NORGES BANK

Economic Bulletin

3
06

October

The *Economic Bulletin* is published quarterly by Norges Bank.

Editor: *Svein Gjedrem*
Editorial officer: *Helle Snellingen*
Coordinator: *Beverley Wahl*

Communications regarding the *Economic Bulletin* should be addressed to:
Norges Bank
Information Department
P.O. Box 1179 Sentrum
N-0107 Oslo, Norway
Telex: 56 71 369 nbank n
Fax: +47 22 31 64 10
Telephone: +47 22 31 60 00
E-mail: central.bank@norges-bank.no
Internet: http://www.norges-bank.no

Printed at: Tellus Works AS

ISSN 0029-1676 (printed)
ISSN 1503-8831 (online)

Standard signs used in the tables:

.	Category not applicable
..	Data not available
...	Data not yet available
-	Nil
0 0.0	Less than half the final digit shown

The Norges Bank website (www.norges-bank.no) features the Bank's publications, statistics, announcements, press releases, speeches and other information in Norwegian and English.

Readers may subscribe to the following English-language publications: *Annual Report, Economic Bulletin, Financial Stability, Government Petroleum Fund Annual Report, Government Petroleum Fund Quarterly Report, Inflation Report, Occasional Papers, Report on Payment Systems, Reprints and Working Papers.*
Please send your request by e-mail to posten@norges-bank.no.

Economic Bulletin
Volume LXXVII

October 2006
No. 3

Corrections to Economic Bulletin 2/06
Due to an error, the summary of the article "Review of ECB's Strategy and Alternative Approaches" was not included in the print version of *Economic Bulletin* 2/06. The article with the summary is available in the electronic version of this publication: www.norges-bank.no/english/publications/economic_bulletin/2006-02
In addition, the first line of page 75 was omitted. The text reads: "a higher share of indebted households in the age groups".

Forecasting in Norges Bank

Arne Kloster, assistant director, and Kristin Solberg-Johansen, economist, in the Economics Department of Norges Bank[1]

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

1 Introduction

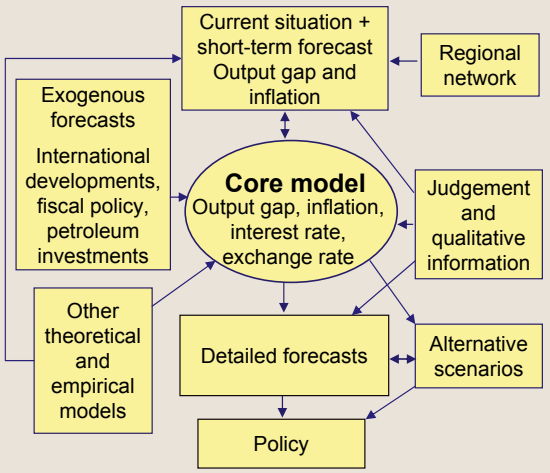
Norges Bank's forecasting forms an important part of monetary policy. In the work on forecasting, we analyse the current economic situation and the driving forces that will influence the economy in the period ahead. Since *Inflation Report 3/05,* demand, output and inflation forecasts have been based on Norges Bank's own interest rate forecasts. The forecasts of the interest rate and other economic variables are interdependent: the interest rate is influenced by developments in output and inflation, while interest rate developments must be assessed against the background of output and inflation forecasts. They indicate whether the interest rate forecast strikes a reasonable balance between the objectives of monetary policy. The forecasts of the interest rate and other variables are therefore made simultaneously in a multiple iteration process[2].

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

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

The analysis of the current economic situation and short-term developments is described in more detail in section 2. Section 3 describes the procedure for projecting developments further ahead.

Chart 1 Norges Bank's forecasting and policy analysis system



2 Analysis of current situation and short-term developments

Current situation

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

[1] We would like to thank Anne Berit Christiansen, Anne Sofie Jore, Kåre Hagelund, Amund Holmsen, Fredrik Wulfsberg, Nils Eide, Solveig Erlandsen, Kjersti Haugland and Einar W. Nordbø for useful input and comments. We would also like to thank other colleagues at Norges Bank.

