banks should use a simple target criterion, which is not optimal, but reasonable robust across different models, similar to the motivation for simple instrument rules. As of yet, the performance of various simple target

⁷ See e.g., Norges Bank Inflation Report 3/2006.

criteria has not been investigated in the literature. The specification suggested by Woodford has the following form:

$$(1.1) \quad (\pi_t - \pi^*) + \alpha(y_t - y_{t-1}) = 0,$$

In the canonical New Keynesian model, the criterion (1.1) is optimal, and the coefficient α is equal to the weight on the output gap in the loss function times the inverse of the slope of the Phillips curve. In more realistic models, the criterion (1.1) is not optimal, but might still capture important elements of optimal policy.

By visual inspection, we see from figure 3.1 above that Norges Bank's forecasts of inflation and the output gap do not satisfy this criterion, as the inflation forecast is below the inflation target the first couple of years, while the growth of the output gap is expected to be negative during most of this period. With the simple target criterion (1.1), monetary policy would have to be considerably more expansionary than implied by the interest rate in the Report.

Referring to the “sign restriction” in criterion 2 in earlier Reports, Woodford (2007) interpreted this as a target criterion of the form (1.1), but with the level, and not the change, in the output gap. However, visual inspection of figure 3.1 shows that in 2010, the forecasts of both gaps are positive, which violates such a specification. Thus, the simple target criterion does not seem to describe Norges Bank's monetary policy strategy very well. This does not, however, necessarily imply that simple target criteria are not useful from a *normative* perspective, and Norges Bank would welcome research on the design of such criteria.

4.2 Modelling the interest rate path

Given the above general criteria for an interest rate that “looks good”, the staff's task is to produce a set of consistent forecasts based on interest rate paths satisfying the criteria. With exogenous interest rate assumptions, like constant rate or implied forward rates, the problem of modelling monetary policy does not arise. When publishing the Bank's own interest rate forecasts, however, one has to consider how to model the interest rate. In the literature, there are two common ways to model monetary policy; either by a simple interest rate rule, or by optimal monetary policy, in the sense of minimizing a loss function. Norges Bank has

used both approaches when producing interest rate paths. When we first started publishing our interest rate forecasts, we used simple rules supplemented with judgment. This also seems to be the approach used by the Reserve Bank of New Zealand (Hampton, 2002). In the recent Reports, we have also used forecasts based on optimal policy in a ‘timeless perspective’, as suggested by Woodford (1999), as a normative benchmark. We will consider the two approaches in turn, and discuss our experiences with them from a practical point of view.

4.2.1 Simple rules

A popular class of simple rules is generalised Taylor rules of the following type:

$$i_t = \rho i_{t-1} + (1 - \rho)[r_t^* + \pi^* + \alpha_1(E_t \pi_{t+k} - \pi^*) + \alpha_2 E_t (y_{t+i} - \phi y_{t+i-1})] \quad (1.2)$$

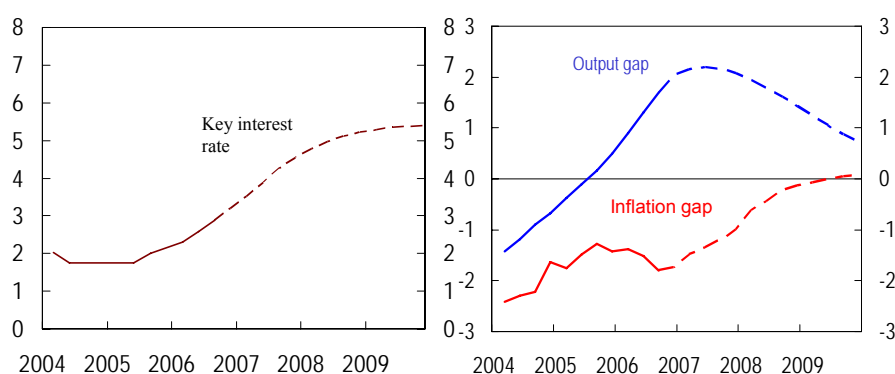
where i_t is the nominal interest rate, r_t^* is the neutral real interest rate, π_t is the inflation rate, π^* is the inflation target, and y_t is the output gap. The rule opens up for having both the *level* and the *change* of the output gap, depending on the coefficient ϕ . This type of rule has been shown to perform reasonably well in a variety of models. In addition to serving as a normative benchmark, simple rules have also been popular from an empirical perspective, as estimated Taylor rules can give a good representation of actual monetary policy.⁸ Because of the normative aspect of the interest rate forecast, one cannot just apply a specification that “fits” the historic interest rate pattern. In practice, one has to find a specification that provides the maximum achievement of the central bank’s objectives. In this process, considerable judgment is used, in particular with respect to the values of the coefficients.

