

Forecasting in Norges Bank

Arne Kloster, assistant director, and Kristin Solberg-Johansen, economist, in the Economics Department of Norges Bank¹

Norges Bank's forecasts of economic developments form an important part of the basis for monetary policy. The projections of economic variables and Norges Bank's interest rate forecast are interdependent. Current information about economic developments, judgment and various economic models are all employed in our forecasting work. The current economic situation and developments in the next few quarters are assessed first, and then we determine the long-term impact of driving forces in the economy. This article describes the work on forecasting.

1 Introduction

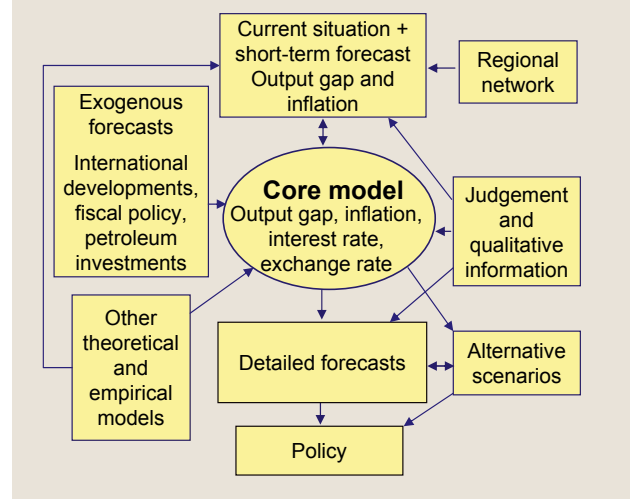
Norges Bank's forecasting forms an important part of monetary policy. In the work on forecasting, we analyse the current economic situation and the driving forces that will influence the economy in the period ahead. Since *Inflation Report 3/05*, demand, output and inflation forecasts have been based on Norges Bank's own interest rate forecasts. The forecasts of the interest rate and other economic variables are interdependent: the interest rate is influenced by developments in output and inflation, while interest rate developments must be assessed against the background of output and inflation forecasts. They indicate whether the interest rate forecast strikes a reasonable balance between the objectives of monetary policy. The forecasts of the interest rate and other variables are therefore made simultaneously in a multiple iteration process².

The purpose of this article is to provide insight into Norges Bank's forecasting work, and to describe the methodology underlying the projections published in the *Inflation Report*. The article discusses the various stages of the work and the tools used. The main emphasis is on the procedure.³

The structure of the forecasting work is illustrated in Chart 1. The projections of developments ahead are based on two premises in particular. The first is an assessment of the current economic situation and short-term forecasts. The second is forecasts for exogenous variables – those that have to be determined outside our model. On the basis of these premises, we use our macroeconomic core model to produce an initial set of projections for developments in output, inflation, the interest rate and the exchange rate. The forecasts in the *Inflation Report* cover a broader set of economic variables. They are produced through an iteration procedure between projections based on the core model and a system of smaller models surrounding it. The use of judgment plays a decisive part in shaping the economic outlook presented in the *Inflation Report*.

The analysis of the current economic situation and

Chart 1 Norges Bank's forecasting and policy analysis system



short-term developments is described in more detail in section 2. Section 3 describes the procedure for projecting developments further ahead.

2 Analysis of current situation and short-term developments

Current situation

The projections in the *Inflation Report* are based on an interest rate path that in the view of the Executive Board provides a reasonable balance between the objectives of monetary policy. In order to project future economic developments in a way that provides the best basis for these assessments, it is decisive that we have a reliable analysis of the current economic situation. The analysis of the current situation is based mainly on current statistics and other information about economic developments. However, short-term statistics are often uncertain, and there may be a long lag between the measurement and publication of new figures. Information from

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² Repeated calculations where the results of the previous calculation are taken into account in each new one so that a better result is obtained after each process.

³ The most important tools used are documented elsewhere (see Husebø et al. (2004) and Qvigstad (2005).

Norges Bank's regional network

- 7 regions
- 5 information rounds per year
- 40 meetings with contacts per region per round, minutes from each meeting
- 5 reports on business conditions per year from each region:
Qualitative reports with approximate quantification of economic conditions
- 5 national reports per year on economic conditions

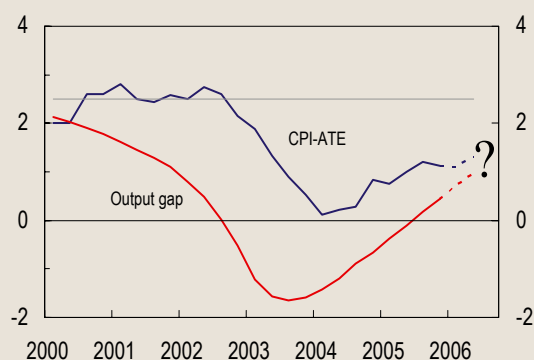
Norges Bank's regional network therefore provides an important supplement to current statistics. This network consists of companies, organisations and municipalities throughout Norway. Five times a year, business and community leaders are interviewed about developments in their sectors, and the impressions they provide form part of the basis of our assessment of the current and near-term economic situation. Preliminary surveys indicate that the network provides reliable information about developments before it becomes available through official statistics.⁴

An important part of the work consists of analysing the driving forces behind the current economic situation. The analysis of the current situation culminates in an assessment of capacity utilisation and inflationary pressures in the economy today, and forecasts for developments in the next few quarters (see Chart 2).

The output gap

The estimate of the output gap expresses our assessment of total capacity utilisation in the economy. The output gap is defined as the difference between actual output and potential output, which is the output level that is

Chart 2 CPI-ATE¹⁾ and estimate of output gap²⁾. Per cent. 2002 Q1 – 2006 Q2³⁾



¹⁾ CPI-ATE: CPI adjusted for tax changes and excluding energy products. A further adjustment is made for the estimated effect of reduced maximum day-care rates from January 2006.

