Evaluation of Norges Bank´s projections

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This article analyses Norges Bank's projections for 1998, published in autumn 1996 and autumn 1997 respectively. Compared with earlier articles on this subject, we go one step further in the analysis by examining projections with a two-year horizon. It is also important to be able to analyse economic developments further ahead because decisions on economic policy will influence the economy more than one year ahead. The evaluation focuses on the contributions from erroneous assumptions concerning exogenous variables, such as public demand and externally generated inflation. A comparison with two-year projections from Statistics Norway is also included.

All in all, our forecast errors for 1998, presented in autumn 1997, were smaller than the forecast errors for earlier years. There is no clear evidence that the projections would have been substantially better if we had known actual movements in exogenous variables in advance. The forecast errors increase for some variables and are reduced for others.

In principle, one would expect the forecast errors in the projections presented at the end of 1996 to be greater than the errors in the projections presented at the end of 1997. This is confirmed for important real variables such as mainland demand and employment. For wage and price inflation, however, the forecast errors are smallest in the earliest projections.

The projections for 1998 show a larger forecast error in the projection for consumer price inflation than in earlier years as a result of lower-than-expected imported price inflation. Towards the end of 1998 it was evident that consumer price inflation was lower than implied by exchange rate movements. In the consumer price equation, we have since 1999 used an expanded import-weighted exchange rate index, which includes the currencies of several countries in Asia. The actual forecast error is largely due to the fact that the effects of the crisis in Asia were erroneously evaluated in two ways. First, the crisis had a surprisingly strong effect on international prices. Second, the depreciation of Asian currencies contributed to a stronger effective krone exchange rate than implied by traditional exchange rate indices.

Analyses of forecast errors are an important part of the work aimed at making the projections more accurate. At the same time, continuous efforts are made to improve the analyses, in the form of both short-term cyclical analyses and further development of the model. The analysis of forecast errors in the projections for 1998 confirms that there is a potential for improving the RIMINI model. Various types of shock, such as international financial turbulence and fluctuations in the oil price, will nevertheless continue to be a source of uncertainty in economic developments.

Norges Bank's analyses of developments in the Norwegian economy are published in the inflation reports four times a year. Projections for developments in the Norwegian and international economy are an important basis for the formulation of monetary policy. In addition, the analyses are used as a basis for advice on the orientation of economic policy in general. The macroeconomic model RIMINI, developed in Norges Bank's Research Department, has been the principal tool for the Bank's analyses since 1994. RIMINI is an econometric model with nearly 400 equations. About 70 of the equations are estimated on the basis of historical data, while the remaining equations are definitional relationships.

Norges Bank aims to produce the best possible projections for the Norwegian economy. It is important that errors are revealed in order to improve the model and the way in which the model is used. This in turn will result in more accurate projections. We also wish to compare Norges Bank's projections with those of other institutions.

Norges Bank places considerable emphasis on trans-parency 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 have arrived at our projections and how accurate they are. 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 analysis.

Norges Bank intends to publish analyses of its projections annually. So far, such analyses have been published in articles in *Economic Bulletin* 1998/1 (Jore 1997) and 1999/2 (Jore 1999). In addition to detailed analyses of Norges Bank's projections, these articles presented summary measures of forecast errors for the Ministry of Finance and Statistics Norway, showing that the three institutions' projections were almost equally accurate. The articles also showed that the amplitude of the cyclical upturn was considerably underestimated by all the institutions. In an article published in *Penger og Kreditt* 1996/1 (Madsen 1996), Norges Bank's projec-

tions for the years 1987-1994 were compared with those of other institutions. This article also concluded that Norges Bank's forecasts were about as accurate as projections from other institutions.

The article in Economic Bulletin 1999/2 primarily analysed the projections for 1997. The projections for 1998 were examined briefly on the basis of preliminary national accounts figures for 1998. This article is based on revised national accounts figures published in September and provides a more thorough analysis. This time the analysis has been expanded to include forecast errors in the projections presented at the end of 1996.

Finally, we compare Norges Bank's projections two years ahead with corresponding projections from Statistics Norway.

