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# Staff Memo

Monetary Policy

Policy-making and models at Norges Bank

by

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# Policy-making and models at Norges Bank

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**Jan F. Qvigstad**[1]


**Summary of talk held at Norges Bank's conference entitled "Economic models at central banks", in Oslo 7 April 2005.**[2]

# Monetary policy framework and models

- Monetary policy provides a nominal anchor

- Trade-off between variability in inflation and variability in output in short/medium term

- Models help in identifying disturbances/shocks

- Institutional framework varies between central banks

- Institutional framework has an impact on modelling approach

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The most important task of monetary policy is to provide an anchor for inflation expectations – a nominal anchor. There is no permanent trade-off between inflation and output. There is, however, a trade-off between variability in inflation and variability in output in the short and medium term. Norges Bank operates a flexible inflation targeting regime, so that weight is given to both variability in inflation and variability in output and employment when interest rates are set. Flexible inflation targeting builds a bridge between the long-term objective of monetary policy, which is to keep inflation at bay to provide an anchor for inflation expectations – a nominal anchor – and the more short-term objective of stability in the real economy.

Our economies are exposed to disturbances. Monetary policy responds to these disturbances in order to secure the nominal anchor. Because of disturbances, it may now take some time before inflation reaches its target, but a more aggressive monetary policy aimed at pushing up inflation more rapidly would probably increase pressures in the economy. Allowing such pressures to emerge could undermine expectations that future inflation will be close to the target

Such considerations and assessments are common to all central banks. But the monetary policy framework differs between countries, for historical or institutional reasons. Some central banks define themselves as inflation targeters, some as flexible inflation targeters and others, like the ECB and the Fed in the USA, don't give themselves a specific label. The monetary policy framework will of course influence the modelling approach in each central bank.

# Models at Norges Bank

- Assessment: How useful are models for our purposes?

- The main question to answer is: How should interest rates be set (now and in the future) to best meet our objectives?

- Inflation targeting requires specific modelling tools
  - endogenous interest rate and exchange rate

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The value of macro models depends on how useful they are for monetary policy assessments. Under an inflation targeting regime, the focus is largely on risks, on understanding what type of disturbances to which the economy may be exposed and on analysing the appropriate monetary policy response to various disturbances. The question that we seek to answer is at what level the interest rate should be set now and in the future to bring inflation back to target and stabilise economic developments around trend.

In the policy and risk analysis, we look at the consequences for economic developments of alternative assumptions about the interest rate, the current economic situation and the functioning of the economy. Such analyses of alternative scenarios must be based on a macro model.

Last year, David Archer (Reserve Bank of New Zealand and BIS) and Per Jansson (Riksbanken) evaluated Norges Banks interest rate setting process. They suggested using models more actively to help aggregate new information in terms of the implication for interest rates. Such analyses, of course, require a model where monetary policy is endogenously determined.

I think the question "What does new information imply for interest rates now and in the future", is perhaps more relevant than the question "What does new information imply for inflation?"

## Roles for models

1. Analysis of the current economic situation and identification of shocks

2. Forecasts/projections

3. Policy analysis and analysis of risk and uncertainty

4. Communication

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What are the roles for models in a central bank with inflation targeting?

First of all, the role for a model is to assist in the analysis of the current economic situation. Getting the starting point for the economy right, and trying to identify which shocks are hitting the economy, is extremely important. Optimal policy depends on what the shocks are. But models alone are in no way sufficient. Digesting incoming data and getting a feel for what is going on in the economy by talking to businesses around the country is very important.

The second role for models is forecasting or projections. This naturally has to do with the forward-looking nature of monetary policy. Models can be useful in their own right by structuring our thoughts and giving us some guidelines.

## Different time aspects – different methods

Chart labels:
- CPI-ATE
- Output gap
- Detailed analysis
- Aggregated model
- Iteration process
- Detailed analysis
- Long-run equilibrium values
- Current situation
- Projection period
- Long term

