

Evaluation of Norges Bank's projections for 1999

By Anne Sofie Jore, senior economist in the Economics Department, Norges Bank*

In order to provide the central bank with an optimal basis for the conduct of monetary policy, the central bank must evaluate its projections for economic developments. Norges Bank has previously published analyses of its projections for 1996, 1997 and 1998. This article evaluates the Bank's projections for 1999.

The article starts with an analysis of the projections in the December 1997 *Inflation Report*. The baseline scenario in the report implied a cyclical turnaround in 2000, but the turnaround occurred as early as mid-1998 and was followed by slow growth in 1999. The analysis of main developments was broadly in line with actual developments, but events in 1998 led to an earlier-than-projected turnaround. The projections for 1999 were therefore not particularly accurate. However, the report also included alternative projections where important assumptions were changed, for example a substantial depreciation of the krone and a rise in interest rates. Developments in the latter half of 1998 and into 1999 were closely in line with this alternative. The projections for 1999 published in the December 1998 *Inflation Report* were closer to the mark.

Norges Bank's projections are compared with those of Statistics Norway and the Ministry of Finance. Norges Bank's forecast for wage growth can be said to be at least as good as that of the two other institutions. There are no systematic differences with regard to the accuracy of price inflation projections.

Norges Bank's analyses of developments in the Norwegian economy are published in our quarterly *Inflation Report*. The projections for developments in the Norwegian and world economy provide an important background for the formulation of monetary policy. In addition, the analyses serve as a basis for advice on the orientation of economic policy in general. Since 1994 Norges Bank's macroeconomic model RIMINI, developed in the Research Department of the Bank, has been the main tool for our analyses. The RIMINI model is an econometric model with almost 370 equations. Around 70 of them are estimated on the basis of historical data, while the remainder are definitional relationships. A revised RIMINI model, based entirely on the Revised National Accounts, is now being tested. The new model will be operational in the course of the winter. With the introduction of the new model, it will also be possible to analyse the model's and the model users' contribution to forecast errors. Alternative modelling tools are also being developed to supplement the RIMINI model on some points.

Norges Bank aims to produce the best possible projections for the Norwegian economy. It is important to reveal errors in order to improve the analyses. Evaluations of Norges Bank's projections in relation to those of other institutions also contribute to this.

Norges Bank places emphasis on transparency and the availability of its forecast work. This work also includes analyses of earlier projections. The projections are based on a model that is publicly known, and the Bank's use of the model is published. The purpose is to provide others with the basis for evaluating how we arrived at our projections and their accuracy. Systematic evaluation also places greater demands on consistency and documentation of the projections in the *Inflation Report*, which in itself will improve the quality of the analyses.

Analyses of forecast errors in Norges Bank's model-based projections are presented here for the fourth time.

Previously, we have evaluated and attempted to find the sources of the forecast errors in the projections for the years 1996 to 1998. As in the article in *Economic Bulletin* 1999/2 (Jore 1999), this article also looks at projections two years ahead.

For further discussion of forecast errors in general, see previously published articles (Madsen 1996, Jore 1998, Jore 1999).

Forecasts for 1999 published in December 1997

The projections in the December 1997 *Inflation Report* pointed to higher growth rates over the next two years. A cyclical turnaround with stagnating employment and rising unemployment was expected from 2000. The cyclical turnaround in the baseline scenario was predicted in the light of the deterioration in competitiveness as a result of high wage growth relative to our trading partners, in addition to an expected decline in petroleum investment.

Developments in key parameters through 1998 and 1999 turned out to be very different from that assumed towards the end of 1997. First, there were the contagion effects of the Asian crisis. Financial market turbulence spread to our part of the world and contributed, in conjunction with the weakening of competitiveness as a result of high wage growth, to a depreciation of the krone and higher money market rates. Growth in the world economy slowed, which led to a decline in international producer prices. The fall in oil prices over 1998 contributed to a general fall in prices. On the other hand, petroleum investment was substantially higher than we had assumed both in 1998 and 1999.

In several areas, developments were different from our assumptions. A number of factors indicated that price inflation would be higher than expected:

*With thanks to my colleagues at Norges Bank for their useful comments

- As a technical assumption, the krone was assumed to remain unchanged at the previous month's level to the end of the projection period. This implied a virtually unchanged exchange rate between 1997 and 1999. However, the import-weighted exchange rate index (I-44) depreciated by 2.2 per cent between 1997 and 1998, followed by an appreciation of 1.2 per cent between 1998 and 1999.
- Public consumption was estimated to increase by 2 per cent in 1998 and 2½ per cent in 1999. Growth was almost twice that in 1998 at 3.8 per cent, while the estimate for 1999 proved to be accurate.
- We assumed a 17 per cent fall in petroleum investment between 1997 and 1999. However, petroleum investment expanded by a good 5 per cent during the period.
- Oil prices were estimated at around NOK 130 per barrel in both 1998 and 1999. Prices fell to NOK 96 on average in 1998, while rising to NOK 139 in 1999.
- Real wage growth in 1998 turned out to be almost twice as high as our December 1997 estimate.