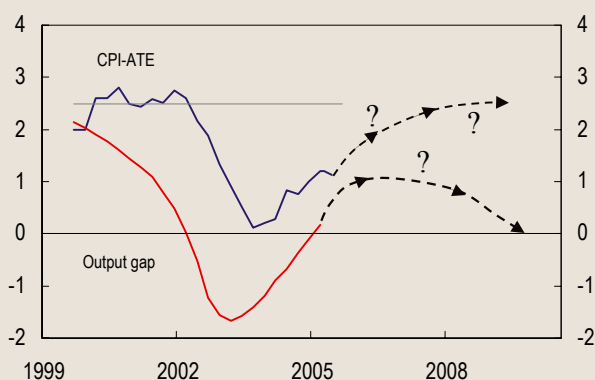
²⁾ Quarterly figures for the output gap have been derived from annual figures.

³⁾ Estimate for period 2006 Q1 – 2006 Q2

consistent with stable inflation over time. The output gap has to be estimated, as potential output is an unobservable variable. In order to make a correct assessment of economic pressures, and hence inflationary pressures ahead, it is important that our assessment of the output gap at the time in question is correct. If the initial level is incorrectly estimated, the error will be diffused over the forecast period. This will impair the basis for assessing which interest rate path can best contribute to achieving the desired developments ahead. The desired developments are illustrated in Chart 3.

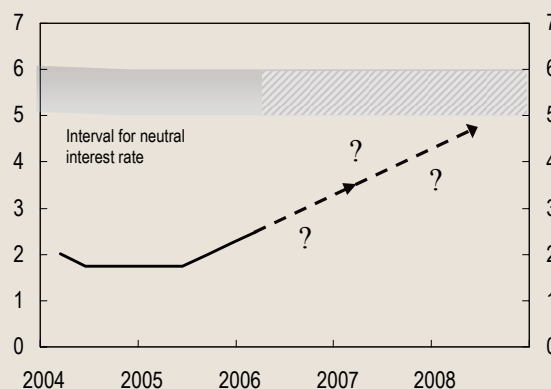
Our estimate of the output gap is the result of an overall assessment of available information concerning resource utilisation in the economy. Norges Bank's output gap estimates are based on several different methods and data sources, which may help to reduce the uncertainty of the estimates.⁵

Chart 3a Output gap and CPI-ATE



Sources: Statistics Norway and Norges Bank

Chart 3b Sight deposit rate



Source: Norges Bank

⁴ See Haugland, Kallum and Sjøtøl (2005) for a further discussion of Norges Bank's regional network.

⁵ See box in Inflation Report 3/05 for a discussion of output gap uncertainty.

- We base our assessment of the output gap on technical calculations of trend growth in the Norwegian economy. There are a number of methods for estimating the output gap. The most commonly used methods generally provide the same picture of cyclical fluctuations over time (see Chart 4)⁶. At certain times, however, the different methods may result in fairly different estimates of the output gap level. Our estimate is based on trend growth as calculated using a Hodrick-Prescott filter, but the results of other methods are also included in the assessment.
- Our estimate of the potential GDP growth rate is adjusted if we have information about extraordinary factors that influence developments. In the past, for example, we have made adjustments for the increase in the number of vacation days in 2001 and 2002, and the rapid decline in sickness absence in 2004. These are examples of changes that are captured by technical methods after a period, but which would have to be adjusted if we have information on sudden shifts.
- In our assessment of the output gap we also take into account other indicators that provide direct or indirect information regarding the utilisation of resources in the Norwegian economy. Among other things, we use information from Norges Bank's regional network to develop an index of average capacity utilisation in the Norwegian economy which can be compared with the output gap (see Chart 5). Statistics Norway's business tendency survey for manufacturing, and in particular the capacity utilisation index, may also function as a cross-check.
- The situation in the labour market provides important information about the output gap. The unemployment level fluctuates with the business cycle, and forms an important basis for assessing capacity utilisation. The unemployment level that is consistent with stable price and cost inflation is uncertain, however, and has to be estimated. The level of unemployment that is consistent with normal resource utilisation in the economy may also vary over time, among other things as a result of structural changes in the labour market. At the same time, the different unemployment statistics may in periods give different signals about labour market tightness. Historical experience plays an important part when these factors are assessed.
- Developments in the labour force, the number employed and person-hours worked also provide information about the extent to which available labour resources are being used. These variables normally fluctuate with the business cycle, and can provide a more nuanced picture of resource utilisation than that obtained by looking at the unemploy-

Chart 4 The output gap calculated using different methods

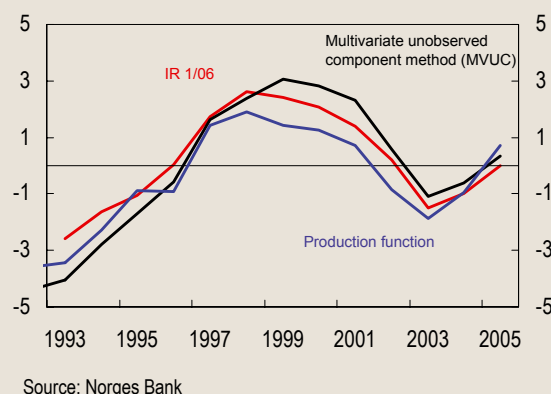
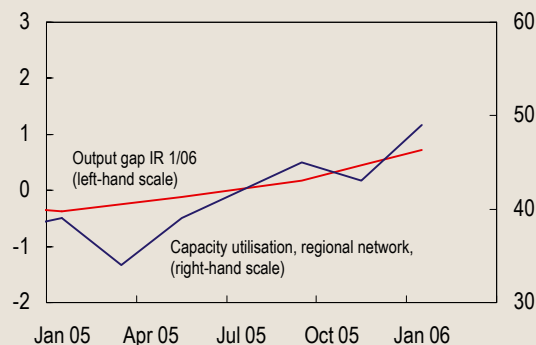


