Evaluation of Norges Bank's projections for 2006

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Growth in the mainland economy in 2006 was appreciably higher than projected by Norges Bank and it is likely that the output gap was also more positive than projected. At the same time, consumer price inflation adjusted for tax changes and excluding energy products was lower than expected. Unexpectedly low inflation coupled with higher-than-projected output and employment growth may reflect the influence of unforeseen factors on the supply side of the economy. In recent years, for example, inward labour migration has been higher than assumed by Norges Bank. This has eased labour shortages and contributed to growth in potential output. Productivity growth has also been higher than expected in many industries. Other forecasters' projections for developments in output and prices in 2006 were not substantially better than Norges Bank's projections.

1 Introduction

Projections for inflation and future economic developments are an important basis for monetary policy decisions. Therefore, Norges Bank works continuously to improve the basis for these projections. Analysing deviations between actual developments and projections is an important part of this work. This article evaluates the projections for 2006. First, we describe briefly actual economic developments in 2006. We then look at the deviations between actual developments in 2006 and Norges Bank's projections at different times. We place most emphasis on the projections in *Inflation Report* 1/05 and subsequently. Next, we compare Norges Bank's projections with those of other institutions. Finally, we consider the historical accuracy of Norges Bank's projections.

In the *Inflation Reports*, Norges Bank has presented projections for developments during the next three years or over a longer period. The methods utilised for preparing projections depend on the forecast horizon. The two-to-three-quarter-ahead forecasts depend largely on the analysis of the current economic situation and an assessment of how various disturbances which have affected the economy will unfold. Monetary policy influences the economy with a lag. Therefore, the interest rate path on which the Report's projections are based will not have a significant impact on the short-term projections. Simple statistical models where economic theory is not a main component and econometric equations for developments in individual variables are useful in preparing the short-term projections.

The projections for developments in the somewhat longer run are important for determining the interest rate path that is best suited to reaching the inflation target and stabilising developments in output and employment. Economic models that incorporate monetary policy directly are therefore important for these projections. At the same time, the assessment of the current situation and the short-term projections are an important premise for the more long-term projections. The longer-term projections also depend on developments in the exogenous variables, such as government spending and global economic developments, being in line with projections.[2]

The projections for economic developments are necessarily uncertain. This is partly because the forecasts are based on incomplete information about the current economic situation, about the driving forces in the economy in the period ahead and about the functioning of the economy.[3] Therefore, Norges Bank presents the projections for the most central economic variables with a fan chart.[4] According to the Bank's assessment, the most probable outturn is the midpoint on the fan, but the probability of realising this exact outturn is relatively small. Therefore, it would be incorrect to say that the projections are wrong if actual developments are not the midpoint on the fan. A more interesting question is whether the fan charts illustrate the correct probabilities of different outturns. We will return to this question in Section 5. In the following sections, we will concentrate on the point forecasts.

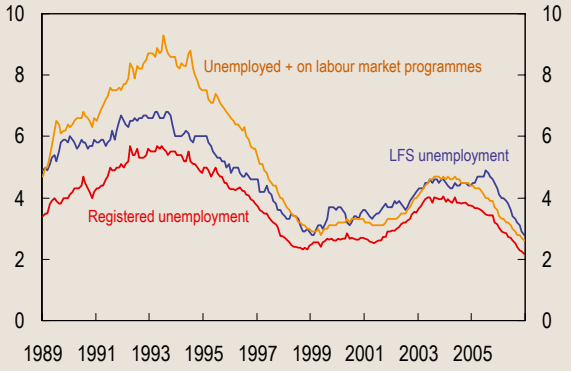
[1] I would like to thank Leif Brubakk, Anne Berit Christiansen, Karsten Gerdrup, Asbjørn Fidjestøl, Kåre Hagelund and Ingvild Svendsen for valuable comments and suggestions. I would also like to thank other colleagues at Norges Bank. Any remaining errors in this article are the responsibility of the author. In addition, I would like to thank Leif Anders Thorsrud and Kathrine Hoff Vaagen for their assistance in collecting data.

2 See Kloster and Solberg-Johansen (2006) for a more detailed description of the forecasting work at Norges Bank. Refer also to a box on short-term GDP projections in *Inflation Report* 2/06.

3 Up to and including *Inflation Report* 2/05, Norges Bank based its projections on technical assumptions concerning the interest rate and the exchange rate. These assumptions were based on forward rates. Since *Inflation Report* 3/05, Norges Bank has based its projections on the Bank's own interest rate forecasts. Interest rate developments shall provide a reasonable balance between the objectives of monetary policy and are thus both a response to and a basis for the other projections.

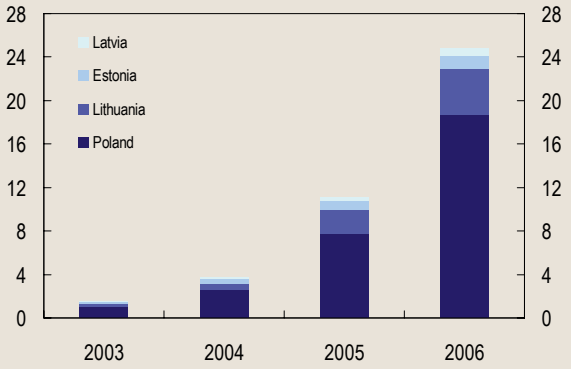
4 The estimate for the output gap, which summarises Norges Bank's view of the current economic situation, is also presented as a fan chart backwards in time. This is partly because the estimate of the current output gap is based on preliminary national accounts figures which may be revised extensively at a later time. Please refer to the boxes in Inflation Report 3/05 and 3/06.

Chart 1 Unemployment. LFS unemployment and registered unemployment. Per cent of labour force. Seasonally adjusted. Jan 1989 – Dec 2006



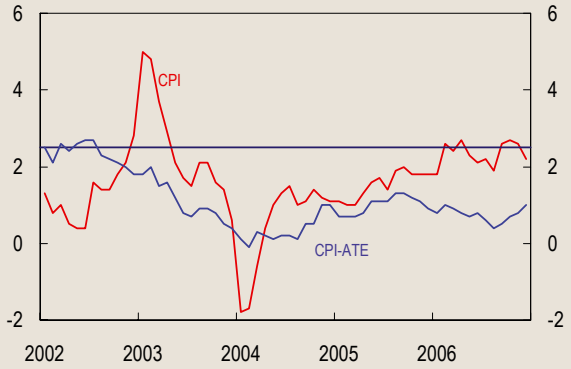
Sources: Statistics Norway and Norwegian Labour and Welfare Organisation (NAV)

Chart 2 Registered employees from new EU countries. In thousands. Annual figures. 2003 – 2006



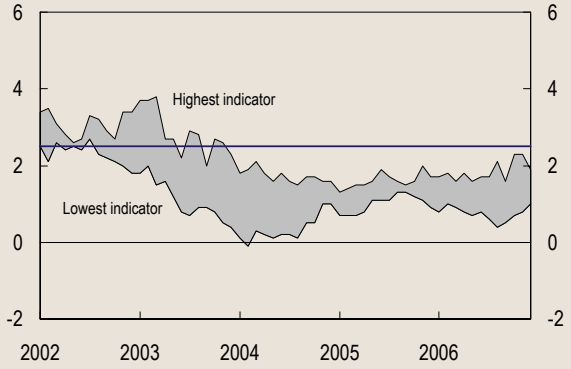
Source: Central Office - Foreign Tax Affairs

Chart 3 Various inflation indicators. 12-month change. Per cent. Jan 2002 – Dec 2006



Source: Statistics Norway

Chart 4 Uncertainty interval for underlying inflation. Highest and lowest indicator.[1] 12-month change. Per cent. Jan 2002 – Dec 2006



[1] Highest and lowest indicator of CPI-ATE, weighted medium and trimmed mean.