There is, however, a pitfall when applying judgments with respect to the coefficients in the rule. When a given specification of the rule is chosen, the forecasts are usually made under the assumption that this rule will be followed in the future. The question is whether the specification utilises the current state of the economy, i.e., ‘initial conditions’. Then, one must keep in mind that the ‘initial conditions’ will change over time, even if no new shocks occur. If one “re-

⁸ Examples of both applications of the rules are found in Taylor (ed.) (1999).

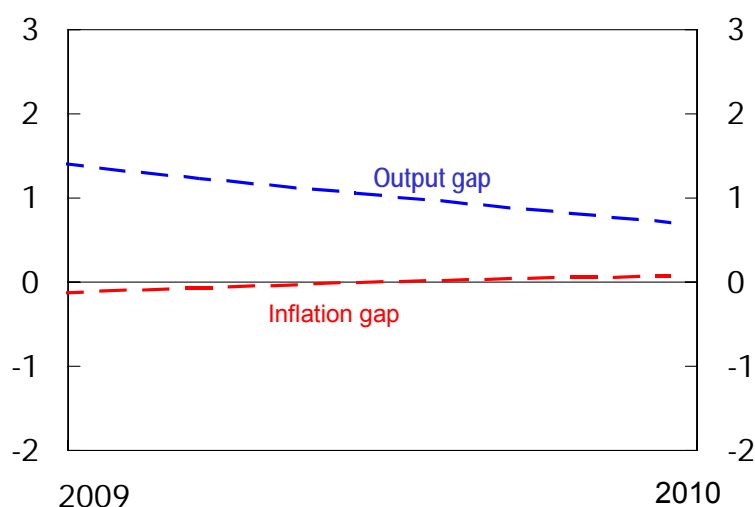
optimises” the coefficient each strategy round, based on the ‘initial conditions’ then prevailing, one should take this into account when specifying the rule in order to make it time-consistent. Making the rule time-consistent gives, however, an interest rate path that is consistent with discretionary policy. A time-consistent interest rate path is not the path that gives the maximum degree of objective achievement, as there is generally a gain from committing to a specific reaction pattern.

Figure 4.1. Forecasts in *Inflation Report 3/06*



An important experience from deriving an interest rate forecast is that we had to take the “rules-versus-discretion” issue seriously. With an endogenous interest rate path, time-inconsistency is not only a theoretical issue, but something we face, and must take a stand on, every time we make interest rate forecasts. A closer look at the forecasts in *Inflation Report 3/2006*, represented in figure 4.1, can indicate whether the interest rate path is time-consistent or not. The forecasts of inflation and the output gap represent both the Bank’s views on an appropriate interest rate and the Bank’s forecast of its own behaviour if no new shocks occur. If one enlarges the last part of figure 4.1, as in figure 4.2, we see that there will be an incentive to re-optimize in 2009 and set a higher interest rate, in order to achieve a more appropriate balance between the inflation gap and the output gap.