On the other hand, some factors pushed down price inflation:

- International producer prices were assumed to rise by 1½ per cent in 1998 and 1999. The actual fall in producer prices was 2.5 per cent in 1998 and a further 3.5 per cent in 1999.
- We assumed a ¾ percentage point rise in money market rates between 1997 and 1999. Money market rates rose by 2½ percentage points, calculated as annual averages.

Table 1 shows our projections for 1999 and the actual figures for 1999 as presented in the preliminary national accounts published in September 2000. Wage growth and consumer price inflation turned out to be more moderate

than projected, while the projection for real wage growth was correct. International price developments were the main reason behind the overestimation of price and wage inflation. In addition to the fall in producer prices in 1998 and 1999, the depreciation of many Asian currencies against the Norwegian krone contributed to the fall in prices for imported consumer goods in 1999. Imports from several Asian countries have a higher content of consumer goods than the average for Norwegian imports. Combined, this was more than sufficient to offset the effect of factors that pointed to higher-than-projected price inflation, such as the depreciation of the Norwegian krone against the US dollar and European currencies and higher-than-expected wage growth in 1998.

Economic growth in 1999 was substantially lower than projected at the end of 1997. Growth in domestic demand was only 1.6 per cent, while our forecast was 3 per cent. This was primarily due to slower-than-expected growth in private demand. Traditional merchandise exports also proved to be lower than implied by our projections, while the contraction in petroleum investment was smaller than expected. Employment growth was lower than expected and unemployment higher. This must be seen against the background of real wage growth, which was markedly higher than expected through 1998.

In many ways, economic developments were imbalanced through 1998 and 1999 as a whole. A high level of petroleum investment and brisk growth in public demand contributed to strong pressures in parts of the economy, while fixed investment in the mainland economy, traditional exports and to some extent private consumption showed a more moderate development. Overall pressures in the economy led to markedly higher wage growth in 1998 compared with earlier in the 1990s, particularly in the public sector and other services. While the tendency towards rising domestic price inflation, particularly service prices, continued, the general rise in prices was restrained by lower prices for imported consumer goods.

The uncertainty inherent in the exogenous assumptions is considerable. The December 1997 *Inflation Report* contained several examples of how alternative assumptions concerning key exogenous variables could change economic developments compared with our estimates. One example was a 5 per cent depreciation of the krone in the first half of 1998 combined with a 3 percentage point increase in interest rates, triggered by rising wage growth. This was largely what occurred through the spring and summer of 1998.

The analysis of cyclical developments in the December 1997 *Inflation Report* led to substantial forecast errors for 1999, but the analysis was in many ways fairly accurate. The projected cyclical turnaround materialised, but as a result of the contagion effects of the Asian crisis the turnaround came earlier than implied by our analyses.

Chart 1 shows Norges Bank's and Statistics Norway's forecasts for unemployment, mainland GDP growth and wage and price inflation. Price inflation in 1999 was approximately in line with Statistics Norway's forecast, while Norges Bank's forecast was ¾ percentage point

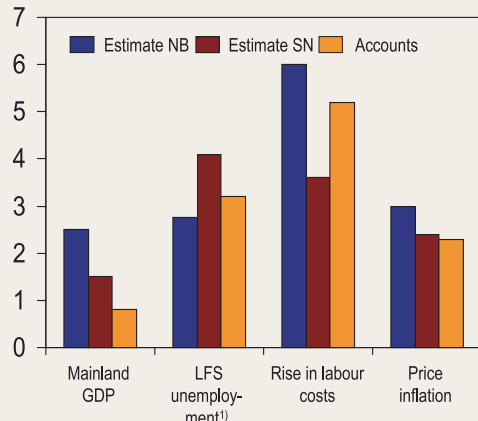
Table 1. Projections for 1999 made in December 1997, and actual figures for 1999 (as at September 2000) Percentage growth on previous year unless otherwise indicated

1999	Projection	Actual	Forecast error ¹⁾
Mainland demand	3	1.6	1½
Private consumption	4¼	2.4	1¾
Public consumption	2½	2.7	-¼
Fixed investment	0	-2.1	2
Petroleum investment	-19	-12.6	-6½
Exports	4¼	1.7	2½
Oil, gas and pipeline transport	4¼	-0.1	4¼
Traditional goods	5	2.6	2½
Imports	1¾	-3.1	4¾
Traditional goods	2	-2.0	4
GDP	2¾	0.9	1¾
Mainland GDP	2½	0.8	1¾
Employment	1¼	0.7	½
Annual wages	6	5.2	¾
Consumer prices	3	2.3	¾
LFS unemployment	2½	3.2	-½

¹⁾ Positive figures indicate that estimates are too high.
Sources: Statistics Norway (Economic Survey 3/2000) and Norges Bank (Economic Bulletin 1997/4)

too high. Statistics Norway's estimates¹⁾ pointed to lower GDP growth than Norges Bank's estimates, with rising unemployment and very moderate wage growth.