Axis values: 3, 2, 1, 0, -1, -2
Years: 2003, 2004, 2005, 2006, 2007, 2008
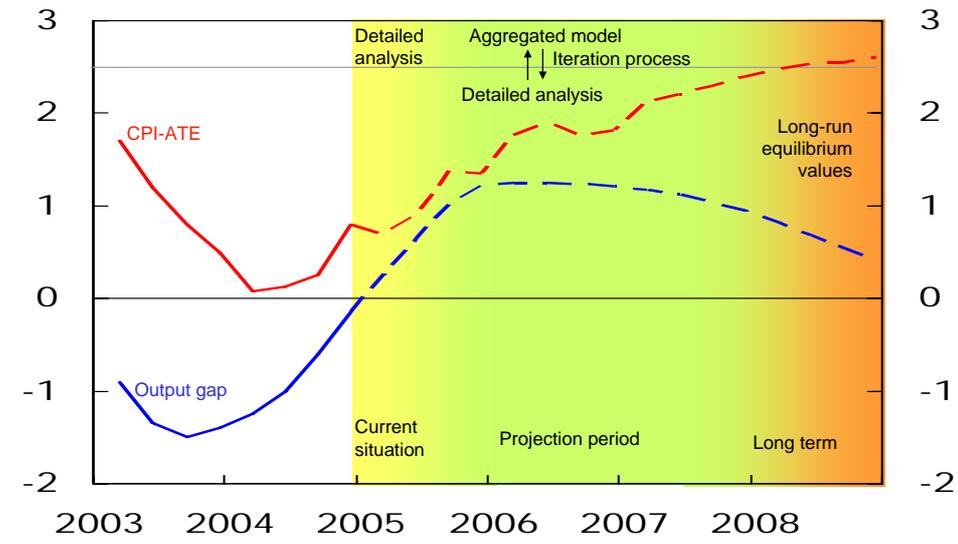
To provide you with some insight into how we make projections for the Norwegian economy, it is useful to consider a tripartite approach: the short-term or current situation, the medium-term or projection period and finally what we call the long-term. The dividing lines are not clearly defined, but are to some extent overlapping, as indicated in the chart.

Knowledge about the current economic situation is absolutely essential to making projections of economic developments that are useful for monetary policy. We must form a picture of capacity utilisation in the economy and whether it is increasing or decreasing. We must also try to identify the driving forces or disturbances that influence developments. A macroeconomic model will be a useful tool in this connection. Nevertheless, thorough analyses of available economic statistics are the most important basis for assessing the current situation. To obtain a good picture of the current situation, it is important to consider developments in context and to distinguish between genuinely new information and noise.

A very useful cross-reference and alternative information channel to official statistics is therefore our own regional network, which consists of enterprises, organisations and local authorities throughout the country.

Our tool box contains various models. Detailed and concrete information and analyses of data with pure statistical models (ARIMA models etc.) play an important role in the short run analysis. The theoretically based models play a more important role the further ahead we look.

Based on experience and economic theory, we can assume that certain relationships will hold in the long term. There is fairly broad agreement that monetary policy cannot affect the level of output and employment over time. Therefore, it is reasonable to assume that output and employment in the long run are determined by supply-side factors. At the same time, inflation is determined over time by monetary policy. Both

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theory and experience indicate that in the long term, the real interest rate must be positive and consistent with the growth potential of the Norwegian and international economy. Experience shows that the real interest rate has generally ranged somewhere between 2 and 4 per cent. In keeping with experience, we can assume that wage income, consumption and investment as a share of production are fairly stable over time. Hence, we have some fairly robust reference points for the economy in the long term.

In our medium-term forecasting, short-term developments are linked to our assessments of long-term developments. In this context, a macroeconomic model can function as a bridge. Moreover, a macro model can ensure consistency between important economic variables. As an alternative and a cross-reference, we also make medium-term projections using a more detailed analysis of a number of economic variables. Simple econometric models are used in this work. The baseline scenario published in the Inflation Report is based on a discretionary overall assessment of the projections derived from the model and the projections coming out of the more detailed analysis.

Making projections and forecasts is therefore an iterative process. The forecasts from aggregated models are confronted with the detailed analysis by sector experts. The detailed analysis and concrete knowledge has the upper hand when deciding on the current situation and the first year-and-a- half of the projection period, while the more aggregated and theory-based models perhaps have the upper hand in the latter half of the forecast period.

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## Roles for models

1. Analysis of the current economic situation and identification of shocks

2. Forecasts/projections

3. Policy analysis and analysis of risk and uncertainty

4. Communication

The third role for models, which is related to the second, is policy analysis, risk assessment and handling uncertainty. What is optimal policy conditional on certain shocks? And what would a robust monetary policy strategy look like? The handling

of uncertainty and policy analysis is aided by having sound economic models at hand.