Sources: Statistics Norway and Norges Bank

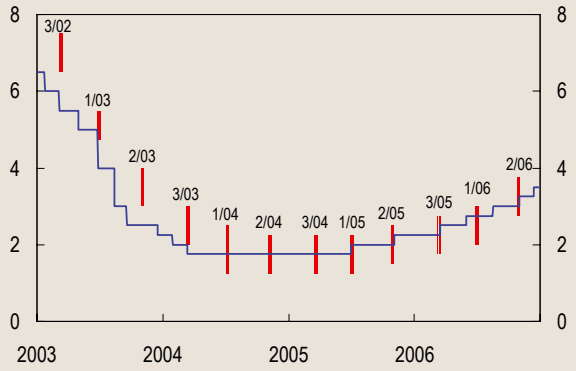
2 Inflation, output and interest rates through 2006

The economic recovery that has marked the Norwegian economy since 2003 continued in 2006. Low interest rates, strong and sustained growth in the global economy and a substantial improvement in Norway's terms of trade have been important driving forces behind the upturn. Low interest rates have contributed to strong growth in private consumption and housing investment, while high oil prices have made it advantageous to increase investment in the petroleum sector. Growth in business investment and non-petroleum exports has also picked up gradually.

Strong growth in productivity and a temporary decline in sickness absence made it possible to increase output without increasing employment for a long period. Since end 2005 and through 2006, however, increasing demand for labour resulted in strong employment growth and a pronounced decline in unemployment (see Chart 1). At end 2006, unemployment was in line with the level prevailing during the previous boom at the end of the 1990s. Some of the increasing labour demand has been satisfied by labour inflows from the new EU member states (see Chart 2). The output gap, which summarises Norges Bank's view of capacity utilisation in the economy, was clearly positive at the end of 2006 according to the Bank's assessment.

Consumer price inflation was pushed up by a sharp increase in energy prices and was close to the inflation target in 2006, but in spite of a boom that had persisted for more than three years, underlying inflation remained low. Consumer price inflation adjusted for tax changes and excluding energy products did not rise from 2005 to 2006. Other measures of underlying inflation also indicated relatively stable developments (see Charts 3 and 4). The low underlying inflation must be seen in the light of relatively low wage growth in relation to the economic situation. Increased labour market competition as a result of increased inward labour migration and the threat of relocating production abroad may have contributed to restraining wage growth. Productivity growth has also been high and the continued shift towards imports from low-cost countries has contributed to a low rise in prices for imported consumer goods and imported intermediate goods. Increased competition

Chart 5 Interval for the sight deposit rate at the end of each strategy period and actual developments. Per cent. 1 Jan 2003 – 31 Dec 2006



Source: Norges Bank

in some Norwegian product markets has also been cited as one explanation of the low underlying inflation.[5]

Although underlying inflation has remained low, increasing capacity utilisation in the Norwegian economy has contributed to a gradual increase in the key policy rate since early summer 2005 towards a more normal level. In 2006, the key policy rate was increased by 0.25 percentage point at five out of nine monetary policy meetings, and at the end of the year the key policy rate was 3.5 per cent (see Chart 5). This was 1.75 percentage points higher than when interest rate increases began in June 2005.

3 Deviations between projections and actual developments

Table 1 shows central assumptions and projections for 2006 in the *Inflation Reports* published since spring 2005.[6]

The output gap

The output gap expresses the relationship between the actual level of output in the economy and the output level that is consistent with stable inflation over time, i.e. potential output. Since potential output is not directly observable, historical values for the output gap must also be estimated. Norges Bank's projections for the output gap in 2006 had been stable at around one per cent before they were revised up in the last two *Inflation Reports* in 2006. The projected development in the output gap through 2006 has also changed somewhat. In *Inflation Report* 1/05, the output gap was projected to peak in the first part of 2006, but since then the estimated cyclical peak has been pushed out in time. At the same time, the economic upturn has been stronger than projected by Norges Bank (see Chart 6).

The output gap was revised up in 2006 primarily

Table 1. Assumptions and projections for key macroeconomic variables for 2006. From Inflation Report 1/05 to Inflation Report 3/06. Annual rise. Per cent

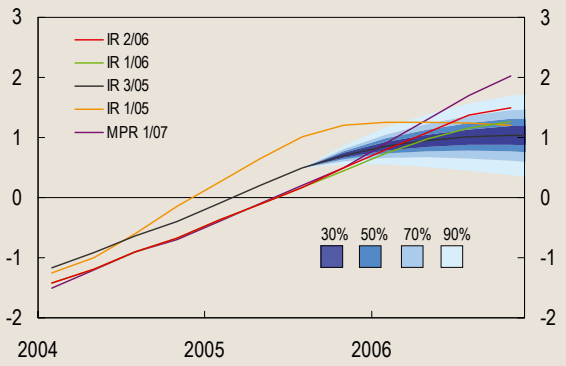
	IR 1/05	IR 2/05	IR 3/05	IR 1/06	IR 2/06	IR 3/06	**Preliminary accounts**
Mainland demand[a)]	3 ¾	3 ¾	3 ¾	3 ¾	4 ¼	4 ¼	**4.3**
- Private consumption	3 ¾	3 ¾	3 ½	3 ¾	3 ½	4	**4.3**
- Public consumption	1 ½	1 ½	2	2 ½	3	2 ¾	**2.2**
- Fixed investment[a)]	6 ½	6	6	6	8	7 ¾	**7.5**
Petroleum investment	–5	–5	2 ½	5	5	5	**9.1**
Traditional exports	3 ½	3 ½	3 ¼	6	6 ¼	6 ½	**6.5**
Imports[a)]	3 ½	3 ½	4 ¼	6	6 ¼	6 ¼	**8.5**
Mainland GDP	3	3	3 ¼	3 ½	3 ¾	4	**4.6**
Potential growth in mainland GDP	2 ½	2 ½	2 ½	2 ½	2 ½	2 ½	**3 ¼**
Output gap mainland Norway[b)]	1 ¼	1	1	1	1 ¼	1 ½	**1 ½**
Employment	1 ½	1 ½	1 ½	1 ¾	2 ¼	2 ¾	**3.1**
Labour fource, LFS	1	1	1	1	1 ½	1 ½	**1.6**
LFS unemployment (rate)[b)]	3 ½	3 ¾	4	3 ¾	3 ¾	3 ½	**3.5**
CPI	2	1 ¾	2	1 ¾	2 ¼	2 ¼	**2.3**
CPI-ATE	1 ¾	1 ½	1 ¾	1	¾	¾	**0.8**
Annual wages	4 ½	4 ¼	4	3 ¾	3 ¾	4	**4.1**
Sight deposit rate[b)]	3	2 ½	2 ¾	2 ¾	2 ¾	2 ¾	**2.7**
Exchange rate[b)]	93.1	91.1	91.0	92.8	90.3	92.5	**92.4**
GDP, trading partners	2 ¼	2 ¼	2 ½	2 ¾	3	3 ¼	**3 ½**
External price impulses	– ¼	– ½	0	– ½	– ¼	1	**0.4**
Oil price (in USD)[b)]	49.5	59.0	60.5	62.1	68.2	64.8	**64.7**

a) Excluding the import of one frigate in 2006
b) Level

5 In a special survey of Norges Bank's regional network in February 2007, 58 per cent of the companies responded that competition has intensified in the past two to three years. Among these companies, 72 per cent responded that this has curbed the rise in prices (see box in *Monetary Policy Report* 1/07).

6 Boxes in the different Reports provide a more detailed account of the changes in the projections.

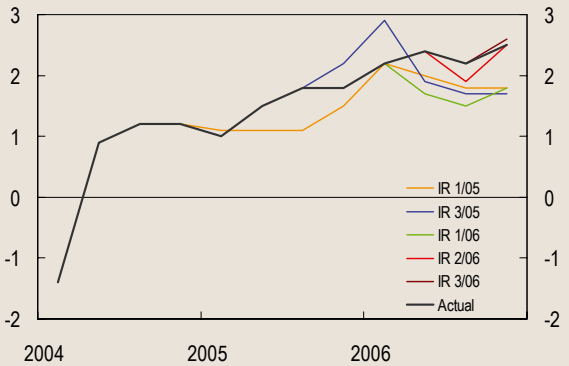
Chart 6 Estimated output gap in the baseline scenario[1] in IR 3/05 with fan chart and estimate in other reports. Per cent. 2004 Q1 – 2006 Q4



[1] Uncertainty concerning the current situation is not taken into account in the calculation.

Source: Norges Bank

Chart 7 CPI projections from IR 1/05 to IR 3/06 and actual developments. 4-quarter rise. Per cent. 2004 Q1 – 2006 Q4



Sources: Statistics Norway and Norges Bank

because actual growth in the economy has been considerably higher than projected. In *Inflation Report* 1/05 and 2/05, growth in mainland GDP was projected at 3 per cent, but from *Inflation Report* 3/05 the projection was gradually revised up, and the first national accounts figures published for 2006 as a whole show annual growth of 4.6 per cent. Growth in employment was also considerably stronger than expected in 2006, and unemployment fell appreciably faster than projected. Employment and unemployment levels in 2006, however, were very close to the projections from early 2005 (see Chart 15 in Section 4).