Chart 1 Estimates for some key variables for 1999 made in 1997 by Norges Bank (NB) and Statistics Norway (SN). Annual increase. Per cent



¹⁾ Level

Sources: Statistics Norway and Norges Bank

Our forecasts for economic developments are based on assumptions that must be made for variables that are exogenously determined. Some of the key assumptions concern the fiscal stance, money market rates, the exchange rate, petroleum investment and international developments. "Incorrect" estimates for exogenous variable are a main source of forecast errors.

Other sources of forecast errors are the model's description of economic relationships. There are uncertainty intervals around each coefficient, and changes may occur in the functioning of the economy, which are not captured by the quantification of coefficients. There are also areas where the model does not sufficiently take into account important economic relationships. These factors require the use of some degree of judgement, for example in interpreting current statistics, particularly for

the shortest projections. In practice, the evaluations are taken into account by adjusting the add factor in each equation. Erroneous adjustments of add factors therefore represent another important sources of forecast errors. However, correct adjustments result in better forecasts.

Due to the main revision of the national accounts, it has not been possible to make a thorough analysis of forecast errors stemming from the model and its use. In order to identify errors so that they provide useful information on the model and its use, the model's equations must be quantified on the basis of the revised national accounts. So far, most equations have been quantified using the old national accounts. New national accounts figures are "recreated" by calibrating the equations' add factors. Once a fully remodelled and re-estimated model can be used, a more complete analysis can be carried out.

As in previous articles, we will confine ourselves to an analysis of how the forecasts are influenced by erroneous estimates for exogenous variables. This can be illustrated by replacing the exogenous assumptions with actual values. This will not necessarily show what our estimates would have been in that case. If we had assumed a different development in the exogenous variable, it is likely that our assessment, which is important when making forecasts, would also have been different.

The first line in Table 2 shows the forecast errors for some of the key variables in Table 1. The second line shows how large the forecast errors are after incorporating correct economic policy assumptions in 1998 and 1999. The exchange rate and money market rates are included here.

The forecast error in the estimates for price and wage inflation increases further. This is the direct result of a weaker exchange rate from 1997 to 1999, with a further contribution from a somewhat tighter labour market. The forecast error for employment growth increases. The forecasts for production and demand improve somewhat, particularly for mainland fixed investment.

The result is a combination of several factors: Public demand was somewhat stronger than assumed, contributing to a further increase in employment growth. On the other

Table 2. Forecast error in 1999 and the effect of changes in assumptions. Positive figures indicate that estimates are too high. Percentage points. Forecasts from December 1997

	Mainland GDP	Employment	Rise in labour costs	Consumer price inflation	Private consumption	Mainland business fixed investment
Aggregate error	1¾	½	¾	¾	1¾	2
Error after changes in policy assumptions	1½	¾	1¼	1	1¼	0
- and after incorporation of correct estimates for all exogenous variables	1½	½	¼	-¼	1½	0

Source: Norges Bank

¹⁾ In December 1997, Statistics Norway produced complete forecasts only for 1998. A box provided a rough outline of macroeconomic developments to 2000, with a description of the effects of some alternative assumptions. Our chart includes Statistics Norway's forecasts for 1999 as presented in that box.

hand, the increase in interest rates has a dampening impact on mainland business fixed investment and housing investment. The rise interest rates has relatively little impact on the model's forecast for private consumption. More recent analyses would indicate that the relationship between the interest rate level and private consumption is stronger than previously assumed when the December 1997 *Inflation Report* was published. The stronger relationship is reflected in a new version of the RIMINI model that was used from the June 2000 *Inflation Report*.

When actual developments for all exogenous variables in 1998 and 1999 are incorporated, the forecast for consumer price inflation is much closer to the mark. The main reason why consumer price inflation is now markedly reduced is that the negative international price impulses are now incorporated correctly. Price inflation is now somewhat under the mark. This must be seen against the background of wage growth, which turned out to be somewhat higher through 1998 than expected in December 1997. Even with a correct development in exogenous variables through 1998, wage growth would have been about 1 percentage point too low that year, cf "Evaluation of Norges Bank's Projections for 1998" (Jore 2000). The forecast errors for wage growth are also markedly reduced, even though wage growth is overpredicted by half a percentage point. The reason for this is that wage growth in 1998 was underestimated by 2 percentage points. The errors for the other key variables show little change in relation to the original forecasts, with the exception of mainland fixed investment, which is now accurate.