As I see it, the fourth role for models is related to a very important aspect of monetary policy: communication. Every sixth week, the Governor or the deputy Governor of Norges Bank has to tell the public what they have done to interest rates and, not least, why. They have to give the public a comprehensible reason for the decision, and they have to try to convince people that the decision is a sensible one. Credibility is endogenous, and plausible stories are needed to build or restore credibility of monetary policy. I see a role for models in this; they help us to tell stories in a coherent and consistent fashion.

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## What can models do for us?

Models can contribute to:

- Identifying shocks
- Telling stories
- Analysing risks
- Structuring debate
- Consistency in formulating projections

- *"Aim is as much to understand the "economics" of the projections or forecasts, as to produce quantitative estimates."*

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So to sum up in a few words what models can do for us:

The most important things models can contribute to is to help us identify shocks, tell stories, analyse risks (by changing both behaviour and exogenous factors), structure the debate and be consistent in the formulation of projections

As our colleague from the Bank of England Spencer Dale expressed: "Aim is as much to understand the "economics" of the forecast, as to produce quantitative estimates."

# Forecasting and Policy Analysis System (FPAS)
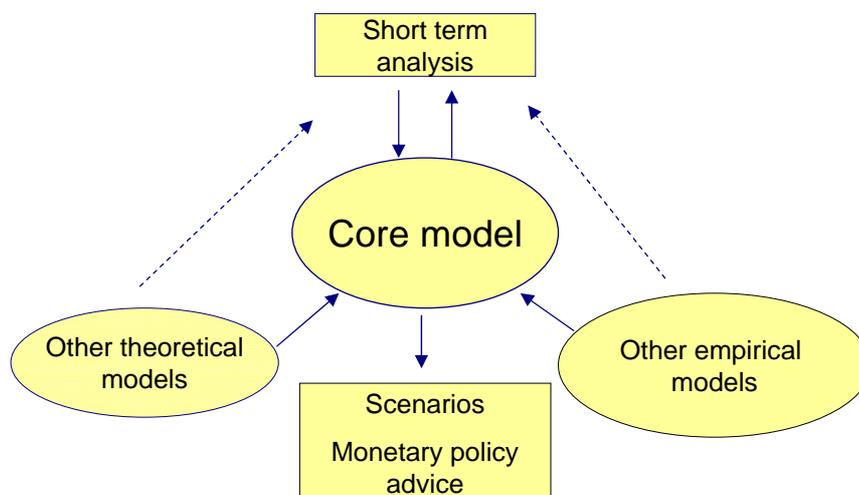


A model is just a tool, and different tasks may require different tools. No model is perfect. Model uncertainty, and the fact that different models are designed for different purposes, highlight the need for a suite or system of models approach. But as the chart illustrates, having an appropriate core model is important for this system to work well.

But it is also crucial to have small empirical models that can be used as inputs in the process of making projections and also for cross checking the results from the core model. We have a long tradition in Norway and Norges Bank of developing and using empirical models, based on traditional time series econometrics. This has been useful to us and always will be.

## Domestic Inflation.
## Actual and projections by single-equation
## econometric model [1]
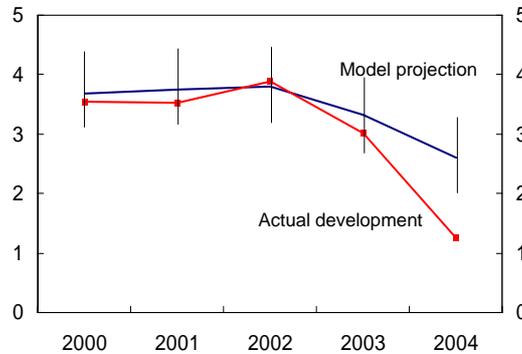


[1] Vertical bars illustrate confidence intervals (95 per cent)

This chart shows how small econometric models can help us to better understand economic developments. The blue line indicates projections of domestic inflation based on a small econometric model. In this (equilibrium correction) model, domestic inflation is explained by developments in unit labour costs and past inflation.

The model predicted inflation quite well in the period 2000-2003, but in 2004 inflation was significantly lower than the developments in unit labour costs would normally imply.

The model projections underpin our intuition and knowledge that extraordinary factors, like intensified competition in the airline industry and strong productivity growth in distribution sectors have exerted downward pressure on inflation.

This supports the view that the recent low inflation to a large extent reflects circumstances which were difficult to foresee on the basis of macroeconomic models.