Sources of forecast errors

The macroeconomic model RIMINI has been the main tool for Norges Bank's projections since 1994. In the model, important economic relationships are represented by quantified empirical relationships. The model also ensures consistency in that demand equals supply in the various markets.

There are important sources of forecast errors in an economic model. The model's coefficients are quantified on the basis of historical data. There are uncertainty intervals around each coefficient, and the interaction between many equations in a model increases the uncertainty around each variable. Changes in the functioning of the economy may not be captured in the quantification of coefficients. Finally, there are areas where the model does not sufficiently take into account important economic relationships.

These factors require the use of some degree of discretion, particularly for the shortest projections. The interpretation of current statistics is an important basis for these discretionary evaluations. In practice, the evaluations are taken into account by adjusting the add factors in each equation. Erroneous adjustments of add factors therefore represent another important source of forecast errors. However, correct adjustments result in better forecasts.

Norges Bank's projections provide our assessment of the most probable developments, given some key assumptions concerning fiscal policy, interest rates and the exchange rate. This is a suitable starting point when projections are to be used to analyse the orientation of economic policy. Often, however, forecast errors will arise because economic policy or the exchange rate deviated from the path assumed. This was particularly the case in 1998.

In addition to forecast errors ascribable to incorrect assumptions concerning economic policy and other exogenous variables, model deficiencies and the use of the model are an important source of forecast errors. The projections are also influenced by changes in the national accounts. Due to the recently implemented main revision to 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 be able to identify errors in such a way 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 on the basis of the old national accounts. New national accounts figures are "recreated" by calibrating the equations' add factors. The work on a complete remodelling and reestimation of the model is now drawing to a close so that more complete analyses can gradually be made.

In this article we analyse the forecast errors for 1998 using the same method as in earlier articles. First, errors stemming from incorrect economic policy assumptions are eliminated, followed by errors ascribable to deviations of other exogenous variables from actual developments. The errors remaining after adjusting for incorrect forecasts of policy variables and other exogenous variables are due to random effects, incorrect model use or model deficiencies. The projections are evaluated against the preliminary national accounts published in September 1999. Revisions to the national accounts are also made after this time, but are usually minor.

Errors in forecasts for 1998

Projections presented in December 1996

Economic Bulletin 1996/4 presented projections for 1997, whereas the projections for the years 1998-2000 were presented as an annual average. We will nevertheless look more closely at the projections for 1998, which are found in our background material, in order to permit a more thorough analysis of forecast errors for longer term projections. Annual projections with a time horizon of two years have been published since Economic Bulletin 1997/4. Perceptions of developments a few years ahead are important in formulating economic policy. It often takes time before economic policy decisions influence economic developments. The need to draw up the best possible projections is therefore equally important in making forecasts with a two-year time horizon as for projections with a time horizon of one year.

In December 1996, Norges Bank projected continued high, albeit slower growth the next few years. The cyclical upturn had then lasted for three years. A rising household saving ratio, a levelling off of fixed investment and lower growth in traditional exports were cited as the most important reasons for the more sluggish trend.

In Economic Bulletin 1999/2, we discussed how these projections underestimated economic growth in 1997. A substantial portion of the forecast errors was due to incorrect assumptions concerning exogenous variables, particularly general government demand and petroleum investment.

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Table 1. Projections for 1998 made in December 1996, and actual figures for 1998 (as at September 1999) Percentage increase on previous year unless otherwise indicated

1998	Projection	Actual	Forecast error
Mainland demand	2¼	3.1	¾
Private consumption	2½	3.1	½
Public consumption	1¾	3.7	2
Fixed investment	2	2.4	½
Petroleum investment	4	21.3	17¼
Exports	3¼	0.5	-2¾
Oil, gas and pipeline transport	2¼	-3.5	-5¾
Traditional goods	4½	3.4	-1
Imports	4	9.1	5
Traditional goods	4	9.6	5½
GDP	2¼	2.1	-¼
Mainland GDP	2¼	3.3	1
Employment	1	2.3	1¼
Annual wages	5	6.5	1½
Consumer prices	2½	2.3	-¼
LFS unemployment	3¾	3.2	-½