The substantial forecast errors in the estimates for 1999 published in December 1997 can partly be explained by the lack of accuracy with regard to the exogenous estimates. This primarily reflects the after-effects of the Asian crisis. The errors remaining after incorporating correct exogenous variables is primarily due to overprediction of private consumption, and thus employment and GDP. The reason for this may be that the consumption equation in the RIMINI model may not have captured interest rate effects.

Projections for 1999 presented in December 1998

At the end of 1998, the prospects for the world economy were relatively dismal. Pessimism was spreading, with falling growth forecasts for Europe. The Norwegian krone (as measured by the import-weighted index I-44) had depreciated by 4 per cent since the end of 1997, and money market rates had increased from 4 to 8 per cent during the same period. These developments reflected the turbulence in international financial markets and an erosion in Norwegian manufacturing industry's competitiveness as a result of the sharp growth in labour costs in 1998. With the aim of restoring confidence in the Norwegian economy and making room for a gradual fall in interest rates, the budget adopted for 1999 relatively tight.

Against this background, Norges Bank projected in the December 1998 *Inflation Report* that the Norwegian economy would enter a period of slower economic growth in an environment of high cost inflation. Table 3 shows our projections in that report and the actual figures as presented in the national accounts in September 2000. We projected a fall in mainland fixed investment and weaker growth in private consumption compared with the previous year. Public consumption was projected to expand by 1 per cent. However, the turnaround was not as pronounced as implied by our projections. With the exception of the projections for mainland demand growth and oil and gas exports, our projections were fairly accurate. Price inflation was $\frac{1}{4}$ per cent higher than projected. The error was somewhat greater for wage growth.

The effective exchange rate was weaker at the end of 1998 and interest rates were high. The underlying assumptions for these variables were as follows:

- As a technical assumption, the exchange rate was to return to its initial range in the course of the first half of 1999, implying an 0.7 per cent appreciation on average between 1998 and 1999. The appreciation was somewhat stronger than assumed, and the import-weighted exchange rate index (I-44) appreciated by 1.2 per cent.
- Interest rates were assumed to follow market expectations as implied by forward rates. This implied a fall in money market rates from 8 per cent in the final quarter of 1998 to 5.7 per cent in the fourth quarter of 1999. This was the first time we applied a technical assumption of this type. Actual interest rate developments followed market expectations fairly closely from December 1998. At the end of 1999, money market rates had declined to 6.2 per cent.

Table 3. Projections for 1999 made in December 1998, and actual figures for 1999 (as at September 2000) Percentage growth on previous year unless otherwise indicated

1999	Projection	Actual	Forecast error ¹⁾
Mainland demand	- $\frac{1}{4}$	1.6	- $1\frac{3}{4}$
Private consumption	$1\frac{3}{4}$	2.4	- $\frac{3}{4}$
Public consumption	1	2.7	- $1\frac{3}{4}$
Fixed investment	-8	-2.1	-6
Petroleum investment	-15	-12.6	- $2\frac{1}{2}$
Exports	$4\frac{1}{2}$	1.7	$2\frac{3}{4}$
Oil, gas and pipeline transport	$6\frac{1}{2}$	-0.1	$6\frac{1}{2}$
Traditional goods	$2\frac{1}{4}$	2.6	- $\frac{1}{4}$
Imports	- $2\frac{1}{4}$	-3.1	$\frac{3}{4}$
Traditional goods	-2	-2.0	0
GDP	$1\frac{1}{4}$	0.9	$\frac{1}{4}$
Mainland GDP	$\frac{1}{2}$	0.8	- $\frac{1}{4}$
Employment	$\frac{1}{2}$	0.7	- $\frac{1}{4}$
Annual wages	6	5.2	$\frac{3}{4}$
Consumer prices	$2\frac{1}{2}$	2.3	$\frac{1}{4}$
LFS unemployment	$3\frac{1}{2}$	3.2	$\frac{1}{4}$

1) Positive figures indicate that estimates are too high.

Sources: Statistics Norway (Economic Survey 3/2000) and Norges Bank (Economic Bulletin 1998/4)

Other key assumptions showed larger deviations:

- International producer prices were assumed to fall by $\frac{1}{2}$ per cent point between 1998 and 1999. Producer prices fell by 3.5 per cent, ie a markedly greater decline than assumed.
- Public consumption was assumed to increase by 1 per cent, while the turnout was 2.7 per cent.
- Oil prices in NOK were assumed to remain at the low level prevailing in the latter half of 1998, ie around NOK 90 per barrel. The actual price was substantially different at NOK 190 per barrel at the end of the year.
- Production and oil and gas exports were markedly lower than assumed.