The estimate for the output gap in 2006 would have been significantly higher if Norges Bank had not revised up its estimate for growth in potential output.[7] Revised national accounts figures have shown that recent years' growth in both output and productivity has been stronger than indicated by earlier figures, and since the EU enlargement in 2004, the supply of foreign labour has increased more than expected. Overall, this indicates that potential growth in the Norwegian economy in recent years may have been stronger than previously assumed by Norges Bank. In *Monetary Policy Report* 1/07, the estimate for potential growth in 2006 was revised up from 2½ to 3¼ percent. Potential growth was also revised up for several of the previous years.

Norges Bank has also revised up the estimate for potential output backwards in time in earlier Reports. As a result, the Bank now assumes that there was somewhat more spare capacity in the economy in 2005 than projected in the Reports published that year (see Chart 6). The third factor that can in principle contribute to a larger- or smaller-than-projected output gap, i.e. the uncertainty surrounding the level of the output gap at the time the projection was prepared, has pointed towards a somewhat lower output gap if we look at the *Inflation Reports* published in 2005. The level of the output gap at the beginning of 2006 has not been changed significantly.

Revisions of national accounts figures may explain to some degree the higher-than-projected mainland GDP growth in 2006. In the *Inflation Reports* published in 2005, Norges Bank projected that growth would slow somewhat from 2005 to 2006, whereas in the Reports published in 2006, the Bank projected that the growth rate in 2006 would be approximately the same as in 2005. The first national accounts figures published by Statistics Norway showed 3.7 per cent growth in the mainland economy in 2005, whereas the most recent preliminary figures showed 4.5 per cent growth. The projection for 2006 would probably have been higher if the earlier figures had indicated such high growth in 2005.

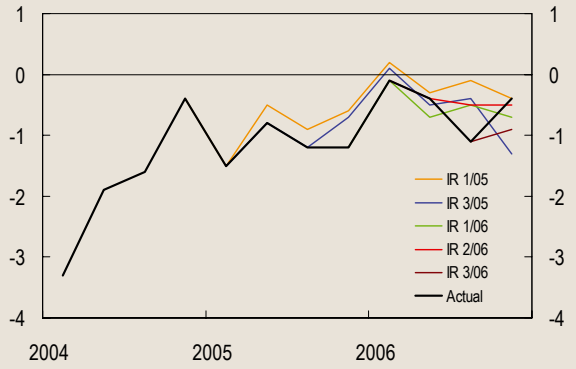
Growth in all sub-components of mainland GDP was higher than projected in 2005 (see Table 1). This may be attributed partly to the ripple effects of stronger-than-expected growth in a number of economic aggregates over which monetary policy has little influence. First, the increase in petroleum investment was appreciably stronger than expected. In the 2005 Reports, Norges Bank projected a decline or weak growth in petroleum investment in 2006, whereas preliminary national accounts figures indicate an increase of 9.1 per cent. Second, total GDP growth among Norway's most important trading partners was somewhat higher than assumed. This may have contributed to considerably higher growth in exports in 2006 than projected in the Reports in 2005. Prices for many of Norway's exports have also been particularly high. Third, somewhat stronger growth in public expenditure has also pushed up GDP growth. In addition to these exogenous factors, we cannot rule out that low interest rates over time have had a stronger effect on housing investment and household consumption than assumed by Norges Bank.

Inflation

The rise in the overall consumer price index in 2006 was somewhat higher than projected in the *Inflation Reports* in 2005 and *Inflation Report* 1/06 (see Chart

7 If GDP growth and growth in potential output are the same for a period of one year, the output gap will not change in relation to the year before.

Chart 8 Imported consumer goods. Historical inflation and projections from IR 1/05 to IR 3/06. 4-quarter rise. Per cent. 2004 Q1 – 2006 Q4

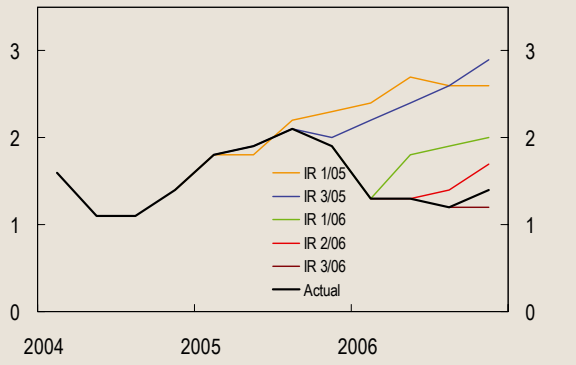


Sources: Statistics Norway and Norges Bank

Chart 9 I-44. Actual developments and projections. 2002 Q1 – 2006 Q4

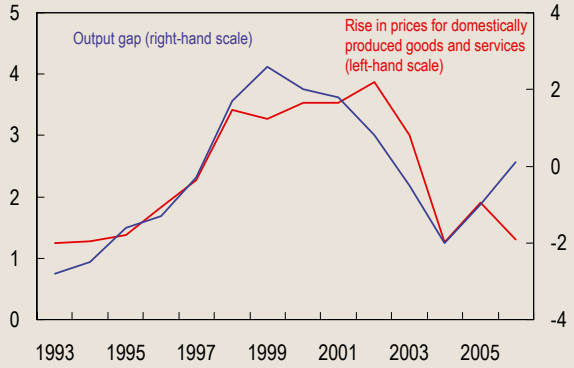
Source: Norges Bank

Chart 10 Domestically produced goods and services. Historical inflation and projections from IR 1/05 to IR 3/06. 4-quarter rise. Per cent. 2004 Q1 – 2006 Q4



Sources: Statistics Norway and Norges Bank

Chart 11 Annual rise in prices for domestically produced goods and services in the CPI-ATE and the output gap level the year before. 1993 – 2006



Sources: Statistics Norway and Norges Bank

7). The projection for the annual rise in CPI inflation in *Inflation Report* 2/06, however, was fully in line with the actual rise. The annual rise in CPI inflation was higher than projected due to an unexpectedly sharp rise in prices for energy products. Low inflows to water reservoirs through summer resulted in high electricity prices until year end in spite of normalised reservoir levels in the last months of 2006. Until autumn, petrol prices also contributed to pushing up overall inflation.

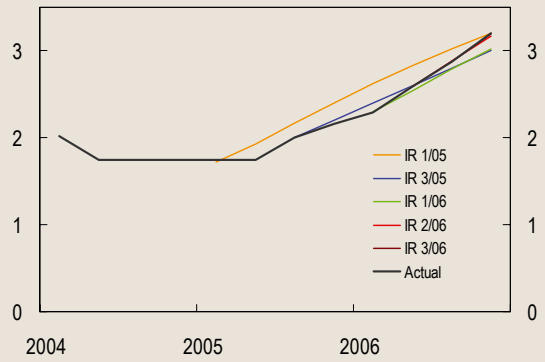
The rise in prices for imported consumer goods was broadly in line with projections made at various times (see Chart 8). One important reason for this was that the exchange rate developed approximately as assumed in the various Reports (see Chart 9). In the second half of 2006, there were larger movements in the krone exchange rate, but it normally takes some time before such movements affect prices for imported consumer goods. At the same time, movements in prices for imported consumer goods, measured in international currency, were approximately as projected.

The rise in prices for domestically produced goods and services in 2006 was considerably lower than projected (see Chart 10). Adjusted for tax changes and excluding energy products, the rise in prices for domestically produced goods and services was 1.3 per cent.[8] In the Reports in 2005, Norges Bank projected a rise in prices for domestically produced goods and services of about 2.5 per cent in 2006, whereas in *Inflation Report* 1/06, the Bank projected a rise of approximately 2 per cent. However, the year-on-year rise in prices for domestically produced goods and services remained at about 1.3 percent throughout the year, after falling from 1.9 per cent in December 2005 to 1.3 per cent in January 2006.