Figure 4.2. Forecasts in *Inflation Report 3/06*



Thus, by visual inspection, one is able to conclude that the interest rate path is time-inconsistent, which means that there is an element of commitment behind the forecasts. A difference between commitment and discretion will generally arise in the type of models most central banks use today. To be able to analyse the time-inconsistency issue of the interest rate path adequately, it proved useful to derive optimal interest rate paths under commitment.

4.2.2 Optimal policy

When computing optimal policy, one needs to specify a loss function. The second criterion for a “good-looking” interest rate path, as discussed above, could be interpreted as minimising a standard loss function with the inflation gap and the output gap as arguments, i.e.,

$$(1.3) \quad E_t \sum_{k=0}^{\infty} \delta^k [(\pi_{t+k} - \pi^*)^2 + \lambda y_{t+k}^2]$$

In practice, minimizing the above loss function often leads to quite aggressive interest rate responses to shocks and may therefore not satisfy criteria 3 and 4.⁹ The task of the staff is to produce a menu of interest rate paths which the Board may choose from. To produce a menu with reasonable interest paths, i.e., paths that do not look unacceptable at first glance, our experience is that we need to add a term that penalises large changes in the interest rate in the loss function, that is, interest rate smoothing. Various reasons for interest rate smoothing have been suggested in the literature, although a sound theoretical rationale for such concerns is yet to come. Irrespective of lack of theoretical rationale, we apply a loss function of the following form:

$$E_t \sum_{k=0}^{\infty} \beta^k [(\pi_{t+k} - \pi^*)^2 + \lambda y_{t+k}^2 + \gamma(i_t - i_{t-1})^2] \quad (1.4)$$

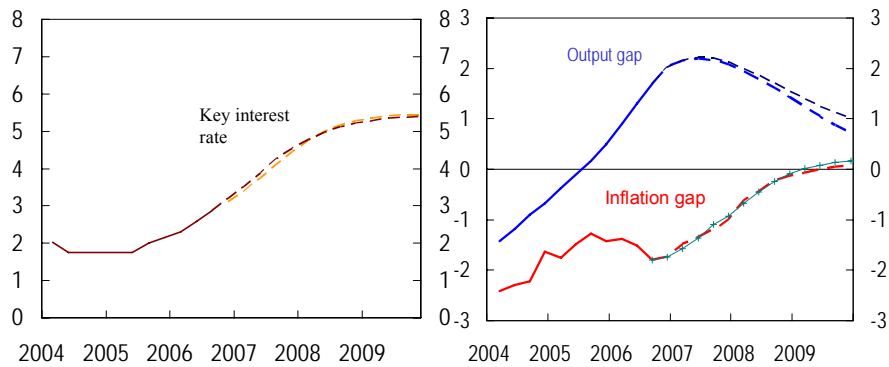
When minimising the loss function assuming commitment, one has to consider what type of commitment one assumes that the central bank conducts. Two often discussed types of commitment is a) the “Ramsey rule”, where the central bank exploits the initial conditions, but commits in all future periods, and b) the timeless perspective, suggested by Woodford (1999), where the central bank acts as if it made the commitment far in the past. The Ramsey rule has the advantage that it, per definition, gives the lowest expected loss from today onwards. The rule is, however, dynamically inconsistent, as pointed out by Woodford, since it treats the initial period differently than the subsequent periods. Although alternative types of commitment solutions have been proposed, see e.g., Blake (2001) and McCallum (2005), the timeless perspective has received considerable attention as a solution to the dynamic inconsistency of the Ramsey rule.¹⁰ From the point of view of monetary policymakers, the timeless perspective seems more attractive because of its dynamic consistency. Moreover, it may be argued that it is easier to establish credibility with a timeless policy than a policy where the central bank optimises in the first period. In any case, the Ramsey rule converges to the timeless perspective as time passes after the initial period. Thus, if one assumes that the initial period optimization was chosen sufficiently long time ago, for

⁹ This is a larger problem with minimisation under discretion than under commitment in a timeless perspective, as in the latter case the interest rate is more inertial and the immediate shock response is smaller.