The first line in Table 4 shows forecast errors for some of the main variables. The second line shows remaining errors after incorporating actual developments in policy assumptions, including the exchange rate and money market rates.

The forecasts are more accurate after correct exogenous estimates for policy variable are incorporated. The price inflation projection is on the mark after incorporating a stronger exchange rate. The somewhat tighter labour market resulting from the incorporation of correct developments in policy variables contributes to keeping the wage growth forecast unchanged in spite of low price inflation. Both mainland GDP and employment are now accurately projected, while the forecast errors for growth in private consumption and mainland fixed investment are reduced.

When correct developments for all exogenous variables are incorporated, the forecast error for private consumption, fixed investment and wage growth is reduced, while the error for mainland GDP and consumer price inflation increases. A more positive trend in household financial wealth and higher real disposable income contributes to an accurate estimate for private consumption. Combined with somewhat higher fixed investment, the production forecast also increases. While mainland GDP was initially underestimated, the forecast is now too high.

Consumer price inflation is now estimated at $1\frac{3}{4}$ per cent, ie $\frac{1}{2}$ percentage point too low. A stronger exchange rate and weaker international price impulses than expected therefore resulted in an underestimation of

consumer price inflation rather than an overestimation. An important reason why the consumer price inflation forecast is now too low is that labour costs turned out to be higher in 1998 than projected as late as in December of the same year. Wage growth in the mainland economy was projected at 6 per cent, while it later became clear that wage growth reached 6.4 per cent. Hourly labour costs, which were also estimated at 6 per cent in 1998, reached almost 7 per cent. The higher-than-expected increase in labour costs in 1998 implies higher consumer price inflation in the following years, even though wage growth was lower than projected in 1999. Another contributory factor is that the RIMINI model's import price equation was adjusted so that import prices increased at a slower rate than implied by the model's relationships. Previous experience implies that the model-determined estimates for import prices would be too high. The downward adjustment contributed to pushing down import price inflation and resulted in a more accurate inflation projection than would otherwise have been the case. After incorporating correct and much lower international price inflation and a stronger exchange rate, the downward adjustment results in an underestimation of inflation.

On the whole, the projections for 1999 in the December 1998 Inflation Report provided a relatively accurate picture of actual developments. One reason why real wage growth was overpredicted was that real wage growth was higher in 1998 than assumed in the report. Employees' organisations endorsement of the recommendations in the so-called Arntsen report was probably another reason behind the overestimation of wage growth. Assumptions concerning fiscal policy continue to be off the mark. In recent years, we have supplemented the estimates in the budget documents with our own analyses of local government finances, for example, in order to achieve greater accuracy in our estimates for public expenditure. We have also taken into account that there is usually some fiscal slippage through the year in relation to the spending programme adopted by the Storting (Norwegian parliament). The increase in public expenditure in 1999 is to some extent due to unforeseen developments such as expenditure in connection with the intervention in Kosovo.

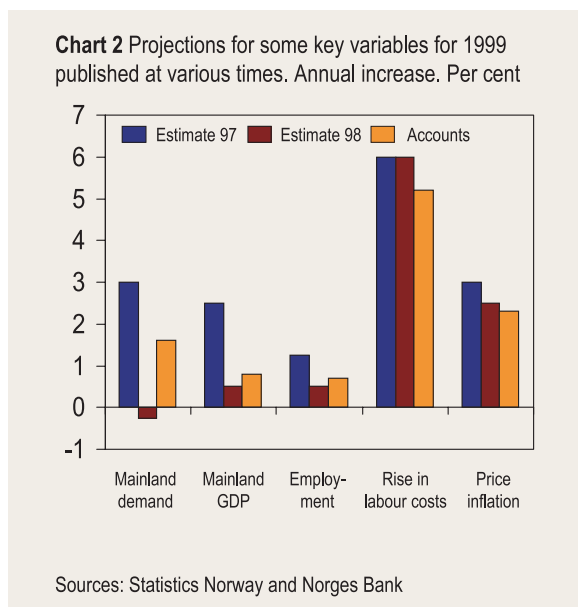
Table 4. Forecast error in 1999 and the effect of changes in assumptions. Positive figures indicate that estimates are too high. Percentage points. Forecasts from December 1998

	Mainland GDP	Employment	Rise in labour costs	Consumer price inflation	Private consumption	Mainland business fixed investment
Aggregate error	$-\frac{1}{4}$	$-\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{4}$	$-\frac{3}{4}$	-6
Error after changes in policy assumptions	0	0	$\frac{3}{4}$	0	$-\frac{1}{2}$	-4
- and after incorporation of correct estimates for all exogenous variables	$\frac{1}{2}$	0	$\frac{1}{4}$	$-\frac{1}{2}$	0	$-3\frac{1}{2}$

Source: Norges Bank

Comparison of Norges Bank's projections for 1999 published at different times

The uncertainty associated with forecasts naturally increases with the time horizon. Chart 2 shows Norges Bank's projections for 1999 for some main aggregates. The projections were published in December 1997 and December 1998.