The rise in prices for domestically produced goods and services in 2006 was appreciably lower than projected by Norges Bank even though wage growth was approximately in line with projections. Since the early 1990s, there has been a close relationship between the

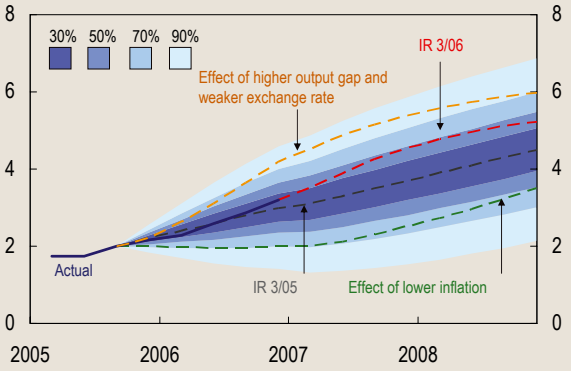
8 In January 2006, Norway reduced maximum day-care rates and this measure in isolation contributed to pushing down the rise in prices for domestically produced goods and services by roughly 0.3 percentage point in 2006. The annual rise in the CPI-ATE was reduced in isolation by 0.2 percentage point. In the *Inflation Reports*, Norges Bank has presented the rise in prices as measured by the CPI-ATE adjusted for the effect of reduced maximum day-care rates. We disregard this adjustment in this article to simplify the comparison with other forecasters that have presented unadjusted CPI-ATE projections.

Chart 12 Interest rate assumptions and actual interest rate. From IR 1/05 to IR 3/06. 2004 Q1 – 2006 Q4



Source: Norges Bank

Chart 13 Sight deposit rate in the baseline scenario with a fan chart and the baseline scenario in IR 3/06 and the isolated effect of a higher output gap and a weaker exchange rate as well as lower inflation. Per cent. Quarterly figures. 2005 Q1 – 2008 Q4



Source: Norges Bank

level of the output gap the previous year and the rise in prices for domestically produced goods and services (see Chart 11). In 2006, however, the rise in prices for domestically produced goods and services was markedly lower than implied by this relationship.

The rise in prices for domestically produced goods and services was unexpectedly low, while growth in the mainland economy was surprisingly high. This may indicate that unforeseen factors on the supply side of the economy have influenced developments. The unexpectedly high inward labour migration since the EU expansion in 2004 has eased labour shortages and contributed to growth in potential output. At the same time, productivity growth has been higher than assumed in many industries. It is likely that the subdued rise in prices for imported, processed intermediate goods has curbed the rise in prices for domestically produced goods and services to a larger degree than expected by Norges Bank. It also appears that competition in some product markets has been stronger than expected.

Interest rate forecasts

Developments in the sight deposit rate have been broadly in line with the interest rate assumptions in the *Inflation Reports* in 2005 and 2006 (see Chart 12). At the same time, economic developments have differed in some cases considerably from projections. If we compare developments with *Inflation Report* 3/05, which was the first Report where projections were based on the Bank's best judgment concerning future interest rate developments, lower than expected inflation, adjusted for tax changes and excluding energy products, has pointed to a lower interest rate (see Chart 13). However, this has been more than offset by unexpectedly strong growth in the mainland economy which has resulted in a higher-than-estimated output gap. Through its impact on inflation and output, a weaker krone exchange rate in the second half of 2006 contributed to pushing up the interest rate path towards the end of 2006.

4 A comparison of projections for 2006 from Norges Bank and other forecasters

In this section, we compare Norges Bank's projections for 2006 with the projections of other forecasters. Such a comparison can clarify whether Norges Bank has made good use of the available information when the projections were prepared. If we look at projections for a single year, however, it is difficult to determine the accuracy of the analysis on which the projections were based because developments in a single year may be marked by events that are impossible to predict.

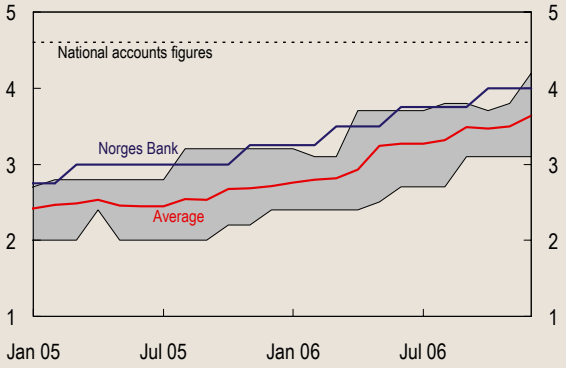
Charts 14 to 18 show Norges Bank's and other forecasters' projections for 2006 for mainland GDP, LFS unemployment, annual wages, CPI-ATE inflation and CPI inflation.[9] The highest and lowest projections from other forecasters are shown as an interval. The charts also show an average of all other forecasters' projections.

None of the forecasters projected that mainland GDP growth would be as high as preliminary national accounts figures indicate (see Chart 14). Norges Bank's projections were generally closer to actual developments than other forecasters' projections. Norges Bank's projections, like those of other forecasters, were revised up gradually through the period observed here.

Early in 2005, Norges Bank was the only institution that projected that LFS unemployment would be as low as it actually was in 2006 (see Chart 15). Like some of the other forecasters, however, the Bank revised up its unemployment projections for 2006 when unemployment was higher than expected through 2005. At the same time, the Bank was somewhat slower than others to revise down its projections again when unemployment began falling in earnest from the end of 2005 and through 2006.

9 Forecasters: The Ministry of Finance, Statistics Norway, DnB NOR, Nordea, Fokus, SEB and Handelsbanken. The chart with projections for CPI-ATE inflation also includes projections from a simple model developed by Professor Ragnar Nymoen at the University of Oslo. Mr. Nymoen has published semi-annual inflation projections since summer 2004. See http://folk.uio.no/rnymoen/forecast_air_index.html.

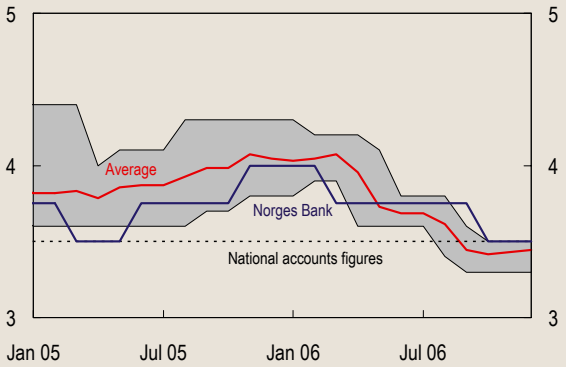
Chart 14 Mainland GDP. Projections for annual growth in 2006 published at different times.[1] Per cent. Monthly figures. Jan 2005 – Dec 2006



[1] Highest and lowest projections from forecasters other than Norges Bank are indicated by the grey shaded area. The red line is an average of the other forecasters' projections.

Sources: Statistics Norway, Norges Bank and reports from the different forecasters

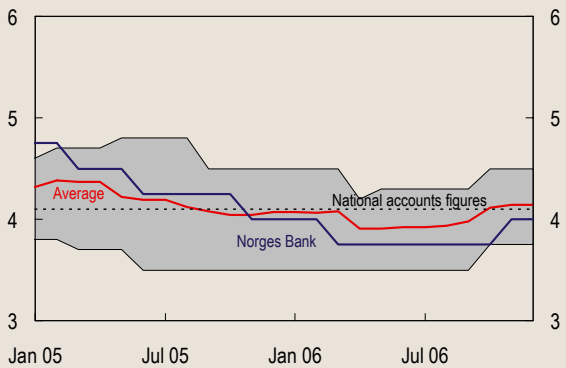
Chart 15 LFS unemployment. Projections for 2006 published at different times.[1] Per cent of the labour force. Monthly figures. Jan 2005 – Dec 2006



[1] Highest and lowest projections from forecasters other than Norges Bank are indicated by the grey shaded area. The red line is an average of the other forecasters' projections.

Sources: Statistics Norway, Norges Bank and reports from the different forecasters

Chart 16 Annual wages. Projections for annual growth in 2006 published at different times.[1] Per cent. Monthly figures. Jan 2005 – Dec 2006



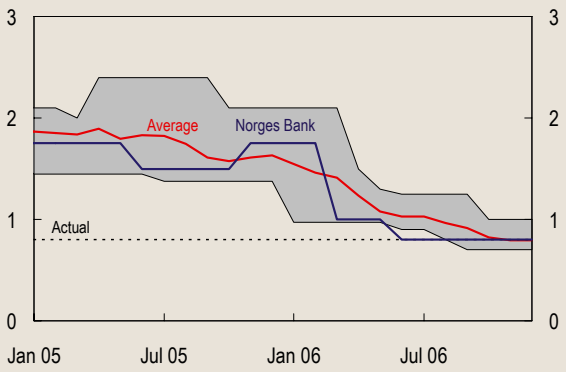
[1] Highest and lowest projections from forecasters other than Norges Bank are indicated by the grey shaded area. The red line is an average of the other forecasters' projections.