Chart 5 Capacity utilisation¹⁾, Norges Bank's regional network and estimate of output gap²⁾. Per cent. Jan 2005 - May 2006³⁾



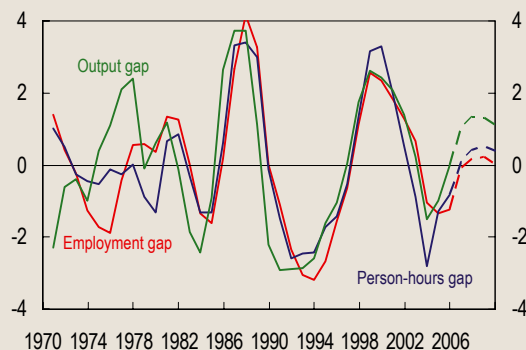
¹⁾ Share of contact firms responding that they have some or considerable problems accommodating increased demand. Per cent.

²⁾ Quarterly figures for the output gap have been derived from annual figures.

³⁾ Estimate for period 06 Q1 - 06 Q2.

Source: Norges Bank

Chart 6 Employment gap, person-hours gap and output gap. Percentage deviation from trend¹⁾. 1970 - 2009²⁾



¹⁾ Trend calculated using HP filter. See Staff Memo 2005/2 (www.norges-bank.no) for further information.

²⁾ Projections for 2006 - 2009.

Sources: Statistics Norway and Norges Bank

⁶ See box in *Inflation Report 1/04* and Bjørnland, Brubakk and Jore (2004) for a further description of different methods used to estimate the output gap.

ment rate in isolation. One approach is to consider developments in unemployment, person-hours and the labour force as deviations from calculated trend levels, as shown in Chart 6.

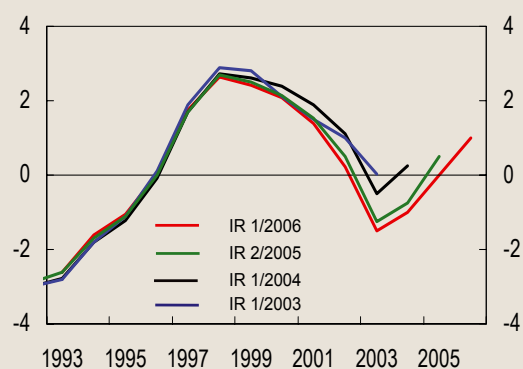
- Developments in financial variables can also provide information about capacity utilisation in the economy. Some financial indicators appear to correlate closely with the output gap, and in some cases can predict developments. See Gerdrup et al. (2006) for a more detailed account of these indicators.
- The link between real and nominal variables is largely found in the labour market. Wage developments provide an indication of how the social partners assess the tightness of the labour market. A considerably stronger increase in real wages than in labour productivity implies strong competition for labour, high capacity utilisation in the economy and inflationary pressures.

The output gap can also influence prices directly through profit margins in the enterprise sector. When demand for goods and services is high relative to production capacity, prices tend to rise to a further extent than implied by firms' costs. The extent to which margins increase in such a situation will depend especially on the competitive situation in the various industries. An assessment of the competitive situation in the economy is therefore important for estimating the effect of higher demand on inflation.

Owing to increased cross-border labour mobility and increased trade in services, assessing the output gap is more complicated than earlier. Increased globalisation may imply that capacity limits in the Norwegian economy are becoming more flexible. Inward migration of foreign labour in periods of expansion may prevent the emergence of bottlenecks. At the same time, increased awareness among Norwegian employees of the possibility of inward migration may have a dampening effect on wage demands. This may imply changes in the relationship between labour market tightness and wage developments. The existing statistics on use of foreign labour in Norway are incomplete, but provide some indication of developments over time. Information from our regional network is also useful in assessing these factors. Nonetheless, our assessment of the implications of increased globalisation for capacity utilisation has to be largely based on judgement.

Our estimates of the output gap level have been revised over time (see Chart 7), reflecting the substantial uncertainty surrounding the estimates. Revised national accounts figures and new information concerning developments in output, employment, unemployment, prices and wages may result in revision of the output gap level, both in retrospect and looking forward.

Chart 7 Estimates of the output gap in various Inflation Reports



Source: Norges Bank

Prices

The operational objective of monetary policy is annual consumer price inflation of approximately 2.5% over time. When assessing the attainment of this objective in retrospect, we look at whether average consumer price inflation (CPI) has been close to the inflation target over time.

Developments in consumer prices are influenced by a number of factors. There may be random monthly variations which do not provide information about underlying inflation. Like the output gap, underlying inflation is unobservable, and we therefore look at a number of different price indices in order to gain the best possible understanding of developments. The consumer price index adjusted for tax changes and excluding energy products (CPI-ATE) is an important indicator. Taxes and energy prices are often determined by factors other than underlying economic developments. Among other things, we find that electricity prices vary widely as a result of fluctuations in temperature and precipitation.

Other indicators of underlying inflation may place less emphasis on groups of goods that historically have shown wide price fluctuations, or groups of goods that have recently exhibited particularly wide price changes. Examples of such indicators are trimmed mean inflation⁷ and weighted median inflation⁸, where the most extreme price changes each month are excluded from the basis of calculation (see Chart 8). See Jonasson and Nordbø (2006) for a discussion of various indicators of underlying inflation in Norway. Producer prices, wholesale prices and building costs also provide information about inflation.

In order to analyse developments in consumer prices, the various sub-indices of the CPI are assessed individually. This may provide information about the forces that drive inflation. For example, prices for imported goods will be largely influenced by forces other than prices for goods and services produced in Norway. Capacity utilisation in the economy has the strongest effect on

⁷ Trimmed mean inflation is calculated by excluding the largest price movements when calculating inflation. The goods and services excluded vary from one month to the next.