The projections changed substantially in the course of 1998. The cyclical turnaround projected at the end of 1997 to take place in 2000 materialised already in the latter half of 1998. The turnaround was not as pronounced as widely expected towards the end of 1998. Demand - particularly private consumption - recovered more quickly than projected. There are several reasons for this. The effects of the Asian crisis were more transient than feared, oil prices doubled in 1999 and fiscal slippage reduced the fiscal tightening that was planned. The decline in money market rates during the first half of 1999 fed through more quickly to private consumption and fixed investment than implied by the equations in the RIMINI model.

Despite substantial changes in the real economic picture, the price and wage inflation projection showed little change. This primarily indicates that nominal variables are more stable, or react more slowly, than demand and production. It takes time before changes in demand and production have an impact on wage growth through labour market tightness. Moreover, mechanisms such as the wage carry-over contribute to smoothing wage growth even though nominal pay increases vary.

Overview of projections from 1994 to 1999

Charts 3 to 10 show the projections for the years 1994 to 1999, produced in December of the preceding year, and the outturn. The projections from Statistics Norway and the Ministry of Finance are shown alongside Norges Bank's projections. The projections are published in *Economic Bulletin* (1993/4, 1994/4, 1995/4, 1996/4, 1997/4 and 1998/4), *Economic Survey* (3/93, 3/94, 3/95, 3/96, 3/97 and 3/98), Final Budget Bill (1993, 1994, 1995, 1996) Supplementary Proposition (1997) and the National Budget (1999).

The three institutions' projections are fairly similar with regard to economic developments, albeit with some differences. Statistics Norway was the most pessimistic at the end of 1998, and projected a fall in mainland GDP, employment and demand in the mainland economy. Norges Bank projected a slight fall in demand, while the Ministry of Finance was closest to the mark with a projected growth rate of 0.8 per cent. Earlier in the 1990s the projections for these variables were more closely in line with each other. The three institutions underestimated the amplitude of the cyclical upturn from 1994 to 1997, while the projections for 1998 were more accurate.

The projections for traditional exports for 1999 from Statistics Norway and Norges Bank were fairly accurate, while the estimate from the Ministry of Finance was somewhat higher. This is reflected in the estimates for imports. The projections for exports and imports were far off the mark throughout the period from 1994. The average relative errors, which take into account the size of the errors in relation to actual growth, are also substantial in relation to the projection errors for most of the other variables.

The projections for wage and price inflation have by and large been the most accurate. For the period as a whole, Norges Bank's projection for wage growth has shown the highest accuracy, but our projection for 1999 was less accurate than that of the Ministry of Finance and Statistics Norway. Norges Bank's projection was too high. On the other hand, Norges Bank's projection for consumer price inflation that year was only ¼ percentage point too high, while the forecast error for the projections from the two other institutions was higher. Statistics Norway's lower projection for wage growth is due to their underestimation of labour market tightness, cf chart 10, which shows employment growth. The projections for both labour market developments and wage growth from the Ministry of Finance were accurate. The overestimation of inflation in 1998 and 1999 is related to the effects of the Asian crisis.

Table 5 shows average absolute error (AAE²) and average relative error percentage (RRMSE³). These measures sum up the accuracy (or inaccuracy) of the forecasts for the period as a whole. AAE provides an

² AAE (average absolute error) is defined as $(1/N) \sum_{n=1}^N |y_n - \hat{y}_n|$, where y_n represents the actual growth rate and \hat{y}_n is the projected growth rate.

³ RRMSE (average relative error percentage) is defined as $\sqrt{1/N \sum_{n=1}^N \left(\frac{y_n - \hat{y}_n}{y_n} \right)^2}$ where y_n represents the actual growth rate and \hat{y}_n is the projected growth rate.