Sources: Statistics Norway, Technical Reporting Committee on Income Settlements, Norges Bank and reports from the different forecasters

An average of other forecasters' projections for wage growth was more accurate than Norges Bank's projections (see Chart 16). The Bank's projections early in 2005 were too high and were also higher than many other forecasters' projections at the time. This must be seen in the light of the Bank's expectations of a tighter labour market in 2006 than envisioned by many others. Projections for wage growth were then revised down gradually in pace with upward revisions of unemployment projections for 2006. Projections for wage growth were revised down excessively, however, if we look at the preliminary figures from the Technical Reporting Committee on Income Settlements.

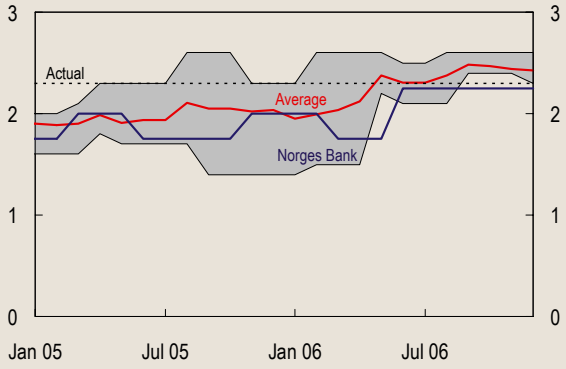
None of the forecasters considered in this article were able to project the low level of CPI-ATE inflation in 2006 until well into the year (see Chart 17). Norges Bank's projections were always relatively low compared with the other institution's projections, with the exception of *Inflation Report* 3/05. The Bank revised down its projection fairly quickly in 2006, and actual figures were broadly in line with projections through the year.

Chart 17 Projections for annual CPI-ATE inflation in 2006 published at different times.[1] Per cent. Monthly figures. Jan 2005 – Dec 2006



[1] Highest and lowest projections from forecasters other than Norges Bank are indicated by the grey shaded area. The red line is an average of the other forecasters' projections

Chart 18 Projections for annual CPI inflation in 2006 published at different times.[1] Per cent. Monthly figures. Jan 2005 – Dec 2006



[1] Highest and lowest projections from forecasters other than Norges Bank are indicated by the grey shaded area. The red line is an average of the other forecasters' projections

Sources: Statistics Norway, Norges Bank and reports from the different forecasters

The rise in CPI inflation was more in line with the projections of Norges Bank and other forecasters (see Chart 18). More accurate projections from some of the other forecasters must be seen in the light of Norges Bank's projections of relatively low CPI-ATE inflation, which also has a considerable influence on projections for CPI inflation. The Bank was somewhat slower, however, than some other forecasters about revising up its projections for the rise in energy prices in 2006.

We have pointed out that unforeseen factors on the supply side of the economy may have resulted in lower-than-projected inflation in 2006 at the same time as GDP growth was higher than projected. Norges Bank's projections for the rise in consumer prices adjusted for tax changes and excluding energy products were generally somewhat lower than an average of other forecasters' projections. At the same time, the Bank's projections for mainland GDP growth were consistently higher than other forecasters' projections. It appears, therefore, that the other forecasters considered here did not have a significantly better understanding of the factors that coloured economic developments in 2006 in advance.

5 Norges Bank's projections for several periods

It is useful to analyse why actual developments deviate from the projections in a single year, but it is necessary to look at projections for several periods to be able to identify systematic weaknesses in the forecasting work. In this section, we will formally evaluate Norges Bank's short-term inflation projections. We will then evaluate the inflation projection fan charts before we compare the accuracy of Norges Bank's projections for several key macroeconomic variables with the accuracy of other institutions' projections.

Norges Bank's short-term projections for inflation

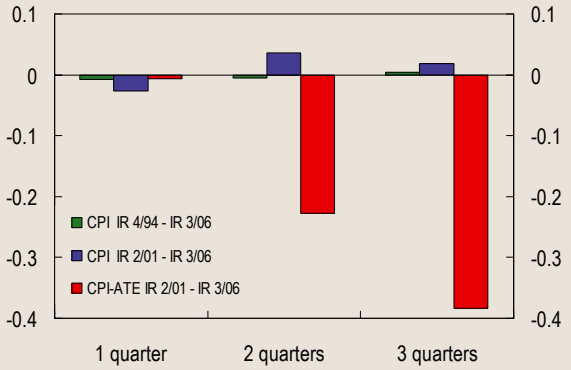
Formal statistical methods may be useful in the evaluation when we examine projections for several periods. For the statistical methods to be meaningful, the projections considered must as a rule be independent of one another. A number of observations are also necessary. For example, if we make projections for inflation eight quarters ahead, there will be eight quarters between each projection that is completely independent of the previous one. Therefore, long time series are necessary if we wish to evaluate projections with a horizon many quarters ahead. In a box in this article, we have illustrated how, when the forecast horizon is several quarters ahead, we can get a run of forecast errors, all of the same sign, even if we make best possible use of all information.

For the short-term projections, however, we have more independent observations. Thus, the formal methods may be useful tools. Although inflation projections two to three quarters ahead do not have the largest impact on monetary policy, it is still interesting to evaluate the quality of these projections because deviations from projected short-term developments have an impact on longer-term projections. Thus, deviations from projected short-term developments may also have an impact on the Executive Board's monetary policy assessments.

We have evaluated the projections against established criteria for optimal projections in the literature.[10] The first criterion is that the mean projection error over time is zero, which means that the projections are unbiased. The second criterion is that there should not be a systematic relationship between forecast errors from one period to the next. If such a relationship exists, the forecaster could improve the projections by taking this relationship into account. A professional forecaster will also strive to be more accurate in projecting economic developments than a naïve forecaster who predicts that inflation will be the same as in the previous period throughout the projection period.[11]

We have described the empirical tests used and reported the actual test results in the appendix to this article. Here, we will only present some of the main results. We have analysed the quarterly projections for CPI-ATE inflation and CPI inflation since *Inflation Report* 2/01, but we have also examined the CPI projections since the first *Inflation Report* in December 1994.[12]

Chart 19 Projections and actual developments. CPI and CPI-ATE. Average forecast error.[1] 4-quarter change. Percentage points



[1] Actual development less the projection made the same quarter the *Report* is published (1 quarter), the following quarter (2 quarters) and the quarter thereafter (3 quarters). A negative figure indicates that the average has been higher than actual outturns and a positive figure indicates that the average has been lower than actual outturns.

Sources: Statistics Norway and Norges Bank

10 See, for example, Timmermann (2006). The criteria mentioned apply if the forecaster has a quadratic loss function with respect to the forecast error, i.e. a projection that is too high is as serious as a projection that is too low and large deviations from actual developments are relatively more serious than small deviations.

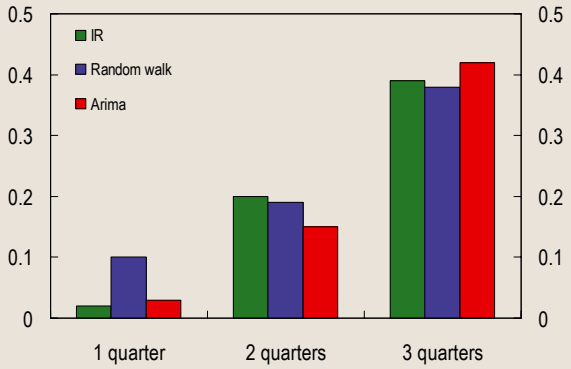
11 This is not considered to be a formal criterion because the last value for a variable may also be the optimal forecast for developments ahead. On the basis of economic theory, one would expect, for example, that the best projection for the exchange rate tomorrow is today's exchange rate, when it is adjusted for any interest rate differences between the countries observed.

12 The quarterly projections for CPI inflation are not presented in all of these Reports. Therefore, the analysis is based on internal documentation in some cases.