⁸ Weighted median inflation is obtained by ranking changes in prices for some goods and services from lowest to highest. The median is the middle value obtained when CPI weights are taken into account.

Chart 8 Different indicators of inflation. CPI-ATE, trimmed mean and weighted median

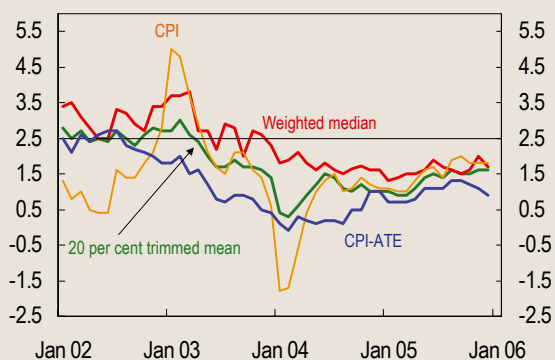
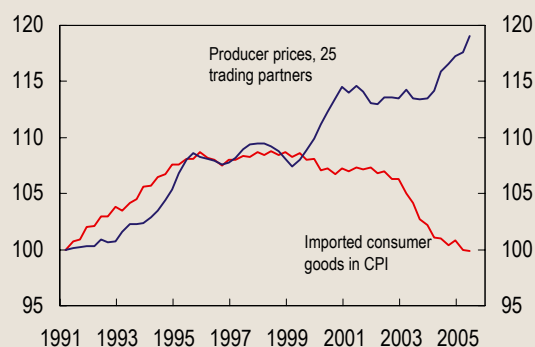


Chart 9 External price impulses to imported consumer goods. 1991 Q1 = 100



Sources: Statistics Norway and Norges Bank

the rise in prices for goods and services produced in Norway, while changes in the exchange rate, the trade pattern and external prices have the strongest effect on prices for imported consumer goods.

An analysis of sub-indices may also indicate whether changes in consumer prices are broad-based or driven by substantial changes in prices for only a few goods or services. A broad-based rise in inflation indicates that driving forces other than changes in prices for only a few groups of goods or services are behind the rise.

When assessing the current situation, observed developments in consumer prices are compared with the results of estimated equations for price developments. This is useful for determining whether developments are in line with historical experience, given the different driving forces, or whether they deviate. If there is a difference, the reasons for the difference have to be analysed. Without a correct analysis of the driving forces, it is not possible to draw up projections with a high degree of precision.

An example of such an analysis is the work devoted to understanding the low inflation of recent years. When inflation fell in 2003, primarily as a result of a sharp fall in prices for imported consumer goods, the fall was sharper than implied by our analytical tools. A possible interpretation was that the strengthening of the krone exchange rate through 2002 had had a more rapid, stronger effect on import prices than we had assumed. However, this was contrary to the findings of a number of international surveys which indicated that the pass-through from the exchange rate to consumer prices had declined over time.⁹

More detailed analyses indicated that the low rise in prices for imported consumer goods was related to changes in our trade pattern.¹⁰ A steadily increasing share of goods is imported from low-cost countries in Asia and central Europe. Importers' costs fall when suppliers in western industrialised countries are replaced by suppliers in countries with a substantially lower cost

level. A portion of this fall in costs translates into lower retail prices for imported goods in Norway. For example, clothing prices fell markedly. At the same time, strong productivity growth in some industries internationally led to falling prices for many internationally traded consumer goods.

In order to gain insight into and systemise these new forces, a new indicator was constructed in 2004 to measure external price impulses to Norwegian consumer goods (see Chart 9)¹¹. The new index shows that traditional calculations based on producer prices among our traditional trading partners may have on average overestimated external price impulses by close to 3 per cent annually over the past 6 years.

Observed changes in historical relationships may be a sign of long-term changes in the functioning of the economy. However, they may also be due to disturbances of a more short-term or random nature. It is difficult to determine in real time whether such changes are due to structural shifts or noise. Our assessments may have a considerable bearing on our forecasts.

The example above illustrates how important analysis of the current situation is for projections. If we had pointed to the low rise in prices for imported goods as the explanation for the stronger pass-through from the exchange rate, our projections would have been different than they did when we took into account the effects of the change in Norway's import pattern.

Short-term forecasts

Economic policy and other forces affect the economy with a lag. The output and inflation projections for the next few quarters can therefore be seen relatively independently of our projections for developments in interest rates, exchange rates, global developments and other driving forces. In our forecasting work we have therefore decided to use tools other than our core model to project developments in the next couple of quarters.

⁹ See for example Campa and Goldberg (2002, 2005).

¹⁰ See box in *Inflation Report* 1/04.

¹¹ See Røstøen (2004).

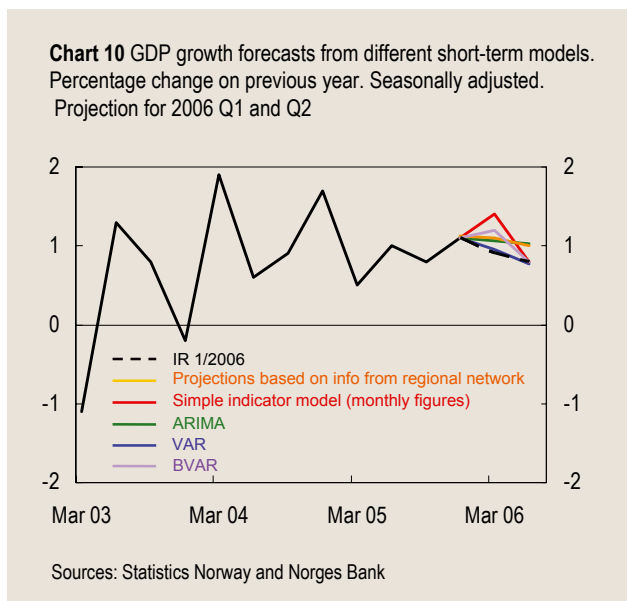
Detailed knowledge of developments in the different sectors of the economy is particularly useful for forecasting short-term developments. The core model plays a more important part as an aid in forecasting developments further ahead, which have to take greater account of projected interest rate and exchange rate developments.