Charts 3 – 10 Growth estimates for 1994-1999 from Statistics Norway (SN), The Ministry of Finance (FIN) and Norges Bank (NB), compared with actual growth (Actual). Per cent

■ SN ■ FIN ■ NB — Actual

Chart 3 Mainland demand

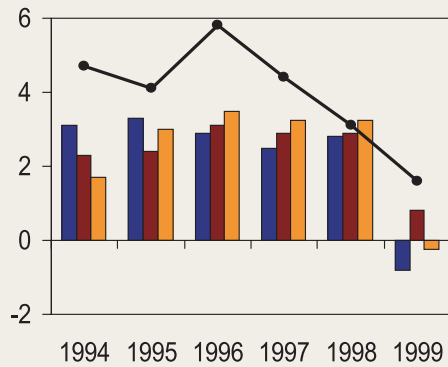


Chart 4 Export of traditional goods

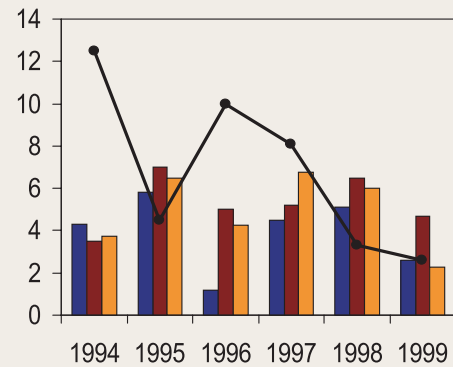


Chart 5 Petroleum investment

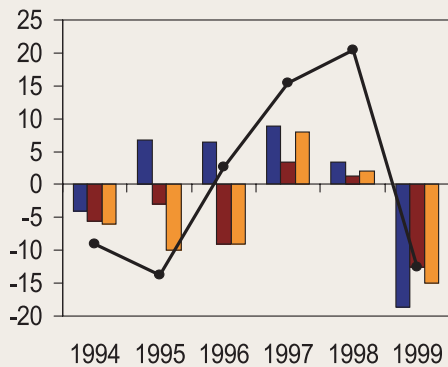


Chart 6 Mainland GDP

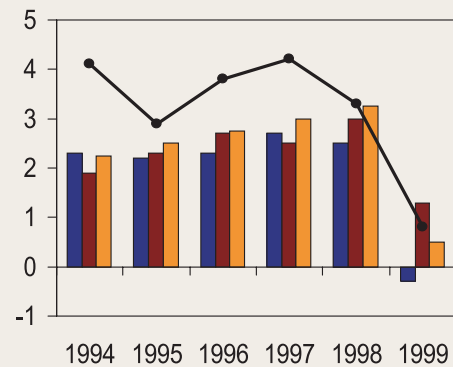


Chart 7 Import of traditional goods

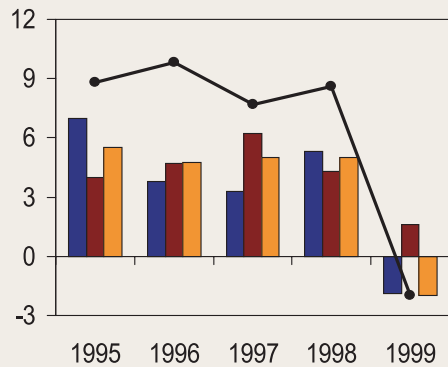


Chart 8 Annual wage growth

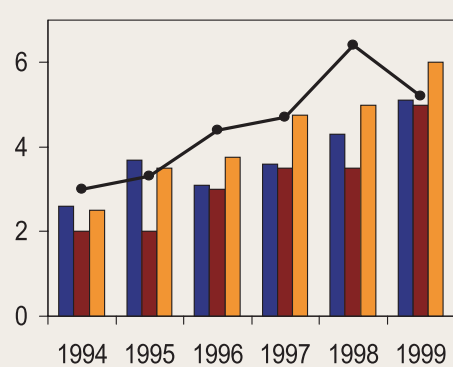


Chart 9 Consumer price inflation

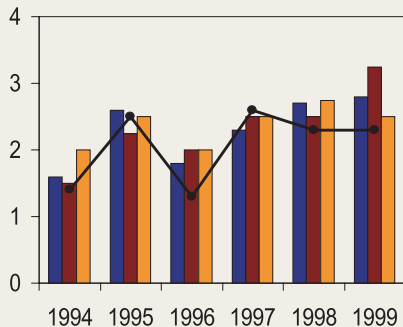
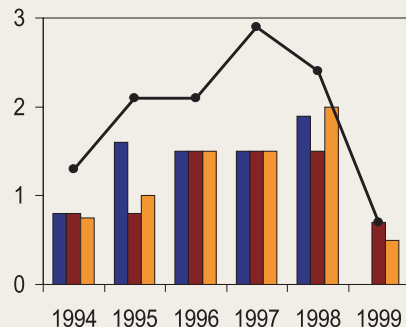


Chart 10 Employment growth



indication of the size of the average forecast error in percentage points over these years, without the forecast errors with opposite signs offsetting each other. RRMSE penalises large forecast errors more heavily than small errors, and indicates the size of the errors in relation to actual growth. This allows a comparison of the size of forecast errors across different variables. The table also includes sub-components of domestic demand.