It appears that Norges Bank has systematically overestimated CPI-ATE inflation as early as the quarter after the publication of the *Inflation Report*. There are no indications, however, that short-term projections for CPI inflation in the same period were biased. The same applies to the projections for CPI inflation for the entire period back to 1994 (see Chart 19). For the longer horizons, actual CPI-ATE inflation has been considerably lower than projected. Statistically, however, we cannot rule out the possibility that this is due to random factors because we have few independent projections.

Moreover, the estimated relationship between forecast errors in the current quarter is negative for the projections for CPI-ATE inflation from quarter to quarter. This may be interpreted as an indication that the Bank has had a tendency to respond too strongly to deviations from actual developments in the short term. Unexpectedly low inflation in one quarter may have prompted the Bank to revise down its projections too much for the next quarter so that inflation was then higher than projected. This relationship is not significant, however, measured by normal statistical criteria, and considerable emphasis should therefore not be placed on this result.

Chart 20 Forecast errors for CPI-ATE in *Inflation Reports* and from naive models.[1] IR 2/01–IR 3/06. Mean square error (MSE)



[1] 1 quarter is the quarter in which the report is published; 2 quarters is the quarter after the report has been published; 3 quarters is the following quarter.

Sources: Statistics Norway and Norges Bank

Norges Bank's short-term projections for CPI-ATE inflation since *Inflation Report* 2/01 are approximately as accurate as projections based on completely naïve methods (see Chart 20). We have compared the forecast errors from the *Inflation Reports* with the forecast errors that would have arisen if the Bank had assumed that inflation would remain unchanged from the previous quarter throughout the projection period, i.e. that inflation followed a random walk.[13] A simple time series model would also have projected inflation approximately as accurately as Norges Bank in this period.[14] That simple models can provide accurate inflation projections is not new. Refer, for example, to Stock and Watson (2005). The simple models are therefore useful in Norges Bank's work on short-term inflation projections.

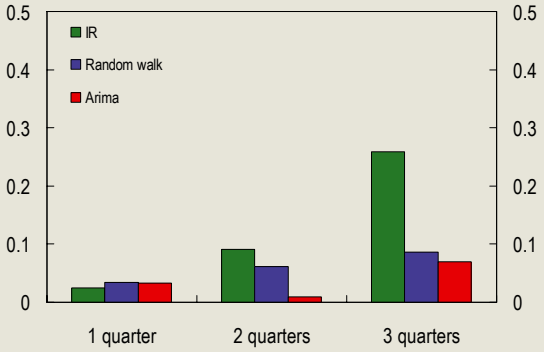
The fan charts for the CPI-ATE projections

Norges Bank presents its projections for the most central economic variables as fan charts. An evaluation of the Bank's projections will therefore not be complete without an evaluation of whether the fan charts have illustrated the correct probabilities for various outturns. In this work, it is absolutely necessary to examine the projections for several periods since the outturn in each period is only a single point on the chart. We have

Short-term projections in 2006

The short-term projections for CPI-ATE inflation in the *Inflation Reports* in 2006 have deviated more from actual inflation than projections from naïve models (see Chart 21). The projections in the *Inflation Reports* have only predicted actual inflation as accurately as the naïve models in the quarter in which the *Inflation Report* was published. This is partly because Norges Bank projected that the rise in prices for domestically produced goods and services would pick up fairly quickly after the twelve-month rise fell from 1.9 per cent in December 2005 to 1.3 per cent in January 2006. However, the twelve-month rise remained at about 1.3 per cent throughout 2006.

Chart 21 Forecast error for CPI-ATE in the *Inflation Reports* and from naive models.[1] IR 1/06–IR 3/06. Mean square error (MSE)



[1] 1 quarter is the quarter in which the report is published; 2 quarters is the quarter after the report has been published; 3 quarters is the following quarter.

Sources: Statistics Norway and Norges Bank

13 We have assumed here that the four-quarter rise in CPI-ATE inflation will be the same as in the previous period throughout the forecast period. We have examined the four-quarter rise on the basis of the figures for the past three months before the various Reports have been published. For example, in the Reports that have been published in June, we have assumed that inflation ahead will be the same as inflation during the period March–May of the previous year until March–May of the year in which the Reports were published.

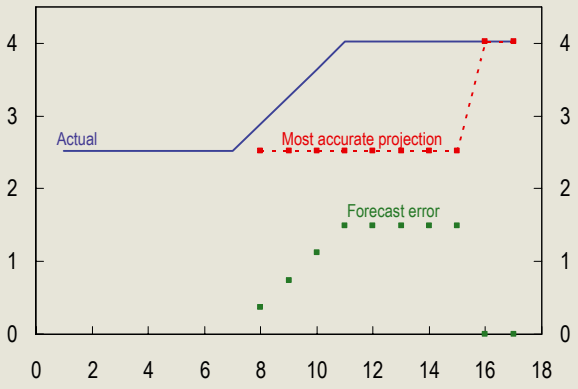
14 We have used the a so-called arima model. Here, the projections are determined solely by the estimated dynamics of the time series.

Correlation between forecast errors

Using a simple example, we will illustrate why a number of forecast errors of the same sign arise when the projections observed overlap, i.e. we prepare new projections before we pass the horizon for the previous projection.1 Imagine, for example, that we forecast the four-quarter rise in prices eight quarters ahead and we prepare a new projection each quarter. We also assume that the best projection for inflation ahead is current inflation.[2]

The blue line in Chart 22 shows the actual quarterly rise, whereas the red squares are the best projections prepared eight quarters earlier. Initially, inflation is 2.5 per cent and remains at this level for seven quarters. In the eighth quarter, there is an unexpected disturbance. As a result, the four-quarter rise climbs gradually to 4 per cent and remains there. The inflation projections prepared before the eighth quarter will be consistently lower than actual inflation. In the eighth quarter, the forecaster becomes aware of the disturbance and can adjust the projections. However, the projections will not be in line with actual developments again before the 16th quarter. The projections prepared at various times have always been optimal in that the forecaster has made optimal use of all available information. Nevertheless, the result is a series of outturns with higher-than-projected inflation.

Chart 22 Best projection 8 quarters ahead, actual and forecast error. 4-quarter rise. Per cent



To avoid drawing incorrect conclusions in the evaluation of projections with a horizon of several quarters, we should study projections that do not overlap. This requires long data series if the horizon is several quarters. Ten independent projections with a projection horizon of eight quarters require, for example, 20 years of data.

[1] The example is from Elder et al. (2005). See also Pagan (2003) for a discussion of the same problem.

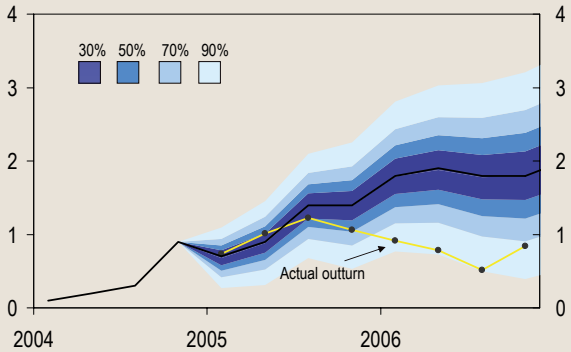
[2] We assume here that inflation follows a random walk given by $\pi_t = \pi_{t-1} + \varepsilon_t$, $\varepsilon_t \sim N(0, \sigma)$. π_t is the quarterly rise in prices.

examined the fan charts for the CPI-ATE projections from *Inflation Report* 2/01 to *Inflation Report* 3/06.[15]

The fan charts for Norges Bank's projections illustrate an interval within which actual developments are expected to lie with a 90 per cent probability.[16] Chart 23 shows the CPI-ATE projections with fan charts from *Inflation Report* 1/05. The black dots along the yellow line show actual developments. Nine out of ten outcomes are expected to lie within the fan, and the outcomes are expected to be evenly dispersed across the entire fan over time. This means that three out of ten outturns should be in the middle, dark blue area, while one out of ten outturns should be in each of the gradually lighter areas above and below the dark blue area. In other words, the outcome may be expected to lie outside the dark blue area, which also contains the point forecast, as often as seven out of ten times, assuming the fan charts provide an accurate picture of uncertainty.