¹⁰ The timeless perspective is, however, still time-inconsistent in the Kydland-Prescott (1977) sense, since the policymaker has an incentive to re-optimize.

example, when the inflation targeting regime was established, the two strategies will, for practical purposes, lead to approximately the same interest rate path.

Figure 4.3. Forecasts in Inflation Report 3/06 and optimal policy in a timeless perspective



A practical challenge when computing optimal policy in a timeless perspective is to estimate the lagged shadow prices (Lagrangians) belonging to the forward-looking variables. It is not obvious what is the appropriate approach to estimate such shadow prices, and the literature on optimal policy has not yet considered this issue. See Maih (2008) for details on alternative estimation approaches.

We see from figure 4.3 that it is possible to replicate the forecasts reasonably well with optimal policy in a timeless perspective. In this exercise, the loss function (1.4) was calibrated as follows: $\beta = 0.99$, $\lambda = 0.3$, $\gamma = 0.2$. The exact specification of the loss function should not be interpreted literally as the loss function of Norges Bank, since there is a range of alternative parameter combinations that give quite similar paths. However, calibrating loss functions that replicate the Bank's reference forecasts under the timeless perspective is useful for checking whether the preferences of the Board change between various inflation reports. One of the tasks of the staff is to alert the Board if the preferences on inflation stability versus output stability appear to have changed. In addition, computing optimal policy in a timeless perspective is a natural normative benchmark for the process of developing the interest rate forecast. That said, it is important to bear in

mind that, in practice, one has to apply considerable judgment on top of the model. Although some judgments can be incorporated directly in the model when computing optimal policy, for example as explained in Svensson (2005), in practice one has to apply a great deal of judgment on top in order to take into account factors such as robustness, financial stability, and how market participants would respond to the forecast.

Another advantage of computing optimal policy is to produce a menu of alternatives for the Board, as illustrated in Figure 4.4. From the point of view of the staff, the loss function and its relative weights are meant to represent the preferences of the Board. This is in contrast to much of the recent monetary policy literature, where the loss function approximates the utility loss of the representative consumer. In principle, it could be argued that there is little difference between these two views of the loss function, as the task of policy makers is ultimately to maximize welfare.

Figure 4.4. Optimal policy in a timeless perspective with different λ 's

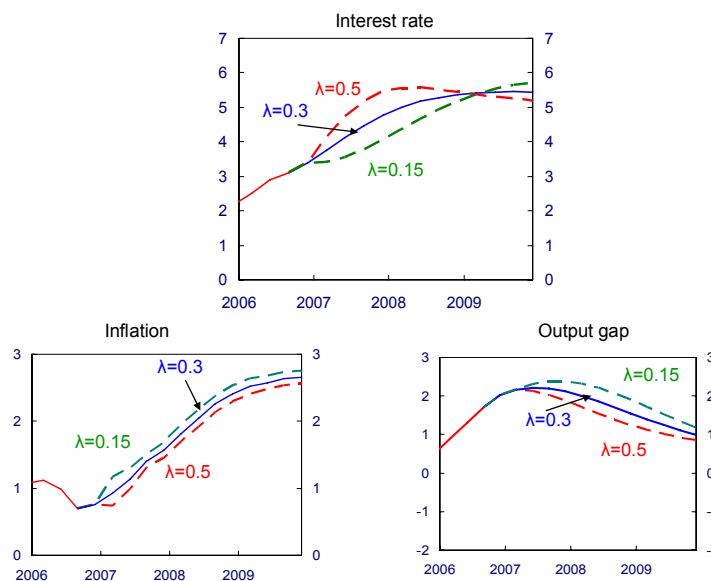


Figure 4.4 illustrates how a set of alternative trajectories based on different preferences could be presented to the Board. One should bear in mind that there is a psychological bias to opt for the centre alternative in such a menu, and some might argue that this could be tool for the staff to lead the decision process

towards a specific choice of interest rate path.¹¹ One could, however, turn this potential psychological bias to an advantage. If the staff let the centre alternative in the menu represent the path based on a “lambda” which is consistent with the earlier preferences of the Board, the psychological bias will lead to a bias towards continuity and predictability in the Bank’s reaction pattern.