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

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

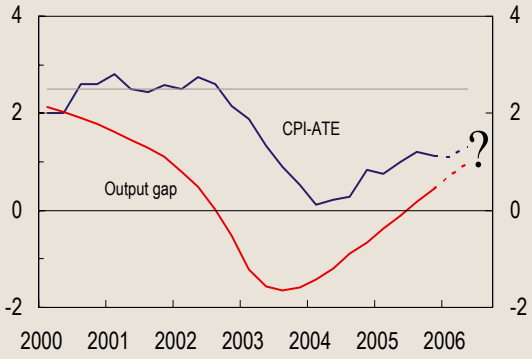
Norges Bank's regional network

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

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

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

Chart 2 CPI-ATE[1] and estimate of output gap[2]. Per cent. 2002 Q1 – 2006 Q2[3]



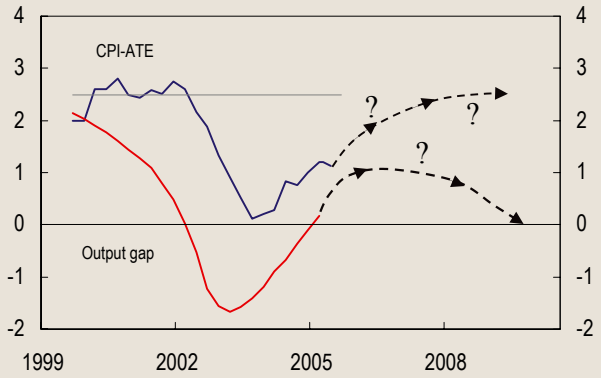
[1] CPI-ATE: CPI adjusted for tax changes and excluding energy products. A further adjustment is made for the estimated effect of reduced maximum day-care rates from January 2006.
[2] Quarterly figures for the output gap have been derived from annual figures.
[3] Estimate for period 2006 Q1 – 2006 Q2

The output gap

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

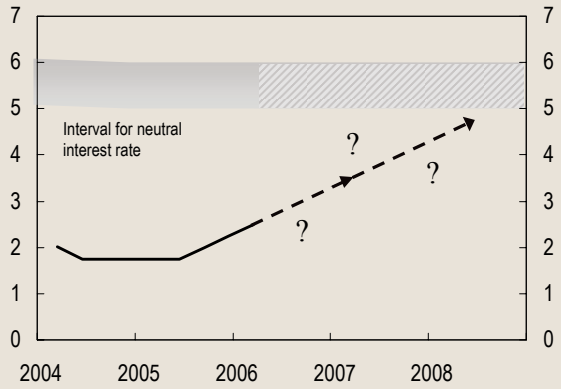
Our estimate of the output gap is the result of an overall assessment of available information concerning resource utilisation in the economy. Norges Bank's output gap estimates are based on several different methods and data sources, which may help to reduce the uncertainty of the estimates.[5]

Chart 3a Output gap and CPI-ATE



Sources: Statistics Norway and Norges Bank

Chart 3b Sight deposit rate

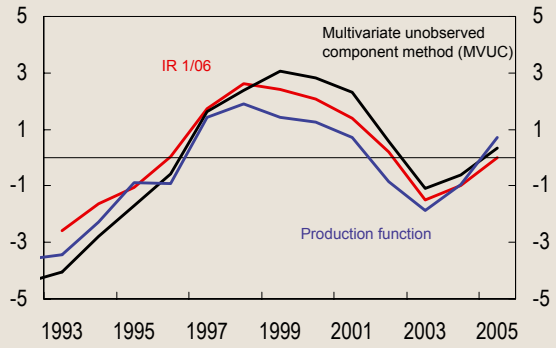


Source: Norges Bank

[4] See Haugland, Kallum and Sjåtil (2005) for a further discussion of Norges Bank's regional network.
[5] See box in Inflation Report 3/05 for a discussion of output gap uncertainty.