An informal test of the fan charts in retrospect is to compare the fans over time with actual outturns. Norges Bank has published fan charts to illustrate developments in CPI-ATE inflation since *Inflation Report* 2/01, and

Chart 23 CPI-ATE projection with a fan chart from IR 1/05 and actual outturns.[1] 4-quarter rise. Per cent. 2001 Q – 2006 Q4



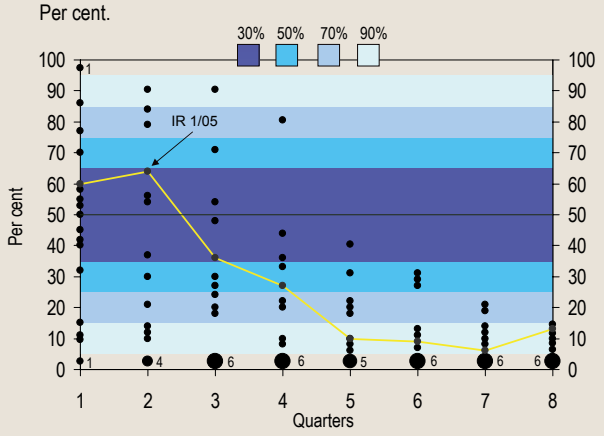
[1] The bands in the fan indicate different probabilities for CPI-ATE developments. Probabilities are calculated on the basis of the difference between projected and actual developments in underlying inflation in the period 1997 – 2004.

Sources: Statistics Norway and Norges Bank

15 In the Inflation Report, Norges Bank has presented its projections for developments up to 16 quarters ahead, where the first quarter is the quarter in which the Report is published. We have examined the fan charts up to and including the eighth quarter. This is because the projections will overlap more frequently at longer horizons, and we can therefore expect the outturns to cluster. In addition, we have very few actual outturns at the most distant horizons.

16 The method utilised to estimate the fan charts has been changed somewhat over time. Up to and including Inflation Report 2/05, the fan charts were estimated on the basis of Norges Bank's historical forecast errors. Since Inflation Report 3/05, the fan charts have been estimated using a small macroeconomic model based on historical disturbances to the economy.

Chart 24 The fan chart and outturns for CPI-ATE. IR 2/01 – IR 3/06. Per cent.



[1] The black dots indicate the distribution of actual outturns in all the fan charts from IR 2/01 to IR 3/06. The black dots connected by the yellow line show the distribution of outturns in the fan chart in IR 1/05. The larger dots indicate that a number of outturns (figure indicates how many) have been outside the fan.

Sources: Statistics Norway and Norges Bank

Chart 24 shows the distribution of actual outturns in all the fan charts since then, a total of 17 *Inflation Reports*. We have examined the projections with a horizon of up to eight quarters, where the first quarter is the quarter in which the Report is published. The yellow line shows the distribution of actual outturns in the fan chart from *Inflation Report* 1/05 (see Chart 23).

The projections for developments several quarters ahead will often overlap from one Report to the next. Therefore, the outturns are likely to cluster in the long term (see box "Correlation between forecast errors"). Chart 24 shows that the fan chart for the CPI-ATE projections seems to have provided a fairly accurate picture of the probability of different outturns in the next few quarters, but this does not seem to be the case further ahead. Five quarters or more ahead, all the outturns are below the midpoint on the fan and a considerable portion of the outturns have been outside the fan.

Since the actual outcome has been outside the fan a number of times, one can raise the question as to whether the fan charts for the CPI-ATE projections have been too narrow. In this discussion, it is important to remember that many of the fan charts have overlapped one another to a large degree. Therefore, the basis for drawing conclusions about anything other than the short-term projections is limited. If we disregard this reservation, however, two aspects about the chart showing the distribution of outturns for CPI-ATE inflation in the different fan charts are worth noticing. First, the actual outturn has been outside the fan more often than we would have expected. Second, there has not been a single outturn in the upper half of the fan since the beginning of the fifth quarter. Ideally, half of the outturns should be here. If the fan had been wider and the projections the same, fewer of the outturns would have been outside the fans, but there would still be no outturns on the upper half of the fans from the fifth quarter.

Comparisons with other forecasters over time

We have examined the accuracy of the projections from the Ministry of Finance, Statistics Norway and Norges Bank in the last publication of the previous year for the years 1995 to 2006.[17] We have examined the projections for mainland GDP growth, wages and consumer price inflation.[18]

Charts 25–27 illustrate the three institutions' mean forecast error (ME), mean absolute forecast error (MAE) and the mean square error (MSE) for the different variables. The mean error is a measure of bias in the forecasts, while the other two are alternative measures of forecast accuracy. Large forecast errors are given more weight in the mean square error than in the mean absolute error.

All institutions have on average underestimated actual mainland GDP growth in the following year, but we don't have evidence, except for Statistics Norway, to indicate that the projections have been systematically underestimated (see Chart 25).[19] Norges Bank's projections have been most accurate, but we have no evidence to indicate that the projections have been systematically better than the projections of other institutions.

The average projections for wage growth from both Statistics Norway and the Ministry of Finance have been too low whereas Norges Bank's projections have been just above actual wage growth (see Chart 26). There is no clear evidence to indicate that any of the institution's projections have been biased or that any of the projections for wage growth have been systematically better.

Consumer price inflation was lower than forecast by all institutions, and Norges Bank's projections were on average furthest off the mark (see Chart 27).[20] We do not have evidence, however, to indicate that any of the

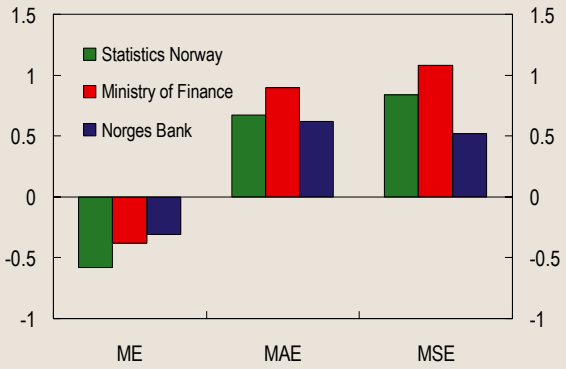
[17] Statistics Norway's projections are from Economic Survey. The Ministry of Finance's projections are from the budget balancing proposal from 1994 to 1996, from the supplementary budget proposal in 1997 and from the National Budgets for 1999 onwards. The institutions publish projections at different times, and therefore the information on which the projections are based differ somewhat. In recent years, Statistics Norway has published its last projections for the year in December. Norges Bank has published its last projections around end-October/beginning-November, while the Ministry of Finance has published its last projections at end-September/beginning-October.

[18] National accounts figures may be extensively revised at a later time, and therefore it is not obvious which version of the national accounts should be used in evaluating the projections. Here, we have chosen to compare the projections with the first national accounts figures published in February/March of the year after the year for which the projections applied. This is partly because definitions in the national accounts have been changed during this period so that the projections and the final figures do not relate to the same measurement system. Statistics Norway projects wage growth per normal person-year. This is also a national accounts variable, and we have therefore used the figures from the first publication of the following year. The Ministry of Finance and Norges Bank project annual wage growth according to the definition of the Technical Reporting Committee on Income Settlements. Here, we have used the final figures.

[19] We have tested this in the same way as when we examined whether Norges Bank's short-term projections were systematically too high or too low (see equation in the appendix). Since we only have observations covering a period of 12 years, however, the robustness of the statistical tests is somewhat limited.

[20] We have used the projections for CPI inflation up to and including 2001. Subsequently, we have used the projections for CPI-ATE inflation.

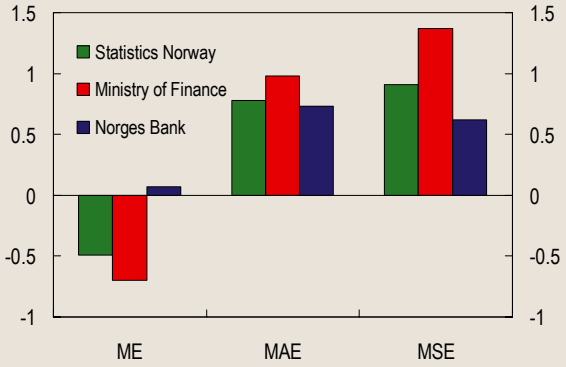
Chart 25 Forecast error for mainland GDP[1]. 1995 – 2006.
Percentage points



[1] ME is the mean error. A negative figure indicates that projections on average have been higher than actual outturns. A positive figure indicates the opposite. MAE is the mean absolute error, while MSE is the mean square error.