In the light of our knowledge of the current situation and recent history, we form a picture of short-term developments. We use information from short-term statistics, the regional network and other relevant sources to forecast developments in the various demand components – private consumption, public consumption, fixed investment in the private and public sector, and petroleum investment. These forecasts are combined into a forecast for total domestic demand. Foreign trade and the supply side of the economy are also assessed based on output and labour market figures. Forecasts of total demand and the supply side are combined to form a picture of mainland GDP for the next few quarters. For consumer prices, we use econometric equations for domestic and imported inflation as a basis for short-term projections. These projections of prices and GDP form the point of departure for forecasting short-term developments.

The overall picture of the economy for the next few quarters is compared with the results from small models which are suitable for forecasting short-term developments. In this work we use univariate forecasts, forecasts based on GDP indicators and various kinds of VAR (vector autoregressive) models.

Univariate statistical models only make use of the historical variation in the actual series. ARIMA models¹² are used, which project numerical series on the basis of their own dynamics. Predictions from these models are useful for cross-checking variables such as inflation over the next few months. Experience indicates that univariate models yield relatively good consumer price projections for the next few months compared with other methods. For other variables, such as consumption and investment, these models are used primarily as an aid in assessing whether the observed fluctuations in the series are within the normal range of variation. They are also an aid in the work on assessing whether changes are due to random disturbances or new information.

Various types of VAR or Bayesian VAR (BVAR) models constitute a third tool for forecasting short-term developments.¹³ The starting point for these models is historical relationships between two or more variables. In classical VAR models, the projection of each variable in the system is based on historical developments in the variable itself and in the other variables in the system. A VAR model with three variables may for example consist of mainland GDP, consumer prices and the short-term interest rate. A priori restrictions are imposed on



coefficients in BVAR models. A common restriction is that recent historical values receive a higher weighting than values further back in time. However, the restrictions are not binding in this type of model.

The models described above are estimated using seasonally adjusted quarterly figures. Quarterly GDP figures are published a good two months after the end of the quarter. Before this, however, monthly indicator statistics are available, which historically have co-varied with GDP, and can therefore be used to project GDP for the current quarter. A simple indicator model in which we have estimated this empirical co-variation is used for these projections. The indicators in the model represent both the supply side (manufacturing output and employment) and the demand side (retail trade, building starts and hotel occupancy rates). The indicators are projected with the help of ARIMA models in order to forecast mainland GDP in the period ahead.

The various models provide a cross-check of projected developments in the main economic variables in the near term and make it possible to look at the figures without requiring judgement. Chart 10 shows examples of projections for mainland GDP generated by the various forecasting tools. The chart shows that the results generated by the various models may differ substantially. Studies indicate that an average of these model-based projections may be more accurate over time than the projections from the individual models.¹⁴ The final projections underlying our analysis will be based to a considerable extent on judgement, since the models are too limited to take account of all relevant information. If our projections deviate considerably from the forecasts generated by these models, however, it is an indication that the projected developments differ from their historical pattern. This may indicate that the projections should be re-examined. The final projections may still

¹² Forecasts from an ARIMA model (AutoRegressive Integrated Moving Average) will be a function of historical values of the series itself and historical error (moving average), given the model. The series is also differentiated so that it is stationary. Forecasting with this type of model can thus be viewed as a sophisticated form of extrapolation.

¹³ Vector autoregressive models. A VAR model with k endogenous variables consists of a system with k equations. One of the endogenous variables is determined in each equation.

¹⁴ See Clements and Hendry (2004).

differ from the results generated by the models. We may, for example, know of regulatory or other structural changes which we believe will influence developments. At the same time, the regional network provides supplementary information that may influence our forecasts. The difference between our forecasts and the model-based results may provide an indication of the weight we have given to this information.

The short-term picture is updated before the monetary policy meetings. New information is compared with the most recent short-term forecasts. The forecasts provide a reference for assessing developments in the period between two Inflation Reports.

3 Forecasts further ahead

The analysis of the current situation and projected short-term developments form the point of departure for forecast further ahead. The horizon for projections in the Inflation Report is 3-4 years. The objective of stabilising inflation close to the target within a reasonable time horizon, normally 1-3 years, requires an analysis of economic developments at least three years ahead.

Projections of main variables

In our forecasting work, the analysis of the current situation and the next few quarters is linked up to our assumptions about long-term economic developments. With the help of our core model we project developments in inflation, the output gap, short-term interest rates and the effective exchange rate. The projections are based on a number of premises:

- The starting point for the output gap, inflation and developments in the next few quarters.
- Projections for exogenous variables. The most important are developments in the international economy, including external price impulses, developments in public sector demand and investment activity in the petroleum industry.
- Our view of the functioning of the economy as quantified in our models.

Given these premises, the aim is to find the interest rate path that results in the least possible deviation from the inflation target over time, taking into account that fluctuations in output should not be too large. The projected developments in the interest rate will ensure that the economy is in equilibrium in the long term, with inflation on target and the output gap closed.

Such an approach may be appropriate in the context of forecasting, even though it is highly probable that the economy will also deviate from equilibrium in the future. The economy is constantly influenced by various disturbances that may be caused by domestic or external factors. Disturbances many years ahead are

very difficult to foresee with any degree of precision, however. For example, very specific information is required to base the projections on the assumption that a disturbance will occur 3-4 years ahead or that the functioning of the economy will change substantially. In a forecasting context, we normally assume that the economy is not exposed to new disturbances.