5 Experiences with interest rate forecasting

Surveys indicate that inflation expectations in Norway have been well anchored among households, economic experts and the social partners¹². It is not obvious whether or to what extent publishing the interest rate forecast has contributed to bolster inflation expectations.

The empirical literature on transparency is not vast. As no central banks have a long history of publishing interest rate forecasts, with the notable exception of the Reserve Bank of New Zealand, there are few empirical studies on this specific topic. Most of the existing empirical literature has focused on the gains from the introduction of inflation targeting and the consequent decreased volatility in the yield curve.

A survey of recent experiences with announcing future policy intentions is given by Ferrero and Secchi (2007). They find that announcing policy intentions seems to improve the ability of market operators to predict monetary policy decisions based on comparisons of data from Norway, New Zealand, The US and the Euro area from 1999. Volatility in short-term money market rates on the days of interest rate revisions has decreased along with the introductions of qualitative and quantitative announcements on future policy intentions. There are too few observations to discriminate between qualitative and quantitative announcements. As predictability has decreased in all the countries in the study, defined by reduced market rate volatility, they cannot exclude the possibility that the improvements in predictability may be related to factors not related to transparency.

¹¹ This point was made by Charles Goodhart under a presentation of this paper.

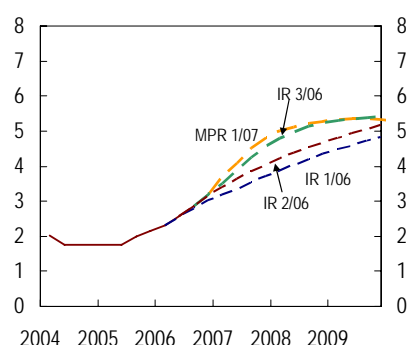
¹² See e.g. TNS Gallup Quarterly Expectation Survey

The transparency measure described above was also applied in a series of studies in the first decade of inflation targeting. Haldane and Read (1999) argued that full credibility will insulate the yield curve from jumps at the time of monetary policy changes. They found that inflation targeting and greater transparency in the monetary policy regime in the United Kingdom resulted in lower volatility, especially in the short end of the yield curve. Muller and Zelmer (1999) found that increased transparency in the Bank of Canada helped market participants anticipate monetary policy actions. They argued that market participants are provided with a superior information set which improves their understanding of the central bank's actions. The results were supported by Coppel and Connolly (2003) who found that short-term interest rate volatility has fallen substantially since the late 1980s in Australia and a range of other countries, as market participants were increasingly able to predict changes in the policy rate.

The Norges Bank did not produce interest rate forecasts before 2005, and it is early to assess the isolated effect of the recent changes in its communication. Figure 5.1 shows a comparison of the interest rate forecasts since November 2005. Notably, the trajectories have been revised upwards, but the latest forecast (June 2007) is still within the 90 percent uncertainty interval drawn up in November 2005. The adjustment has been assigned to changes in the assessment of exogenous shocks to the economy. An upward revision in the output gap since 2005 is the most prominent explanatory factor. The interest rate forecasts have not been adjusted unless there have been changes in at least one exogenous factor.

Figure 5.1. Interest rate forecasts since 2005

Chart 5.1. Norges Bank's interest rate forecasts since 2006.



An argument against publishing the interest rate forecasts, as discussed in section 2, is that the loss of prestige will prevent the central bank from changing the forecast when needed. Figure 5.1 does not support the view that this has been a particular challenge, as the forecasts have been revised several times.