Sources: Ministry of Finance, Statistics Norway and Norges Bank

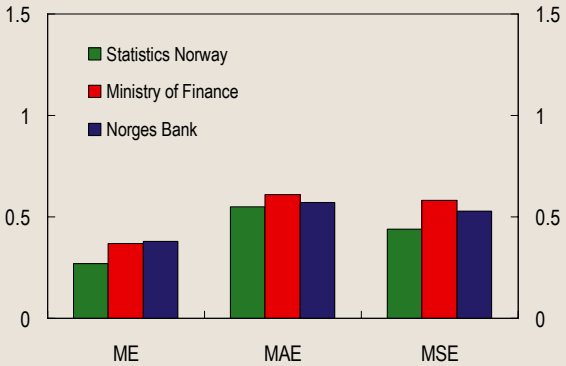
Chart 26 Forecast error for wage growth. 1995 – 2006.
Percentage points



[1] ME is the mean error. A negative figure indicates that projections on average have been higher than actual outturns. A positive figure indicates the opposite. MAE is the mean absolute error, while MSE is the mean square error.

Sources: Ministry of Finance, Statistics Norway, Technical Reporting Committee on Income Settlements and Norges Bank

Chart 27 Forecast error for CPI/CPI-ATE. 1995 – 2006.
Percentage points



[1] ME is the mean error. A negative figure indicates that projections on average have been higher than actual outturns. A positive figure indicates the opposite. MAE is the mean absolute error, while MSE is the mean square error.

Sources: Ministry of Finance, Statistics Norway and Norges Bank

institutions have overestimated inflation systematically. Statistics Norway's forecasts have been most accurate, but the accuracy of all institutions is about the same.

6 Conclusions

It is not surprising that economic developments deviate from the projected path. Projections for future economic developments will always be uncertain, and to illustrate this uncertainty Norges Bank publishes its projections for the most central economic variables as probability distributions – so-called fan charts.

Economic developments in 2006 have differed considerably from projections in some respects. Growth in mainland GDP was appreciably higher than estimated and the output gap may also have been higher than assumed. At the same time, consumer price inflation adjusted for tax changes and excluding energy products was lower than expected. This may indicate that unforeseen factors on the supply side of the economy influenced developments. A comparison with other forecasters has indicated that none of them predicted developments in output and prices in 2006 considerably better than Norges Bank.

Norges Bank's short-term inflation forecasts in 2006 were less accurate than the forecasts of naïve models, and in this article we have revealed formal weaknesses in Norges Bank's short-term projections. In autumn 2006, Norges Bank initiated a larger project designed to utilise newer econometric methods to forecast developments in the short term. Hopefully, this will improve the quality of the short-term projections over time.

At the same time, Norges Bank has been working on the development of a new macromodel for the longer-term forecasts. This model, which is called NEMO (Norwegian Economy Model), will gradually play an important role in the forecasting work.[21] Since NEMO has an explicit theoretical structure, it may also be helpful in the Bank's work on understanding the driving forces behind developments in the past.

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[21] Brubakk et al. (2006) provides documentation of the model.

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Appendix. Empirical tests and results

Here, we will describe in more detail the empirical tests in Section 5. First, we define the forecast errors in period t and t+1:

$$e_t = \pi_t - \hat{\pi}_{t,t-k}$$
$$e_{t+1} = \pi_{t+1} - \hat{\pi}_{t+1,\,t+1-k}$$

π_t is inflation (four quarter rise) in period t, while $\hat{\pi}$t, t-k is the inflation forecast for period t, k quarters ahead. Then, we specify the regression equations used:

$$e_t = \alpha + \varepsilon_t \qquad (1)$$
$$e_{t+1} = \alpha + \beta\, e_t + \varepsilon_t \qquad (2)$$

Unbiasedness requires that $\alpha = 0$ in equation (1), whereas $\alpha = \beta = 0$ in equation (2) implies both unbiasedness and uncorrelated forecast errors.[1] The first regression leads to a simple t-test, whereas we must use an F-test to test whether both coefficients are equal to zero in the second equation. The forecasts for inflation in the present quarter are the only forecasts that are completely independent of forecasts from other *Inflation Reports*. In those cases where the forecasts overlap, we have estimated standard errors using the method proposed by Newey and West (1987) to take into account autocorrelation and heteroskedasticity in the residuals. This is indicated by * following the period designation in the table. Also, we have only considered non-overlapping projections. We have marked this with ** following the period designation.

Table V1 shows the results of the regression equation (1). The projections for CPI-ATE inflation in the quarter after the Report has been published have on average been too high. The estimated average is significantly different from zero, but otherwise, none of the results are significant. There is no evidence to indicate that the projections for CPI inflation have been biased at any horizon in the periods considered here.

Table V1 Have the projections been unbiased?

	Horizon	α (st.e.)	p-value[b)]
CPI-ATE 2001–2006	1 quarter[a)]	–0.01 (0.04)	0.87
	2 quarters*	–0.23 (0.10)	**0.04**
	2 quarters**	–0.30 (0.13)	**0.05**
CPI 2001–2006	1 quarter [a)]	–0.03 (0.04)	0.53
	2 quarters*	0.04 (0.20)	0.86
CPI 1994–2006	1 quarter [a)]	–0.01 (0.02)	0.73
	2 quarters*	–0.01 (0.09)	0.95
	2 quarters**	–0.03 (0.16)	0.83
	4 quarters**	–0.15 (0.16)	0.38

* Standard errors calculated by the method proposed by Newey and West (1987) to take into account autocorrelation and heteroskedasticity in the residuals.
** Only used non-overlapping projections. For over two quarters: Projection for Q1 prepared in Q4 of previous year and projection for Q3 prepared in Q2. For four quarters: Projection for Q3 prepared in Q4 of previous year.
a) 1 quarter is the difference between actual and projected inflation in the quarter in which the Report has been published.
b) The p-value for a t-test of the null hypothesis that $\alpha = 0$ in equation (1). Normally, the null hypothesis is rejected if the p-value is not statistically significant at the 5 per cent level. We have marked these occurrences in boldface.

The results of the tests of forecast errors have been both uncorrelated and equal to zero on average over time as shown in Table V2. In the last column, we show the p-value of an F-test of whether both underlying coefficients are zero. We cannot reject this hypothesis in any cases. The tests are less powerful when we introduce several constraints. This may explain why we found that the projections for CPI-ATE inflation for the next quarter had been systematically too high, whereas we cannot come to the same conclusion now. At the same time, we have few observations of CPI-ATE inflation so that the conclusions here are in any event not very robust.

Several estimates of the coefficient β, which expresses the autocorrelation between the forecast errors, are negative, but none of the estimates are significantly greater than the associated standard errors. Therefore, they are not significantly different from zero in an isolated t-test. We have not reported the results of these isolated tests here.

Table 2 Unbiasedness and uncorrelated forecast errors

	Horizon	α (st.e)	β (st.e.)	p-value[b)]
CPI-ATE				
2001–2006	1 quarter a)	–0.01 (0.04)	–0.34 (0.29)	0.52
	2 quarters	–0.22 (0.13)	–0.01 (0.28)	0.18
	2 quarters**	–0.26 (0.19)	0.10 (0.35)	0.22
CPI				
1994–2006	1 quarter a)	–0.01 (0.02)	0.20 (0.16)	0.43
	2 quarters	–0.01 (0.10)	–0.23 (0.16)	0.35
	2 quarters**	–0.03 (0.17)	0.02 (0.21)	0.97
	4 quarters**	–0.19 (0.20)	–0.16 (0.36)	0.65

** Only used non-overlapping projections. For projections over two quarters: Projection for Q1 prepared in Q4 of previous year and projection for Q3 prepared in Q2. For four quarters: Projection for Q3 prepared in Q4 of previous year.
a) 1 quarter is the deviation between actual and projected inflation in the quarter in which the Report has been published.
b) The p-value for an F-test of the null hypothesis that $\alpha=\beta=0$ in equation (2). Generally, the null hypothesis is rejected if the p-value is not statistically significant at the 5 per cent level.

1 This is often referred to as weak efficiency. There is strong efficiency if none of the information available at the time of the forecast is correlated to future forecast errors, i.e. that $\alpha=\beta=0$ in the equation $e_{t+1} = \alpha + \beta\, z_t + \varepsilon_t$ where zt is any given variable that is available at time *t*.