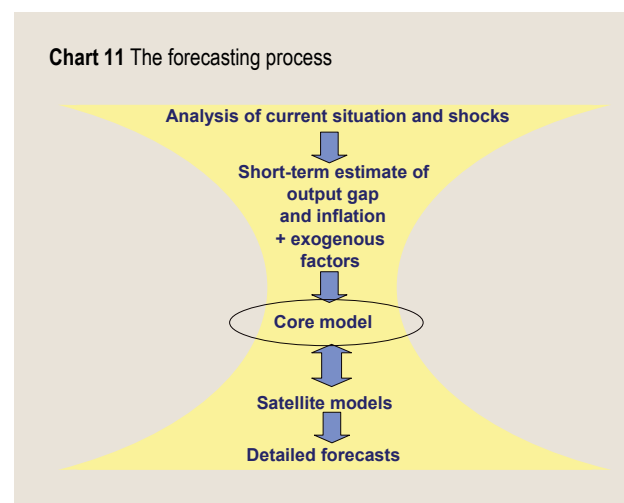
Quantifying the various economic variables in a long-term equilibrium is by no means straightforward. The equilibrium values of many economic variables are unobservable and may change over time. Nevertheless, it is necessary to make an assessment. The assessments may be based on historical developments, pricing of financial contracts with a long maturity and economic theory. The equilibrium the economy is assumed to move towards in the long term, provided that the interest rate is set correctly, is characterised by the following:

- Mainland GDP grows by about 2½ per cent annually
- The real interest rate is between 2½ and 3½ per cent
- The real effective exchange rate is constant

In our forecasting, we seek to build a bridge between our assessment of the current situation and our assumptions about long-term relationships in the economy. The Bank uses several macroeconomic models as tools in this work: the core model and a number of smaller models that are used to make detailed projections and to cross-check forecasts from the core model. These models constitute the main part of our forecasting and policy analysis system (see Chart 1 above).

Our assessments of the equilibrium values in the economy are built into the core model, and in the work on forecasting we have to decide whether any factors indicate that these equilibrium values should be adjusted. The core model is our most important tool for estimating how the economy will move from the current situation towards long-term equilibrium. With the help of the model, projections are made for the output

Chart 11 The forecasting process



gap, inflation measured by the CPI-ATE, the effective exchange rate and short-term interest rates. The model is a very simplified representation of the real economy, and only relationships between a few main variables are quantified. The main role of the model is to ensure consistency in the relationship between important economic variables and consistency in assessments over time. At the same time, a relatively small, straightforward model may be suitable for analysing alternative scenarios for the economy and the monetary responses implied by the different alternatives.

The choice of such a relatively small, aggregated model means that all information about the current situation has to be combined into estimates of the output gap and inflation. In the analysis of the current situation, the large volume of information is 'compressed' into the model's variables, as illustrated in Chart 11.

As the core model contains relatively few economic variables, a number of factors have to be determined outside the model. These exogenous estimates then have to be 'translated' into the model's variables, which entails assessing how they will influence the variables in the model. Neither fiscal policy nor petroleum investment is explicitly included in the model, although they are of considerable importance to economic developments. Projections for these variables are made outside the model, on the basis of available information. We assess how a projected fiscal stimulus, or projected growth in petroleum investment, will affect the output gap, which is the model's variable for economic activity. These assessments are included in the forecasts as an exogenous influence on the output gap (add factor), which in turn influences the projections for inflation, the interest rate and the exchange rate.

In addition to assessing exogenous variables and their effect on the model's variables, we assess how the disturbances we have identified in our analysis of the current situation will develop in the future. We decide whether we are facing new driving forces, or whether the disturbances are of a more temporary nature. If inflation, for example, differs substantially from what our model tools can explain, we must decide whether this deviation will persist, be amplified or reduced in the years ahead. In order to make a correct assessment, we must have understood which forces have influenced inflation to date. In some cases, similar episodes in the past or the experience of other countries provide support for our forecasts regarding future developments in such deviations. In some cases, economic theory can provide a reference. However, there is often little concrete information on which to base these assessments.

One example of such a deviation is the influence on inflation of the shift in our imports towards low-cost countries. After first identifying this effect and assessing its significance for inflation now, we must decide how this shift will develop in the years ahead. What level will our share of imports from low-cost countries

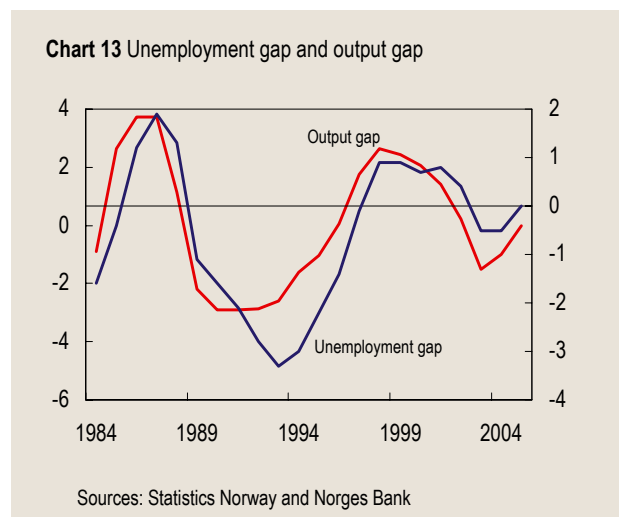
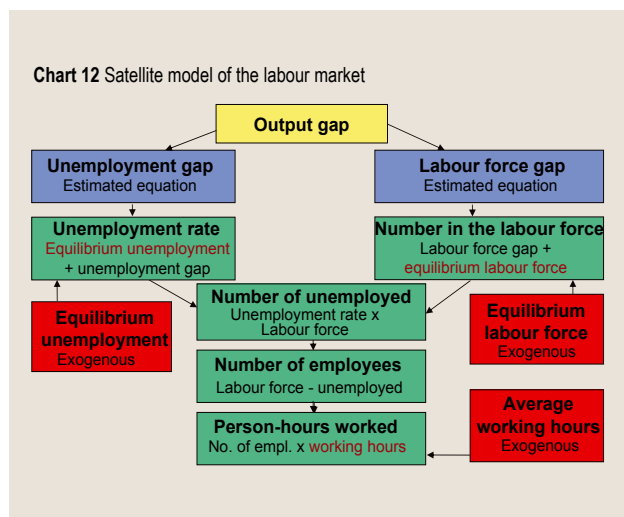
Criteria for an appropriate future interest rate path