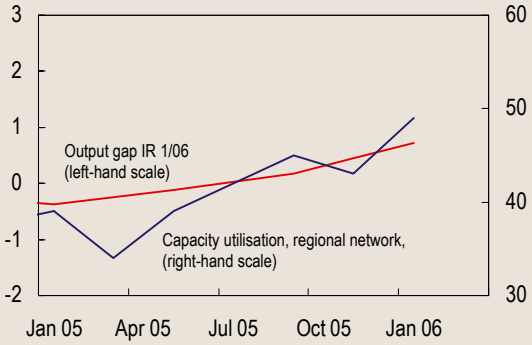
- We base our assessment of the output gap on technical calculations of trend growth in the Norwegian economy. There are a number of methods for estimating the output gap. The most commonly used methods generally provide the same picture of cyclical fluctuations over time (see Chart 4)[6]. At certain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

Chart 4 The output gap calculated using different methods



Source: Norges Bank

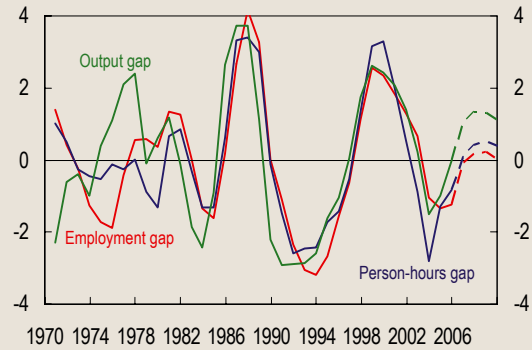
Chart 5 Capacity utilisation[1], Norges Bank's regional network and estimate of output gap[2]. Per cent. Jan 2005 - May 2006[3]



[1] Share of contact firms responding that they have some or considerable problems accommodating increased demand. Per cent.
[2] Quarterly figures for the output gap have been derived from annual figures.
[3] Estimate for period 06 Q1 – 06 Q2.

Source: Norges Bank

Chart 6 Employment gap, person-hours gap and output gap. Percentage deviation from trend[1]. 1970 – 2009[2]



[1] Trend calculated using HP filter. See Staff Memo 2005/2 (www.norges-bank.no) for further information.
[2] Projections for 2006 -2009.

Sources: Statistics Norway and Norges Bank

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

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

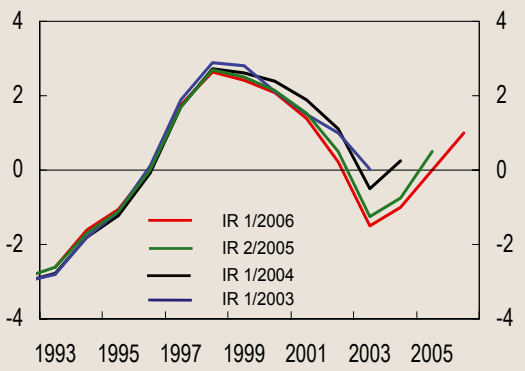
- Developments in financial variables can also provide information about capacity utilisation in the economy. Some financial indicators appear to correlate closely with the output gap, and in some cases can predict developments. See Gerdrup et al. (2006) for a more detailed account of these indicators.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

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

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

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

Chart 7 Estimates of the output gap in various Inflation Reports



Source: Norges Bank

Prices

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

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

Other indicators of underlying inflation may place less emphasis on groups of goods that historically have shown wide price fluctuations, or groups of goods that have recently exhibited particularly wide price changes. Examples of such indicators are trimmed mean inflation[7] and weighted median inflation[8], where the most extreme price changes each month are excluded from the basis of calculation (see Chart 8). See Jonasson and Nordbø (2006) for a discussion of various indicators of underlying inflation in Norway. Producer prices, wholesale prices and building costs also provide information about inflation.