5.1 Direct measures of credibility

The studies referred to above, broadly conclude that the reduced interest rate volatility has been a benign effect of transparency. However, as the ultimate objective of monetary policy is to stabilise inflation expectations, it is not obvious that improved forecastability or reduced interest rate volatility would underpin inflation expectations or be welfare improving.

As opposed to Ferrero and Secchi (2007) and Haldane and Read (1999), who applied the jump in the yield curve connected with interest rate meetings as a measure of credibility, we are able to gauge credibility more directly. Comparing the central bank's forecast with the observed market expectations ex post gives an indication of the credibility of the central bank. If the central bank succeeds in anchoring expectations, its announcements should have an impact on expected interest rate on a longer horizon than the very short end of the yield curve.

Table 1. The difference¹³ between the key policy rate and estimated forward rates¹⁾ the day after the Report. Percentage points.

<i>Report</i>	<i>Mean deviation</i>		<i>RMSD</i>	
	<i>1-4 quarters</i>	<i>5-12 quarters</i>	<i>1-4 quarters</i>	<i>5-12 quarters</i>
<i>IR 3/05</i>	<i>-0,11</i>	<i>-0,18</i>	<i>0,13</i>	<i>0,27</i>
<i>IR 1/06</i>	<i>-0,01</i>	<i>0,03</i>	<i>0,06</i>	<i>0,22</i>
<i>IR 2/06</i>	<i>0,01</i>	<i>0,11</i>	<i>0,05</i>	<i>0,20</i>
<i>IR 3/06</i>	<i>0,10</i>	<i>0,77</i>	<i>0,14</i>	<i>0,80</i>
<i>MPR 1/07</i>	<i>-0,06</i>	<i>0,48</i>	<i>0,10</i>	<i>0,50</i>
<i>MPR 2/07</i>	<i>0,03</i>	<i>0,09</i>	<i>0,03</i>	<i>0,09</i>
<i>Average deviation</i>	<i>0,01</i>	<i>0,22</i>	<i>0,08</i>	<i>0,35</i>

¹⁾ A credit risk premium and a technical difference of 0.20 percentage point have been deducted to make the forward rates comparable with the key policy rate.

Figures 5.2 a-d illustrate the forward market rates¹⁴ (solid lines) with the Bank's forecast (dashed lines) in the reports from summer 2006 through summer 2007. The market rates are based on data from the day after the Bank's forecasts were announced. A general observation is that the market expectations have not deviated substantially from the bank's forecast in the short end of the curve. Table summarizes the findings. The sign of the short-term deviation has varied over time, and the mean deviation over the first four quarters is close to zero. The RMSD is below ten basis points. The mean deviation for the first four quarters has on average been as low as 0.01 percentage points, see Table 5.1. From 5 to 12 quarters the normal mean deviation has been below 20 basis point. In two cases, in IR 3/06 and MPR 1/07, there was a discrepancy of ½ - ¾ percentage point. In the November 2006 Report the market rates seemingly did not adapt to the published forecast. The market rates shifted upwards right after the report was published but the grater part of the shift came in the following weeks, as illustrated by the grey line in Figure 5.1c. It is hard to ascertain whether the market only slowly adjusted to the Bank's forecast or if the shift was driven by