Sources: Statistics Norway *(Economic Survey 3/99)* and Norges Bank *(Economic Bulletin 1996/4)*

The projections for some key variables for 1998 are presented in Table 1 along with actual figures presented in the national accounts published in September 1999. The table shows that economic growth in 1998 was also underpredicted two years earlier. Mainland demand was estimated at 2¼ per cent, while the national accounts figures put growth at 3.1 per cent. All of the domestic demand components were underestimated. However, growth in both traditional exports and exports of oil and gas was overpredicted. Petroleum investment was considerably higher than projected. For 1997 and 1998 combined, petroleum investment was projected to expand by 12 per cent, while growth proved to be more than 50 per cent. The underestimated growth in demand is reflected in underpredicted projections for import growth, mainland GDP growth and employment growth. Unemployment was half a percentage point lower than we projected.

We assumed that the tight labour market would make it difficult to achieve moderate wage growth in the years ahead. This turned out to be correct. The labour market was tighter than implied by our projections, and wage growth in 1998 was therefore even higher than we assumed. However, this did not result in higher-than-expected consumer price inflation. On the contrary, price inflation was a quarter percentage point lower than our projection. This must be seen in connection with the Asian crisis, which contributed to a fall in prices for a number of imported consumer goods in 1998.

Table 2 Forecast error in 1998 and the effect of changes in assumptions. Positive figures denote underprediction. Percentage points. Forecasts from December 1996

	Mainland GDP	Employment	Wage growth	Consumer price inflation	Private consumption	Mainland business fixed investment
Aggregate error	1	1¼	1½	-¼	½	½
Error after changes in policy assumptions	0.1	0.6	0.4	-1.0	-0.1	-3.2
- and after incorporation of correct estimates for all exogenous variables	0	0.3	0.1	-1.1	0	-3.5

Source: Norges Bank

The contribution of inaccurate exogenous assumptions to forecast errors is found by incorporating actual growth rates for the variables determined exogenously. The first line in Table 2 shows the forecast errors for some of the variables in Table 1. The second line shows how large the forecast errors are after incorporating correct economic policy assumptions in 1997 and 1998. This includes public expenditure, the money market rate and the exchange rate. The projections for 1997 and 1998 were, as usual, based on technical assumptions regarding the exchange rate and the money market rate. This entailed an average appreciation of 1 per cent from 1996 to 1997 and an unchanged exchange rate thereafter. The appreciation turned out to be 0.5 per cent in 1997, while there was a depreciation of 4.5 per cent from 1997 to 1998. The money market rate was assumed to be 4.3 per cent in both 1997 and 1998, while actual interest rates averaged 3.7 per cent in 1997 and 5.8 per cent in 1998.

If the economic policy assumptions for 1997 and 1998 had been correct, the estimates for some of the key variables would have been more accurate, but the forecast errors are also seen to increase for some variables. Correct policy assumptions result in a substantial overprediction of mainland fixed investment growth, while the projection for growth in private consumption is fairly close to the mark. Output growth in mainland Norway is then also accurate, while the forecast errors in the projections for growth in employment and wages are substantially reduced.

Projected consumer price inflation rises to 3.3 per cent, 1 percentage point too high. The main reason for higher consumer price inflation is the weaker krone exchange rate. In the RIMINI model, a depreciation of 4.5 per cent results in an increase of about ½ per cent in price inflation the same year. During 1998, however, it turned out that the import-weighted krone exchange rate was less indicative of externally generated price impulses than earlier. This was due to the strong depreciation of a number of Asian currencies in the autumn of 1997.

These countries were not represented in the various effective krone exchange rate indices, partly because they have been of relatively limited importance to Norwegian trade. However, as a result of a significant change in these countries' exchange rates, the rise in prices for Norwegian imports of consumer goods was very low, thereby restraining general price inflation in Norway. Furthermore, Norway imports a relatively higher share of consumer goods from Asia than the level indicated in the model's aggregated import price equation. The RIMINI model would therefore never be fully able to capture the effect of the Asian crisis on Norwegian consumer prices. Since Inflation Report 1999/1 we have looked at movements in an expanded import-weighted exchange rate index, which includes a greater number of Asian countries.