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

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

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

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

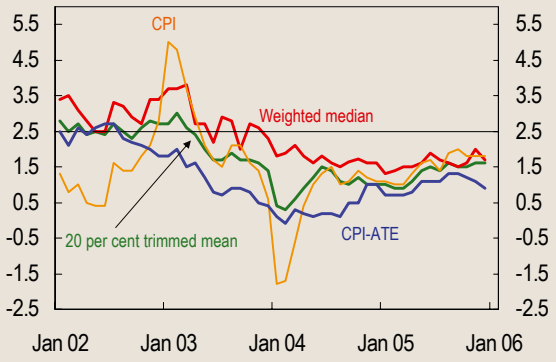
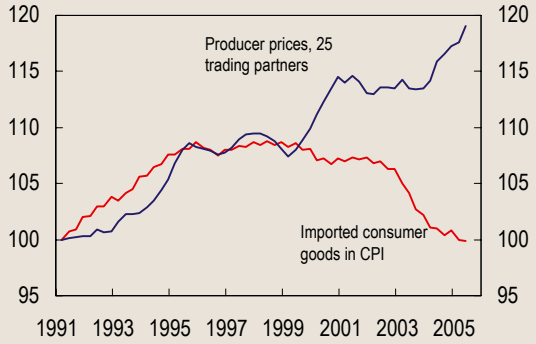


Chart 9 External price impulses to imported consumer goods. 1991 Q1 = 100



Sources: Statistics Norway and Norges Bank

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

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

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

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

More detailed analyses indicated that the low rise in prices for imported consumer goods was related to changes in our trade pattern.[10] A steadily increasing share of goods is imported from low-cost countries in Asia and central Europe. Importers' costs fall when suppliers in western industrialised countries are replaced by suppliers in countries with a substantially lower cost level. A portion of this fall in costs translates into lower retail prices for imported goods in Norway. For example, clothing prices fell markedly. At the same time, strong productivity growth in some industries internationally led to falling prices for many internationally traded consumer goods.

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

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

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

Short-term forecasts

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

9 See for example Campa and Goldberg (2002, 2005).
10 See box in *Inflation Report* 1/04.
11 See Røstøen (2004).

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

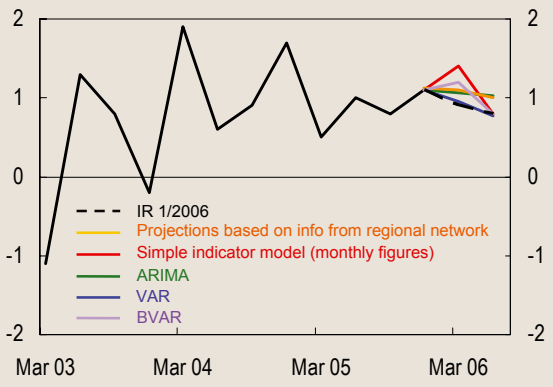
In the light of our knowledge of the current situation and recent history, we form a picture of short-term developments. We use information from short-term statistics, the regional network and other relevant sources to forecast developments in the various demand components – private consumption, public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

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

Univariate statistical models only make use of the historical variation in the actual series. ARIMA models[12] are used, which project numerical series on the basis of their own dynamics. Predictions from these models are useful for cross-checking variables such as inflation over the next few months. Experience indicates that univariate models yield relatively good consumer price projections for the next few months compared with other methods. For other variables, such as consumption and investment, these models are used primarily as an aid in assessing whether the observed fluctuations in the series are within the normal range of variation. They are also an aid in the work on assessing whether changes are due to random disturbances or new information.

Various types of VAR or Bayesian VAR (BVAR) models constitute a third tool for forecasting short-term developments.[13] The starting point for these models is historical relationships between two or more variables. In classical VAR models, the projection of each variable in the system is based on historical developments in the variable itself and in the other variables in the system. A VAR model with three variables may for example consist of mainland GDP, consumer prices and the short-term interest rate. A priori restrictions are imposed on coefficients in BVAR models. A common restriction is that recent historical values receive a higher weighting than values further back in time. However, the restrictions are not binding in this type of model.

Chart 10 GDP growth forecasts from different short-term models. Percentage change on previous year. Seasonally adjusted. Projection for 2006 Q1 and Q2



Sources: Statistics Norway and Norges Bank

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

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

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

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

[14] See Clements and Hendry (2004).