# What kind of core model do we need?

Tool for policy decisions

Data                                                                  Theory
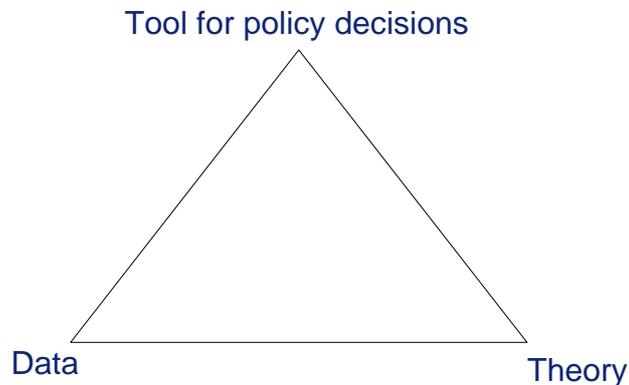
So what kind of core model do we need at Norges Bank, given our institutional framework? I think there are three important dimensions. Firstly, it should provide a reasonable balance between the objectives of theoretical consistency and data coherence.

In practice there may be a trade-off between theoretical consistency and data coherence. By theoretical consistency, I mean that the model must reflect sound and mainstream economic theory, built on decades of learning and research by academics and central banks.

Moreover, the model must be confronted with data, but we must recognise that different empirical approaches can yield different results. Discretion must therefore always be exercised in quantifying the model. And it's of course important to evaluate the model as a system, not only equation by equation.

In sum, the core model must incorporate the bank's assessments of the most important relationships in our economy. In this process, we must combine our overall theoretical and empirical insight.

The third dimension is important and maybe too often forgotten in the debate: The model should be a useful tool for policy decisions: It must be useful for policy analysis in board meetings and for presentations in inflation reports. It must contribute to structuring the debate, consistency, discipline and learning. To achieve this requires that the model mechanisms are well-understood throughout the institution.

## General requirements for a core model

1.  The model must represent consensus views

    • No trade-off between inflation and output in the long term
    • Monetary policy affects the real economy in the short to medium term
    • Monetary policy provides a nominal anchor

2.  Expectations must play an explicit role

3.  Mechanisms and disturbances must be economically interpretable in a consistent fashion

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Moreover, there are some general requirements for a useful core model:

1) The model must represent consensus views about economic relationships:

- The model must reflect that there is no trade off between output and inflation in the long term

- The model must take into account that monetary policy affects output and employment in the short term

- The model must reflect that monetary policy provides the economy with a nominal anchor.

2) The effect of monetary policy depends as much on market participants' expectations concerning future policy as on the central bank's interest rate decisions. It is primarily economic agents' interest rate expectations that influence consumption and investment decisions – and consequently inflation. Expectations must play an explicit role in the model.

3)  Last but not least: It is of particular importance that the mechanisms and disturbances in the model are economically interpretable in a consistent fashion and relatively easy to communicate, both in the internal process and in the Bank's external communication. The importance of analysing risks also means that we must be able to change the various model mechanisms in a straightforward way.

The models we have had satisfy many of the requirements for a sound model, but the introduction of inflation targeting created new needs that these models were not designed to meet. We decided that a new model should be built stone by stone. Each stone should be useful in our daily work before we went further. We did not aim at building a model that could first be useful after three years of work. We started by

building a small pilot model, incorporating our views on the most important economic relationships in Norway.

## Pilot model: Structure

(1) **Output gap** depends on
  – Interest rates (short and long)
  – Exchange rate
  – Economic developments abroad
  – Shocks

(2) **Inflation** depends on
  – Output gap
  – Exchange rate and foreign prices
  – Inflation expectations
    - Past inflation
    - Inflation target
    - Model-based projections
  – Shocks

(3) **Exchange rate** depends on
  – Interest rate differential
  – Expectations
  – Shocks (risk premiums)

(4) **Interest rates** depend on
  – Inflation forecasts
  – Output gap

The pilot model has also been useful in focusing attention on what further features later models should have, and it has been an inspiration for learning. The model is similar to models at other central banks. The theoretical basis is the so called "New-Keynesian theory", also called the "New neoclassical synthesis".

The pilot model is a small-scale model. But it is nonetheless complex because it is forward-looking in its nature. Expectations play an important role in determining inflation, output, exchange rates and interest rates. Understanding the results from the model and presenting them in an intuitive manner orally in board meetings can be challenging enough.

The model consists of four endogenous variables: The output gap depends on short and long term interest rates, the exchange rate, economic developments abroad and shocks.