1. If monetary policy is to anchor inflation expectations around the target, the interest rate must be set so that inflation moves towards the target. Inflation should be stabilised near the target within a reasonable time horizon, normally 1-3 years. For the same reason, inflation should also be moving towards the target well before the end of the three-year period.
2. Assuming that inflation expectations are anchored around the target, the inflation gap and the output gap should be in reasonable proportion to each other until they close.¹ The inflation gap and the output gap should normally not be positive or negative at the same time further ahead.
3. Interest rate developments, particularly in the next few months, 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.
4. The interest rate should normally be changed gradually so that we can assess the effects of interest rate changes and other new information about economic developments.
5. Interest-rate setting must also be assessed in the light of developments in property prices and credit. Wide fluctuations in these variables may in turn constitute a source of instability in demand and output in the somewhat longer run.
6. It may also be useful to cross-check by assessing interest rate setting in the light of some simple monetary policy rules. If the interest rate deviates systematically and substantially from simple rules, it should be possible to explain the reasons for this.

¹ The inflation gap is the difference between actual inflation and the inflation target of 2.5%. The output gap measures the percentage difference between actual and estimated potential mainland GDP.

reach in the long term? How rapidly will this adjustment take place? How will the price levels in these low-cost countries develop in the future?

Developments in other low-cost countries which became part of international trade earlier, and developments in our imports from those countries, can provide an indication. We also look at the levels of the shares of



our imports from low-cost countries for different groups of consumer goods. Nonetheless, the answers to these questions must be largely based on judgement.

On the basis of the analysis of the current situation, the projections for short-term developments and the assessment of exogenous forces, a first run of the model is prepared. This run provides a starting point for forecasting developments in the interest rate, the output gap, inflation and the exchange rate.

In the model, future interest rate developments depend on the projected future deviation from the inflation target and the estimate of the output gap. The model generates an interest rate path that will bring inflation back to the target and close the output gap. The interest rate projection from the core model is considered against the six criteria Norges Bank has defined for an appropriate interest rate path (see box with criteria).¹⁵

The criteria do not provide a precise indication for how the interest rate should be set, but point to factors that should be examined and assessed. In some contexts, there may be a conflict between the various criteria. In these situations, the Executive Board will exercise judgment in connection with the trade-off between the different objectives of monetary policy. If the first projections from the model indicate that one or more of the criteria have not been fulfilled, it may entail adjusting the interest rate path and making new projections for output and inflation.

Detailed forecasts

Based on an interest rate path that appears to be in line with the above criteria, more detailed forecasts for economic developments are produced. We are now looking at a larger set of variables than those in the core model. It is easier to compare this more detailed picture of the economic outlook with developments in the period between two Inflation Reports. In the light of the general picture, we forecast developments in the most important demand components, such as

private consumption, investment and foreign trade. At the same time we assess developments in employment, unemployment and wages. For these more detailed projections we use the system of smaller supplementary models. These models contain estimated relationships between the variables in the core model and the most important variables on the supply and demand side of the economy are built into them.

The structure of the supplementary model of the labour market is illustrated in Chart 12. We use the historical covariation between output, unemployment and the labour force over the business cycle to project developments in the labour market. An unemployment gap can be estimated in the same way as the output gap. The unemployment gap can be defined as the percentage difference between actual unemployment and estimated trend unemployment. Our estimates indicate that there has been a close correlation between the output gap and the unemployment gap in Norway for the last 20 years (see Chart 13). Unemployment is below trend during cyclical upturns and above trend during downturns. The relative variation in the two gaps appears to have been fairly stable over time. Experience shows that mainland GDP fluctuates about twice as much around its trend level as unemployment. If output is 2 per cent higher than its trend level, unemployment has tended to be about 1 per cent lower. The relationship between fluctuations in output and unemployment is known in academic literature as Okun's law¹⁶, and appears to hold fairly true for Norway. By using this relationship together with the estimate of the output gap, we can forecast developments in the output gap. The unemployment gap, an analogous labour force gap, and exogenous estimates of equilibrium values in the labour market are used to forecast developments in the number employed and person-hours worked.

The forecasts of unemployment and inflation form the starting point for assessing wage growth, which is projected on the basis of an estimated equation. In the supplementary model of households, the projections for

¹⁵ See *Norges Bank Working Paper* no. 5/2006: "When does an interest rate path 'look good'? Criteria for an appropriate future interest rate path." (Qvigstad 2006).

¹⁶ See Burda and Wyplosz (2005).

wages and person-hours worked are used to estimate wage income, which in turn is included in an estimated equation for household consumption. We use supplementary models in the same way for other economic variables such as investment, exports and imports and developments in house prices and household debt.¹⁷

An important function of the more detailed forecasts is to provide a cross-check of the results from the core model. If the results of one or more supplementary models appear unreasonable, there may be grounds for adjusting the core model. Among the factors we assess are developments in household saving and how households' financial position develops through the forecast period.

The model-based results are also compared with estimated individual equations external to the model system. For example, we compare the core model's projections for developments in the CPI-ATE with the results of other estimated equations for inflation. If the core model's projections differ substantially from the latter, we try to analyse this more closely. In some cases the comparison may indicate that the projections should be adjusted. These adjustments will in their turn influence the projections for the interest rate and the other main variables in the core model. The use of judgement is central to this iteration procedure.