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

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

3 Forecasts further ahead

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

Projections of main variables

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

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

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

Such an approach may be appropriate in the context of forecasting, even though it is highly probable that the economy will also deviate from equilibrium in the future. The economy is constantly influenced by various disturbances that may be caused by domestic or external factors. Disturbances many years ahead are very difficult to foresee with any degree of precision, however. For example, very specific information is required to base the projections on the assumption that a disturbance will occur 3-4 years ahead or that the functioning of the economy will change substantially. In a forecasting context, we normally assume that the economy is not exposed to new disturbances.

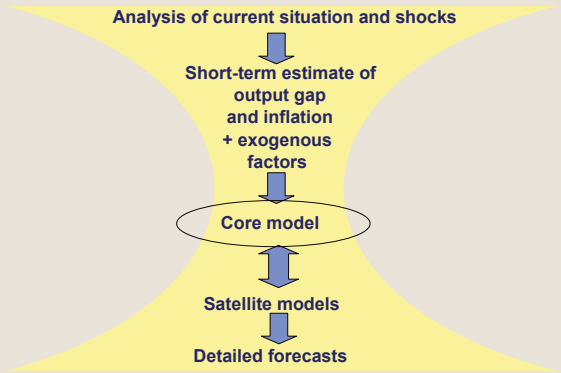
Quantifying the various economic variables in a long-term equilibrium is by no means straightforward. The equilibrium values of many economic variables are unobservable and may change over time. Nevertheless, it is necessary to make an assessment. The assessments may be based on historical developments,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

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

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

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

Chart 11 The forecasting process



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

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

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

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

One example of such a deviation is the influence on inflation of the shift in our imports towards low-cost countries. After first identifying this effect and assessing its significance for inflation now, we must decide how this shift will develop in the years ahead. What level will our share of imports from low-cost countries reach in the long term? How rapidly will this adjustment take place? How will the price levels in these low-cost countries develop in the future?

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

Criteria for an appropriate future interest rate path

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

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

Chart 12 Satellite model of the labour market

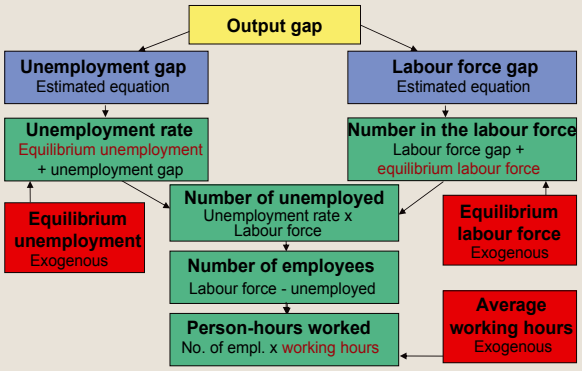
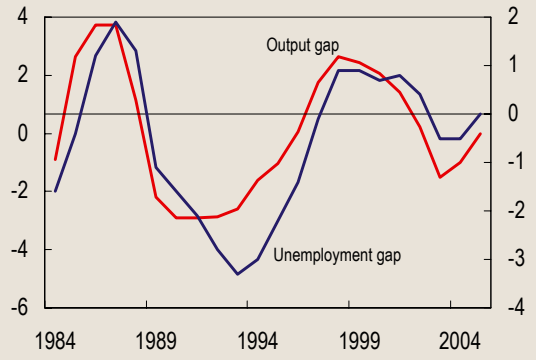


Chart 13 Unemployment gap and output gap



Sources: Statistics Norway and Norges Bank

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

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

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

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

Detailed forecasts

Based on an interest rate path that appears to be in line with the above criteria, more detailed forecasts for economic developments are produced. We are now looking at a larger set of variables than those in the core model. It is easier to compare this more detailed picture of the economic outlook with developments in the period between two Inflation Reports. In the light of the general picture, we forecast developments in the most important demand components, such as private consumption, investment and foreign trade. At the same time we assess developments in employment, unemployment and wages. For these more detailed projections we use the system of smaller supplementary models. These models contain estimated relationships between the variables in the core model and the most important variables on the supply and demand side of the economy are built into them.