When growth in all exogenous variables is incorporated, the forecast error for employment and wage growth is further reduced, while the error for mainland fixed investment growth rises slightly. The forecast error for other variables shows little change.

The errors remaining after correct assumptions concerning economic policy and other exogenous variables are incorporated are due to erroneous estimates for 1996 and 1997, a change in the base year, a break in the national accounts and shortcomings in the model and its use. In later analyses of forecast errors we will also examine the last two reasons for forecast errors.

Projections presented in December 1997

Forecast errors in the projections for 1998, presented in Economic Bulletin 1997/4, were provisionally analysed in the article in Economic Bulletin 1999/2. The projections were compared with the preliminary national accounts figures for 1998, published in February 1999.

Table 3. Projections for 1998 made in December 1997, and actual figures for 1998 (as at September 1999) Percentage growth on previous year unless otherwise indicated

1998	Projection	Actual	Forecast error
Mainland demand	3¼	3.1	-¼
Private consumption	4	3.1	-1
Public consumption	2	3.7	1¾
Fixed investment	2½	2.4	0
Petroleum investment	2	21.3	19¼
Exports	7¾	½	-7¼
Oil, gas and pipeline transport	13½	-3.5	-17
Traditional goods	6	3.4	-2½
Imports	4¾	9.1	4¼
Traditional goods	5	9.6	4½
GDP	5	2.1	-3
Mainland GDP	3¼	3.3	0
Employment	2	2.3	¼
Annual wages	5	6.5	1½
Consumer prices	2¾	2.3	-½
LFS unemployment	3¼	3.2	0

Sources: Statistics Norway (*Economic Survey 3/99*) and Norges Bank (*Economic Bulletin 1997/4*)

Our projections underpredicted economic growth in the years 1994 to 1997. The projections concerning mainland economic developments for 1998 were more accurate (see Table 3). Once again, external factors contributed to forecast errors. This particularly applies to all aspects of the petroleum sector. Fixed investment in this sector rose substantially more than projected, while production and exports of oil and gas were considerably weaker than assumed. The oil price showed a substantially steeper fall than predicted, thereby resulting in a current account deficit instead of the large surplus projected.

Overpredicted growth in private consumption was offset by underpredicted spending growth in the public sector, so that mainland demand was approximately as projected. Traditional merchandise exports were higher than assumed.

The projection for mainland GDP growth was accurate, while growth in total GDP was substantially lower than our projections due to lower oil production. As a result of the sharp increase in fixed investment in the petroleum sector, imports were also higher than projected.

The projection for employment growth was fairly accurate, in contrast to previous years when there were large forecast errors in the projections. This may to some extent be seen in connection with the experience of earlier years. In the work on the projections for 1998, it was taken into account that there has been fairly systematic underestimation of employment growth and overestimation of productivity growth in the past.

Despite the fact that wage growth was underestimated and the exchange rate was weaker than the technical assumption, consumer price inflation was overpredicted. The main reason for this is that imported price inflation was considerably lower than anticipated, despite the weakening of the exchange rate. As noted earlier, this may be ascribed to the fall in foreign producer prices as a result of the Asian crisis.

Table 4. Forecast error in 1998 and the effect of changes in assumptions. Positive figures denote underprediction. Percentage points. Forecasts from December 1997

	Mainland GDP	Employment	Wage growth	Consumer price inflation	Private consumption	Mainland business fixed investment
Aggregate error	0	¼	1½	-½	-1	0
Error after changes in policy assumptions	-0.5	0	1.0	-0.9	-1.0	-3.3
- and after incorporation of correct estimates for all exogenous variables	-0.9	-0.5	0.9	-0.8	-1.0	-3.0

Source: Norges Bank

Table 4 shows forecast errors that are due to incorrect estimates for exogenous variables. The first line in the table shows the forecast errors for some of the variables in Table 3. The second line shows the magnitude of the forecast errors after correct economic policy assumptions for 1998 are incorporated. As previously, this includes general government expenditure, the money market rate and the exchange rate. The projections presented in December 1997 were, as usual, based on technical assumptions concerning the exchange rate and the money market rate. These entailed approximately unchanged exchange and interest rates from the end of 1997. At the end of 1998, the import-weighted exchange rate had depreciated by 4.5 per cent from 1997 to 1998, and average interest rates had risen from 3.7 per cent in 1997 to 5.8 per cent in 1998.