The table provides a summary of the information shown in the charts. For example, we see that the forecast errors are smallest for wage and price inflation. For the period as a whole, Statistics Norway's forecast for price inflation is slightly more accurate than the other institutions, but the differences are very small. Norges Bank's projection for wage growth is the most accurate. The projections for petroleum investment, public consumption and mainland fixed investment consistently show the largest forecast errors, while the errors are smaller for key variables such as mainland GDP, employment and private consumption.

On the whole, the projections from the three institutions are not very different. We cannot assert that the forecasts from one of the three institutions is significantly better than those of the two others. Moreover, the forecast errors analysed are only part of the complete set of forecasts from these institutions. Statistics Norway and Norges Bank publish projections four times annually, while the Ministry of Finance publishes projections in connection with the National Budget and the Revised National Budget.

Summary

The analysis of forecast errors for the projections for 1999 shows that it is difficult to determine the timing of a cyclical turnaround. The timing of the turnaround was also to a large extent influenced by international developments. Norges Bank's projections for 1999 published in December 1997 nevertheless pointed to a cyclical turnaround, but the turnaround was projected to occur later than what proved to be the case. The analysis in the December 1997 Inflation Report was accurate with regard to several important points. In addition, particular emphasis was placed on shedding light on the most important uncertainty factors, including a substantial depreciation of the exchange rate and a rise in interest rates.

As a rule, it is easier to project developments one year ahead. Norges Bank's projections for 1999 published in December 1998 were also fairly accurate at that time. When the projections were made, the krone exchange rate was historically weak and money market rates were high. If we had used our normal approach of applying the preceding month's krone exchange rate and money market rate, our projections would have been considerably less accurate than what proved to be the case. This was the first time we applied the technical assumption that money market rates would follow market expectations. We also assumed that the krone exchange rate would appreciate.

Previously, we identified projections for public expenditure and petroleum investment as two variables that were difficult to project. Errors in these areas have tended to be the source of substantial projection errors earlier.

Table 5. Average absolute error (AAE) and relative root mean square error (RRMSE) Statistics Norway (SN), the Ministry of Finance (Fin) and Norges Bank (NB). 1994 to 1999

		SN	Fin	NB
Mainland GDP	AAE	1.23	1.07	0.81
	RRMSE	0.64	0.40	0.29
Employment	AAE	0.78	0.78	0.71
	RRMSE	0.76	0.41	0.38
Exports traditional goods	AAE	3.95	4.12	3.48
	RRMSE	0.55	0.68	0.54
Imports traditional goods ¹⁾	AAE	3.12	3.86	2.93
	RRMSE	0.42	0.91	0.38
Mainland demand	AAE	1.65	1.55	1.59
	RRMSE	0.69	0.41	0.58
Private consumption	AAE	1.00	1.23	1.03
	RRMSE	0.32	0.36	0.29
Fixed investment ¹⁾	AAE	4.36	3.70	3.69
	RRMSE	1.62	0.87	1.31
Public consumption	AAE	1.15	1.27	1.23
	RRMSE	0.74	0.97	0.96
Petroleum investment	AAE	9.83	9.53	7.77
	RRMSE	0.99	1.92	1.88
Annual wages	AAE	0.90	1.33	0.60
	RRMSE	0.22	0.33	0.14
Consumer prices	AAE	0.33	0.38	0.34
	RRMSE	0.21	0.28	0.29

¹⁾ Because of major revisions in connection with the transition to new national accounts, figures for 1994 are not included.

Sources: Ministry of Finance, Statistics Norway and Norges Bank

Efforts have been made to improve the projections. However, in both areas there is still room for improvement.

Work has been undertaken to improve the inflation projection by developing alternative models. The RIMINI model includes an aggregated consumer price equation that is not ideal for capturing conditions that are not related to labour costs or imported price inflation.

The analysis also illustrates that interest rates changes tend to have a stronger and faster impact on private consumption than implied by historical experience. In the model version used for the calculations in the last two inflation reports, the traditional consumption function was replaced by a consumption function where the interest rates level has a stronger impact on private consumption.

References:

- Jore, Anne Sofie (1997): "Evaluation of Norges Bank's projections from 1994 to 1996", *Economic Bulletin* 1998/1, pp.69-79
- Jore, Anne Sofie (1999): "Evaluation of Norges Bank's projections", *Economic Bulletin* 1999/2, pp.92-99
- Jore, Anne Sofie (1999): "Evaluation of Norges Bank's projections", *Economic Bulletin* 2000/1, pp.12-18
- Madsen, Robert (1996): "Norges Banks prognoser 1987-94: hvor godt traff de?" (Norges Bank's forecasts for 1987-94: how accurate were they?), *Penger og Kredit* 1996/1, pp. B58-B64