The structure of the supplementary model of the labour market is illustrated in Chart 12. We use the historical covariation between output, unemployment and the labour force over the business cycle to project developments in the labour market. An unemployment gap can be estimated in the same way as the output gap. The unemployment gap can be defined as the percentage difference between actual unemployment and estimated trend unemployment. Our estimates indicate that there has been a close correlation between the output gap and the unemployment gap in Norway for the last 20 years (see Chart 13). Unemployment is below trend during cyclical upturns and above trend during downturns. The relative variation in the two gaps appears to have been fairly stable over time. Experience shows that mainland GDP fluctuates about twice as much around its trend level as unemployment. If output is 2 per cent higher than its trend level, unemployment has tended to be about 1 per cent lower. The relationship between fluctuations in output and unemployment is known in academic literature as Okun's law[16], and appears to hold fairly true for Norway. By using this relationship together with the estimate of the output gap, we can forecast developments in the output gap. The unemployment gap, an analogous labour force gap, and exogenous estimates of equilibrium values in the labour market are used to forecast developments in the number employed and person-hours worked.

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

[15] See *Norges Bank Working Paper* no. 5/2006: "When does an interest rate path 'look good'? Criteria for an appropriate future interest rate path." (Qvigstad 2006).
[16] See Burda and Wyplosz (2005).

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

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

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

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

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

4 Concluding comments

Norges Bank's projections in the *Inflation Report* are conditioned by a number of factors. They are shaped by the assessment of the current situation, estimates of exogenous variables, quantification of economic relationships and the characteristics of the economy in equilibrium. In addition, the projections are determined by the Executive Board's assessment of trade-off between the different objectives of monetary policy. When the underlying premises change, the projected developments in the interest rate and other economic variables will also change.

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

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

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

References

Bergo, Jarle (2006): "Projections, uncertainty and choice of interest rate assumption in monetary policy", speech on 27 January 2006, http://www.norges-bank.no/front/pakke/en/foredrag/2006/2006-01-27/

Bjørnland, Hilde C., Leif Brubakk and Anne Sofie Jore (2004): "The output gap in Norway – a comparison of different methods", *Economic Bulletin 2/05,* pp. 90-100

Burda, Michael and Charles Wyplosz (2005): *Macroeconomics: A European Text.* Oxford University Press

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

[18] See Svensson (2003).

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

Campa, Jose M. and Linda S. Goldberg (2005): "Exchange Rate Pass Through into Import Prices", *The Review of Economics and Statistics* 87(4), pp. 679–690

Campa, Jose M. and Linda S. Goldberg (2002): "Exchange Rate Pass Through into Import Prices: A macro or micro phenomenon", *NBER Working Paper* no. 8934

Clements, M.P. and D.F. Hendry (2004): "Pooling of forecasts", *Econometrics Journal,* 7 (1), pp. 1-31

Gerdrup, Karsten and Roger Hammersland (2006): "Financial variables and developments in the real economy", *Economic Bulletin* 3/06, pp. 133-146

Haugland, Kjersti, Jan-Reinert Kallum and Maja Sjåtil (2005): "Norges Bank's regional network", *Economic Bulletin* 3/05, pp. 155-161

Husebø, Tore Anders, Sharon McCaw, Kjetil Olsen and Øistein Røisland (2004): "A small, calibrated macro model to support inflation targeting at Norges Bank", *Staff Memo* 2004/3, Norges Bank [URL: http://www.norges-bank.no]

Jacobsen, Dag Henning and Bjørn E. Naug (2004a): "What influences the growth of household debt?" *Economic Bulletin* 3/04, pp. 103-111

Jacobsen, Dag Henning and Bjørn E. Naug (2004b): "What drives house prices?" *Economic Bulletin* 1/05, pp. 29-41

Jonassen, Morten and Einar W. Nordbø (2006): "Alternative indicators of core inflation for Norway", Article presented at UNECE/ILO meeting on consumer price indices in Geneva, 10-12 May 2006. http://www.unece.org/stats/documents/2006.05.cpi.htm

Røstøen, Johan Øverseth (2004): "External price impulses to imported consumer goods", *Economic Bulletin* 3/04, pp. 96–102

Svensson, Lars E. O. (2003): "The Inflation Forecast and the Loss Function", *CEPR Discussion Paper* no. 3365

Qvigstad, Jan F. (2005): "Policy-making and models at Norges Bank", *Norges Bank Staff Memo* 5/2005, www.norges-bank.no

Qvigstad, Jan F. (2006): "When does an interest rate path 'look good'? Criteria for an appropriate future interest rate path", *Norges Bank Working Paper* 5/2006, www.norges-bank.no

Is the market microstructure of stock markets important?