In contrast to the analysis of forecast errors in the projections presented in December 1996 and earlier analyses of forecast errors, correct developments in exogenous variables do not provide more accurate forecasts. On the contrary, the projections are, on the whole. less accurate.

The projection for mainland GDP growth would have been overpredicted by 0.5 percentage point if correct policy assumptions had been incorporated. This is due to higher demand growth as a result of sharper growth in general government demand and improved competitiveness due to a weaker krone exchange rate. A higher money market rate does not offset this.

The forecast error for employment growth disappears when correct policy assumptions are incorporated, and the error for wage growth is reduced from 1.5 per cent to 1 per cent. This contributes to an even greater forecast error for consumer price inflation. The main reason for this is again in part that the model "misinterprets" the weakening of the exchange rate and partly that we have not taken account of the effects of the Asian crisis on world market prices. As noted, the transition to an expanded import-weighted exchange rate index as from Inflation Report 1999/1 may solve part of this problem. Norges Bank is also evaluating the impact of exchange rates through import prices on consumer prices, among other things in the light of the experience of 1998.

Forecast errors in the projections for mainland GDP growth and employment growth increase when correct developments in all exogenous variables are incorporated. High growth in petroleum investment is part of the reason for this. For other variables there are only small changes in the forecast errors.

This analysis can be used to illustrate important aspects of the work on forecasts without carrying out a complete analysis of the model and its use. The fact that the projections are basically fairly accurate and that the forecast errors for main aggregates increase when correct exogenous estimates are included can also be interpreted to mean that Norges Bank's forecasts for devel-

opments in the Norwegian economy were relatively accurate despite considerable errors in the exogenous estimates. This may to some extent be ascribed to adjustments of add factors in the model's equations. Examples of this include:
- For projections with a short time horizon of only one year the interpretation of current statistics provides a basis for discretionary evaluations. Such evaluations contributed, for example, to fairly accurate projections for GDP and employment growth even though total demand was underpredicted.
- If we look more closely at the projections after incorporating correct exogenous variables, we find that growth in the sum of mainland GDP and total imports is very close to actual growth. It is therefore the distribution between domestic production and imports that is inaccurate. The model's equations have a tendency to underestimate import growth, and it has therefore often been necessary to revise import growth upwards by adjusting the add factor in the import equation.

Comparison of Norges Bank's projections for 1998 published at different times

The uncertainty in forecasts of economic developments increases with the time horizon. Chart 1 shows projections for 1998 for some main aggregates published in December 1996 and December 1997 respectively.

The chart can illustrate several points. First, projections for important real variables with a short time horizon are more accurate than projections with a longer time horizon. The opposite is true for nominal variables; projections published in 1996 were slightly more accurate that the projections published one year later. The relative forecast errors for the 1996 projections were greatest for real variables. This also changes in the forecasts published one year later, where the error was greatest for nominal variables.

Real variables generally show wider fluctuations than nominal variables. Normally, forecast errors will therefore be greatest for real variables, as was the case for the projections from 1996. There are several reasons why the forecast errors for wage and price inflation were greatest in the projections from 1997. The error is reduced after correct exogenous variables are incorporated, but the relative forecast error remains high. In the RIMINI model, wage growth in manufacturing and construction determines wage growth in other sectors. The background material for the projections shows that the forecast error for the projections for wage growth in this sector was considerably smaller than the forecast error for total wage growth. Underpredicted wage growth in public and private services was the main reason for underpredicted total wage growth. This was partly due

Chart 1. Estimates for some key variables for 1998 made at various times. Annual increase. Per cent
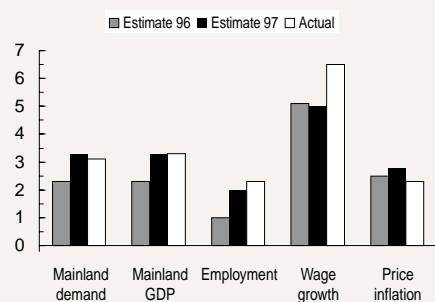
Sources: Statistics Norway and Norges Bank