Inflation depends on the output gap, the exchange rate, foreign prices, inflation expectations and shocks. Inflation expectations are influenced partly by past inflation, the inflation target and model-based projections.

The exchange rate depends on the differential between interest rates home and abroad, expectations and shocks, while interest rates depend on inflation forecasts and the output gap.

# System characteristics of the Pilot Model

1. Monetary policy has an impact on the real economy in the short term
2. No trade-off between inflation and output in the long term (inflation is a monetary phenomenon)
3. Interest rates endogenous and Taylor principle fulfilled

These are the key system characteristics of the model:

First, monetary policy has an impact on the real economy in the short term. Second, there is no trade-off between inflation and output in the long term (inflation is a monetary phenomenon).Third, interest rates are endogenous and the Taylor principle is fulfilled.

## Interest rate, output gap and inflation.
## Scenario of lower-than-expected inflation
Per cent. 2004 – 2008
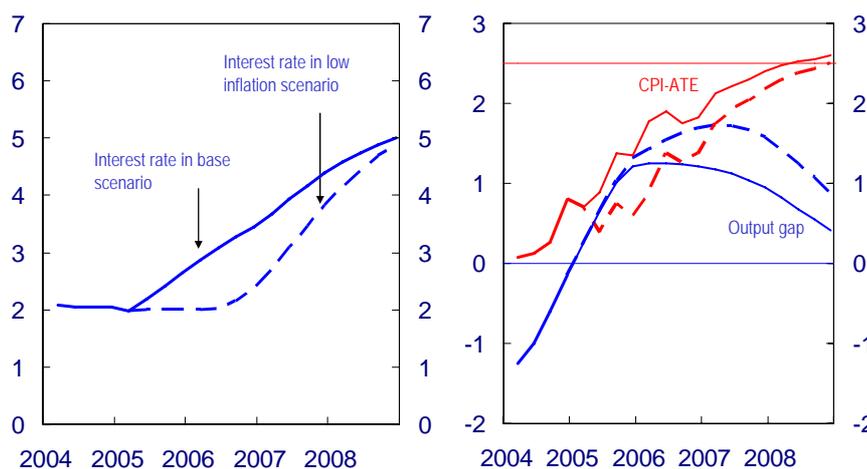


Source: Norges Bank's Inflation Report 1/2005

This chart shows an example taken from the latest Inflation Report, using the pilot model. The right-hand chart shows projections for inflation (red lines) and output gap (blue lines). The dotted red line shows a path for future inflation that for some reason

is significantly lower than expected in the near term. The dotted line in the left hand chart shows a possible interest rate path in such a low inflation environment. Lower interest rates than in the base scenario result in a weaker exchange rate and higher demand and output. This causes a higher output gap (blue dotted line in right-hand chart). The combination of a higher output gap and weaker exchange rate means that inflation increases faster, so that by the end of 2008 the level of the inflation is basically the same as in the baseline scenario.

Given these assumptions and the initial situation of the economy, the alternative interest rate path may result in acceptable developments in inflation and output. But in practice, monetary policy must also assess the background for and the expected duration of the lower-than-expected inflation level.

## In closing

- Inflation targeting places greater demands on our understanding of the way the economy functions than earlier regimes
- First step – Pilot model
- Next step NEMO – Norwegian Economy Model
- Necessary to analyse the economy from different angles

Let me close with the following remarks:

Norges Bank's macro models have played a key role in forecasting work over many years. Inflation targeting probably places greater demands on our understanding of the way the economy functions than earlier regimes, such as (strict) exchange rate targeting.

Developments in economics and computational technology have also provided new possibilities for constructing and solving macroeconomic models. Norges Bank has therefore worked for a while on developing new macro models. The Pilot model was the first step. But this model is very aggregate and the structure is not rich enough to analyse all the issues relevant to an inflation targeting central bank. Therefore we have also started developing a richer model – NEMO. To some extent, this model has already been used. Our Deputy Governor Jarle Bergo illustrated in a speech earlier this year how the model could support the assumption that increased competition has been one of several driving forces behind low inflation. But this model is the topic of a presentation later today.

Macroeconomic models are useful tools that can combine our empirical and theoretical insights. But models cannot provide definitive answers to all the questions that we as decision-makers face on a daily basis. Nor can they eliminate the uncertainty surrounding economic developments. Therefore, it is necessary to analyse the economy from different angles. We must also look out of the window, we must be pragmatic and we must exercise discretion.