Randi Næs, senior adviser, and Johannes Skjeltorp, researcher, both in the Research Department

The market microstructure literature studies how the actual transaction process – i.e. how buyers and sellers find one another and agree on a price – can affect price formation and trading volumes in a market. This article provides an introduction to the concepts, frameworks and most important themes in this literature. The market serves two functions: one is to provide liquidity for buyers and sellers; the other is to ensure that prices reflect relevant information about fundamental value. Microstructure models differ from traditional financial models by recognising that legitimate information about companies' fundamentals may be unequally distributed between, and differently interpreted by, market participants. We can therefore no longer assume that prices will reflect information immediately even if all participants are rational. The microstructure literature argues that both information risk due to asymmetric information and differences in liquidity over time and between companies impact on long-term equilibrium prices in the market.

1 Introduction

If participants in the stock market behave rationally and have the same information, share prices will at all times reflect all available information about companies' fundamental value. Since it was first advanced in the 1960s, this has been one of the most important hypotheses in financial economics. However, over the last 20 years, both the theoretical foundation for this hypothesis and the previously strong empirical support for it have been challenged.

The microstructure literature challenges the hypothesis of efficient markets by studying how prices can deviate from (or converge towards) informationally efficient equilibrium prices as a result of rational participants behaving strategically (Biais et al., 2004).[1] Strategic behaviour can be put down to unequal access to information[2] or to limited liquidity[3] in the secondary market. While the efficient market hypothesis abstracts from the actual process which leads to buyers and sellers finding one another and agreeing on a price, the microstructure literature focuses on the functions performed by the marketplace.

Themes in the microstructure literature divide naturally into three: (i) the actual transaction process, (ii) the effects of market structure and trading rules on the transaction process, and (iii) the transaction process's implications for fundamental economic decisions. This subdivision also largely reflects the chronological development of this research field.

Models of the transaction process are described in section 2 below. There are two main groups of model. The first (inventory models) studies how an intermediary (hereinafter referred to as dealers, see figure 1) can solve the problem of buyers and sellers not being present in the market simultaneously. The second (information models) analyses how information which is asymmetrically distributed between participants in the market is reflected in the prices of securities.

Research into the significance of market structure and trading rules is the subject of section 3 below. The importance of the organisation and design of the stock market came to the fore in the wake of the crash of 1987 and the revelation of collusion among the dealers on NASDAQ in 1994. There has since also emerged a considerable body of literature on the effects of market fragmentation and competition from new electronic trading systems.

Microstructure research rejects the hypothesis that the transaction process and the organisation of markets have no effect on the prices of securities. However, this does not necessarily mean that microstructure is important for our understanding of fundamental economic decisions. In section 4 we discuss a group of studies which look at whether the stock market's microstructure can also have long-term effects on prices and returns. Section 5 then sums up the most important contributions from the literature and highlights key themes and challenges in ongoing research.