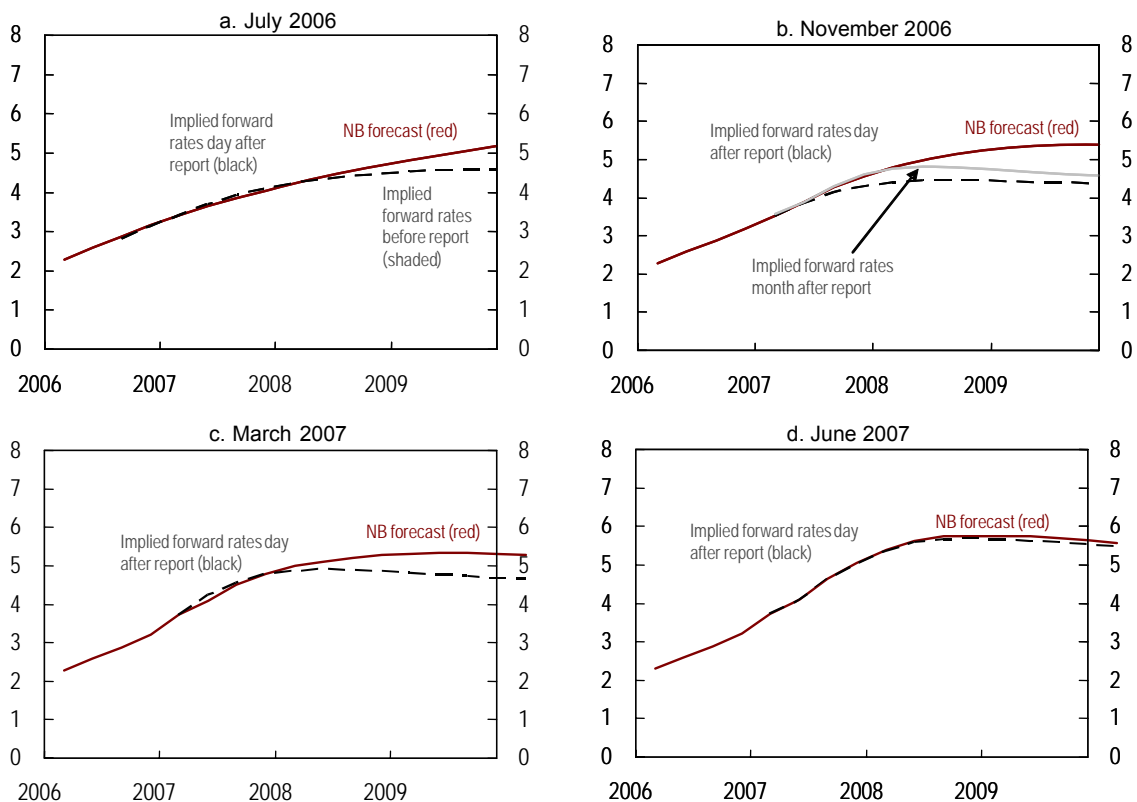
¹³ Norges Bank's policy rate forecast minus implied market rates adjusted for risk premia

¹⁴ Implied forward rates are estimated from four money market rates with terms from 1 to 12 months, and nine swap rates with terms from 2 to 10 years. The estimation is based on the extended Nelson-Siegel method, see Nelson and Siegel (1987) and Svensson (1994, 1995).

new information that arrived after the report was published. We lean towards the former explanation as economic indicators developed in line with expectations, and market observers frequently referred to the Bank's forecast in their own forecasts as the December interest rate meeting approached.

Discrepancies between the bank's interest rate forecast and the market forward rates could challenge the credibility of monetary policy. In our view, the observed discrepancies over the past year can not be interpreted as hampered credibility.

Figure 5.2 a-d. Market reactions after publication of Monetary Policy Reports



First, market agents point to special market conditions forcing the long rates down over the past years. High demand for savings, especially from Asia, seems to have driven long rates down globally. At the same time, institutional changes following the adoption of the Basle II Capital Accord have increased pension funds' demand for longer-dated maturities, pushing long rates down. This is consistent with the

market segmentation hypothesis or the preferred habitat hypotheses where investors have distinct investment horizons and short-term and long-term instruments are imperfect substitutes. Increased demand for bonds and other long-term instruments may have caused a negative risk premium. In that case, the expectation hypothesis is challenged and long-term rates do not necessarily reflect the true interest rate expectations in the market.

Second, the suppressed long-term rates may reflect different views on the transmission mechanism or the external environment. After several years of low underlying inflation, market agents may have had a different view on the inflation dynamics, leading them to believe that a sustained low interest rate level is required to meet the inflation objectives. Related to this, market participants may have believed that an increasing interest rate differential vis-à-vis other countries would lead to a carry-trade driven appreciation of the Norwegian krone, forcing the Bank to set the interest rate lower than it intended. Monetary policy would still be determined as long as economic agents have a correct understanding of the bank's reaction pattern.