Often more than one interest rate path may produce relatively favourable economic developments according to the six interest rate setting criteria. In theory, these paths could be ranked in terms of a so-called loss function, which quantifies the weight the decision-makers give to the various factors the central bank has to take into account in its conduct of monetary policy.¹⁸ In practice, no central bank bases its policy on this quantified loss function.

Norges Bank's Executive Board decides which interest rate path should form the basis for the forecasts. A proposed path with associated projections is submitted to the Executive Board at a seminar about two weeks before the *Inflation Report* is published. At the same time, the premises on which the forecasts are based are submitted. The Executive Board is also presented with projections based on alternative interest rate paths, and discusses alternative paths based on other assumptions about the functioning of the economy and exogenous forces. At the seminar, the Executive Board discusses the various alternatives and uncertainty, and decides which interest rate path that should be applied during the projection period.

4 Concluding comments

Norges Bank's projections in the *Inflation Report* are conditioned by a number of factors. They are shaped by the assessment of the current situation, estimates of exogenous variables, quantification of economic relationships and the characteristics of the economy in equilibrium.

In addition, the projections are determined by the Executive Board's assessment of trade-off between the different objectives of monetary policy. When the underlying premises change, the projected developments in the interest rate and other economic variables will also change.

Forecasting work is divided into different phases in which different methods and tools are used. There are a number of reasons why we find this approach appropriate. Different types of tools may be best suited for different parts of the forecasting work. For example, the analysis of the current situation does not depend on a particular method or model. The distinction between the current situation and exogenous factors on the one hand, and the projections for the future on the other, also provides a distinction between premises and monetary policy assessments.

Our modelling system has been developed into an effective tool for setting interest rates. The core model is a flexible tool for analysing possible monetary policy responses to alternative scenarios. By stripping away most of the details, attention is focused on the mechanisms that are most important to the conduct of monetary policy. One disadvantage of such an aggregated model may, however, be that some problems must be dealt with externally, and that a need for iteration arises. On the other hand, it may be easier to see what is driving the results than in a much larger, more detailed model. Norges Bank also estimates a larger macroeconomic model, NEMO, which is used in various kinds of shift analyses. It is built along the same lines as the current core model, with a Neo-Keynesian theoretical basis and forward-looking agents, but is more disaggregated.

A number of important aspects of forecasting have not been discussed in this article. Assessing the uncertainty surrounding projections is one of them.¹⁹ The analysis of alternative scenarios for the economy is another. In addition to the modelling system and the actual forecasting work, Norges Bank is continuously working on elucidating and communicating these issues.

References

- Bergo, Jarle (2006): "Projections, uncertainty and choice of interest rate assumption in monetary policy", speech on 27 January 2006, <http://www.norges-bank.no/front/pakke/en/foredrag/2006/2006-01-27/>
- Bjørnland, Hilde C., Leif Brubakk and Anne Sofie Jore (2004): "The output gap in Norway – a comparison of different methods", *Economic Bulletin* 2/05, pp. 90-100
- Burda, Michael and Charles Wyplosz (2005): *Macroeconomics: A European Text*. Oxford University Press

¹⁷ See Jacobsen and Naug (2004a, 2004b)

¹⁸ See Svensson (2003).

¹⁹ See the box in *Inflation Report* 1/06 and the speech of 27 January 2006 by Deputy Governor Jarle Bergo: "Projections, uncertainty and choice of interest rate assumption in monetary policy", www.norges-bank.no, for a discussion of the uncertainty surrounding the projections.

- Campa, Jose M. and Linda S. Goldberg (2005): "Exchange Rate Pass Through into Import Prices", *The Review of Economics and Statistics* 87(4), pp. 679–690
- Campa, Jose M. and Linda S. Goldberg (2002): "Exchange Rate Pass Through into Import Prices: A macro or micro phenomenon", *NBER Working Paper* no. 8934
- Clements, M.P. and D.F. Hendry (2004): "Pooling of forecasts", *Econometrics Journal*, 7 (1), pp. 1-31
- Gerdrup, Karsten and Roger Hammersland (2006): "Financial variables and developments in the real economy", *Economic Bulletin* 3/06, pp. 133-146
- Haugland, Kjersti, Jan-Reinert Kallum and Maja Sjøtøl (2005): "Norges Bank's regional network", *Economic Bulletin* 3/05, pp. 155-161
- Husebø, Tore Anders, Sharon McCaw, Kjetil Olsen and Øistein Røisland (2004): "A small, calibrated macro model to support inflation targeting at Norges Bank", *Staff Memo* 2004/3, Norges Bank [URL: <http://www.norges-bank.no>]
- Jacobsen, Dag Henning and Bjørn E. Naug (2004a): "What influences the growth of household debt?" *Economic Bulletin* 3/04, pp. 103-111
- Jacobsen, Dag Henning and Bjørn E. Naug (2004b): "What drives house prices?" *Economic Bulletin* 1/05, pp. 29-41
- Jonassen, Morten and Einar W. Nordbø (2006): "Alternative indicators of core inflation for Norway", Article presented at UNECE/ILO meeting on consumer price indices in Geneva, 10-12 May 2006. <http://www.unece.org/stats/documents/2006.05.cpi.htm>
- Røstøen, Johan Øverseth (2004): "External price impulses to imported consumer goods", *Economic Bulletin* 3/04, pp. 96–102
- Svensson, Lars E. O. (2003): "The Inflation Forecast and the Loss Function", *CEPR Discussion Paper* no. 3365
- Qvigstad, Jan F. (2005): "Policy-making and models at Norges Bank", *Norges Bank Staff Memo* 5/2005, www.norges-bank.no
- Qvigstad, Jan F. (2006): "When does an interest rate path 'look good'? Criteria for an appropriate future interest rate path", *Norges Bank Working Paper* 5/2006, www.norges-bank.no