Chart 2. Estimates for some key variables for 1998 made in 1996 by Norges Bank (NB) and Statistics Norway (SN). Annual increase. Per cent
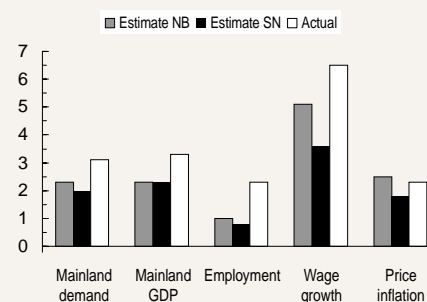
Sources: Statistics Norway and Norges Bank

to the adjustment of wage growth in the public sector to a lower level than a normal use of the model implied when making the projections, in line with actual developments since the mid-1980s. The tendency for wage growth in the public sector to be lower than in the private sector was not captured in the wage equations. In 1998, there was a break in this trend when wage growth in the public sector was higher than in the private sector. Wage growth in private services was also substantially underpredicted, but this cannot be ascribed to our use of the model.

The reason for the high relative forecast error for the inflation projections was the persistent fall in foreign producer prices. As discussed further in an earlier section, most forecasters did not foresee this development.

Comparison of forecasts produced by Statistics Norway and Norges Bank in December 1996

In December 1996, Statistics Norway was the only large institution to produce detailed forecasts for 1998. Norges Bank produced forecasts in the form of averages for several years. We have used the background material for Norges Bank's forecasts from December 1996 to analyse the forecasts for 1998. The Norwegian Bankers' Association and the Ministry of Finance have also published average forecasts for 1998, but they were published earlier in the year. As a result, it is only possible to compare Norges Bank's forecasts and the forecasts published by Statistics Norway.

Chart 2 shows the projections for 1998, published in December 1996, for some key aggregates. The projections for real variables are essentially the same for the two institutions. Even though both Statistics Norway and Norges Bank underpredicted wage growth, Norges Bank's projection was markedly higher than that of Statistics Norway. This is reflected in the projections for consumer price inflation.

Conclusion

The analysis of the projections for 1998 show, as expected, that the forecast errors are greater for the projections published at the end of 1996 than for projections published one year later. A further conclusion is that Norges Bank's projections for the main aggregates were more accurate than those published in earlier years.

Although the forecast errors in the projections for 1998, published in December of the previous year, proved to be closer to the mark than projections for earlier years, a number of sub-components featured substantial errors. The overprediction of growth in private consumption was offset by the underprediction of growth in public consumption. A clear underprediction of petroleum investment was reflected in an underprediction of imports, with the result that the forecast for mainland GDP growth was fairly accurate. Erroneous forecasts for public demand and petroleum investment have prevailed in recent years. As a result, Norges Bank has changed its forecasting routines for these variables. Public demand is now forecast on the basis of expected developments in local government finances, expected movements in public expenditure through the year and estimates in government budget documents. Furthermore, we collect broader information on developments in petroleum investment.

The projections for 1998 show higher forecast errors for consumer price inflation than in previous years, reflecting lower-than-expected increases in import prices. Towards the end of 1998, it was clear that consumer price inflation was lower than implied by exchange rate developments. A broadened import-weighted exchange rate index, which was introduced in 1999, includes the currencies of several Asian countries. The forecast error primarily stems from our evaluation of the Asian crisis. The error relates to two points. First, the crisis had an unexpected strong impact on international price developments. Second, the depreciation of Asian currencies resulted in a stronger effective

krone exchange rate that implied by the traditional exchange rate index.

In contrast to the projections published in earlier years, overall forecast errors increased after incorporating correct growth rates for exogenous variables. This illustrates that evaluations of current statistics can improve forecasts, but also indicates that there is room for improving the RIMINI model. The model was remodelled last autumn and reestimated on the basis of the new national accounts. We will focus on the model's properties with regard to the composition of the supply side when testing the new model, which will be used from the year 2000.

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