The situation would be more demanding should the discrepancy stem from a misunderstanding of the bank's reaction pattern. In that case one might, however, expect a noticeable discrepancy even at the 6-12 months horizon. As the market rate have been well aligned with the central bank's forecast at this horizon, we lean toward the hypotheses above to explain the discrepancies that have occurred at times.

The real effects of the discrepancies have been reduced by the fact that the households have had reduced possibility to benefit from the relatively flat yield curve. Norwegian households are largely financed by floating-rate mortgages. Increased competition in the Norwegian banking market has squeezed the banks' margins in the short end of the curve, but to a lesser extent on fixed-rate mortgages. Thus, the households have in fact been faced with a steeper yield curve than the implicit market rates in Figures 5.1 a-d.

As the ultimate objective of monetary policy is to stabilise inflation expectation it is not obvious what would be the desired effect on volatility in the market rates. When the central bank's reaction pattern is internalised among market participants one should expect reduced volatility on the release of the report. A better-anchored understanding of the reaction pattern could also lead to increased volatility on economic news as deviations from the central bank's forecasts more easily can be interpreted in terms of their implications for monetary policy. The overall conclusion is ambiguous. If the bank succeeds in exploiting the expectation channel it can affect the yield curve not only in the short end but also interest rates with longer maturities, reducing the need for an aggressive monetary policy. If, on the other hand, the credibility of the inflation target is under pressure, the bank needs to act more persuasively to anchor inflation expectations. In that case, the increased volatility in interest rates is desirable.

5.2 Indirect measures of credibility

An intermediate objective of publishing interest rate forecasts could be to reduce uncertainty about future interest rates. The success of such a strategy could be measured by whether forecasts have been a good predictor of future policy and whether economic agents have become better suited to predict future monetary policy.

If the interest rate is considered a means and does not enter into the welfare optimal loss function, interest rate volatility is not relevant. However, if financial wealth is distributed heterogeneously among households or households are credit limited there are arguments that reduced interest rate volatility is welfare improving (see e.g. Pescatori (2005)).

Following Ferrero and Secchi (2007) and Haldane and Read (1999) we assume that increased transparency would result in decreased market volatility at the time of the interest rate meetings. By measuring changes in the short end of the yield curve, we compare the recent period of interest rate forecasts (after 2005) with the previous period (2001-05) where different exogenous assumptions were applied, see Figure 5.3. The bars in the figure express the average jump in the forward

rates at each interest rate meeting. There are 42 meetings in the first period (January 2001 – October 2005) and 17 meetings in the second period (November 2005 – August 2007). The change is measured in a four-hour window around the release of the press statements on the interest rate decisions of the Norges Bank. Applying a two-sample *t*-test, the mean jump in the yield curve is significantly lower in the second period¹⁵.

Although Figure 5.3 gives some support to the hypothesis that market volatility has decreased after the introduction of interest rate forecasts, several caveats should be noted. First, the number of observations is limited and is probably not robust. Second, the sizes of interest changes moves were on average higher in the first period compared to the last, which could induce larger surprises. Third, the decreased volatility could be a result of the maturing of the inflation targeting regime, comparable to the development in other countries and not specific to Norway. Ferrero and Secchi (2007) note that volatility has decreased in several countries, which could be attributed to other factors than increased transparency.

To summarize, the Bank's forecasts have had reasonable impact on the market rates in the short run. More important, the Bank's reaction pattern has affected the market rates continuously, so that market participants in large have reacted adequately on economic news between the reports. In most cases, the market rates have adjusted before the presentation of the bank's forecast so that, in practice, the discrepancy between the two, at least up to the 12-months horizon, has been rather narrow at the time of publishing.

¹⁵ Significant at the 1% level

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