2 The transaction process

2.1 Dealer markets versus limit order markets

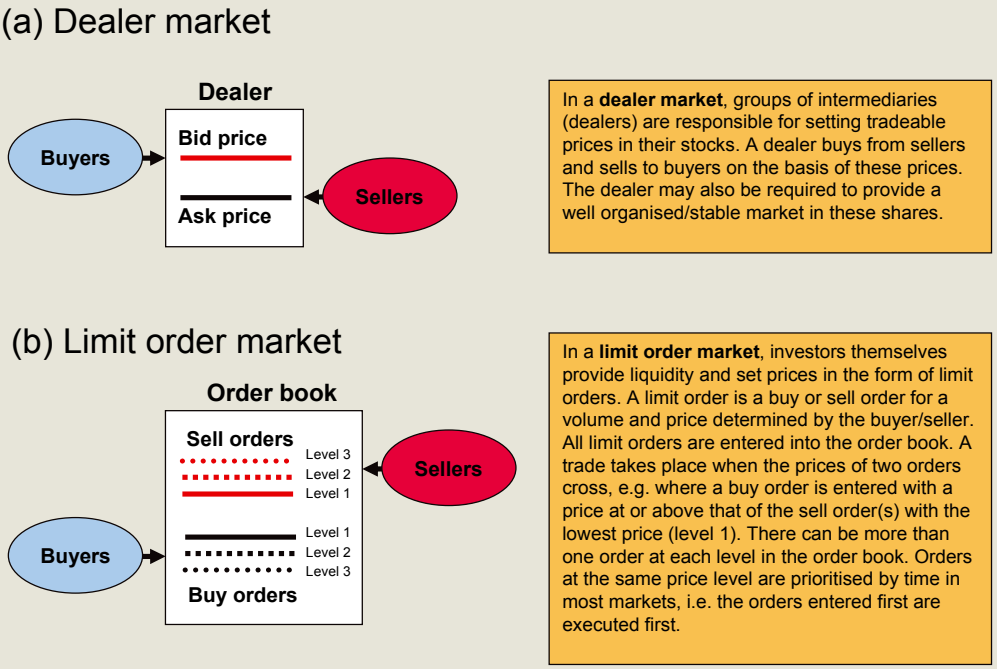
A fundamental function of a market is to ensure that buyers and sellers find one another and have the opportunity to trade when they want to. One way of resolving the problem of coordination between buyers and sellers is to involve a dealer who undertakes to sell when

[1] The behavioural finance literature challenges the assumptions that investors are rational and have unlimited arbitrage opportunities, see, for example, Schleifer (2000).

[2] It is important to stress that, when talking about unequal access to information, we are not thinking of access to illicit inside information. For natural reasons, investors will differ in their ability and inclination to collect and analyse information. For example, large institutional investors, such as banks and insurers, have far greater resources than private investors and are therefore in a better position to obtain and analyse new information.

[3] In this article we use liquidity in the sense of how readily a share can be bought and sold in the secondary market.

Figure 1 Types of markets



somebody wants to buy, and to buy when somebody wants to sell. A trading system of this kind is illustrated in Figure 1(a).[4] To be able to perform this function, the dealer must ensure that he has an adequate inventory of shares. In return for providing this liquidity for buyers and sellers in the market, the dealer earns the difference between the bid price and the ask price (spread).

Another way of resolving the coordination problem is to gather together all buy and sell orders in a limit order book. Figure 1(b) illustrates a market of this kind. Buyers and sellers choose themselves whether they wish to provide liquidity by placing limit orders (orders to buy or sell at a given price) or demand liquidity by placing market orders (orders to buy or sell at the current price in the limit order book). In other words, a limit order market is not dependent on dealers. Trades are generated by electronically matching orders on the basis of set rules, orders typically being prioritised first by price and then by the time they were submitted to the market.

Some markets, known as hybrid markets, have come to include elements of both types of market. One example of a market of this kind is the New York Stock Exchange (NYSE), which has evolved from a dealer market into a hybrid market where the bulk of trading goes through the limit order book but where dealers (known as specialists) have to set prices if liquidity in the stocks for which they are responsible is too low. In limit order markets, there are solutions where brokerage houses enter into agreements with listed companies to act as dealers in these companies' shares. Among other things, the broker must then ensure that the spread between bid and ask prices is not too large.[5]

2.2 Inventory models

Demsetz (1968) was the first to point out that there are costs associated with transacting shares. Besides explicit costs (such as stock exchange fees and brokers' commissions), there is also an indirect cost associated with getting to trade when you want to. As buyers and sellers do not necessarily need to trade at the same time, Demsetz argues that investors wanting to buy quickly must pay a higher price to motivate patient sellers to sell (and vice versa). Another important implication of his analysis is that the price at which you trade depends on whether or not you wish to buy or sell quickly, i.e. that there are two equilibrium prices rather than one.

The first microstructure models assumed optimal dealer behaviour. Garman (1976) looks at how a risk-neutral monopolistic dealer will set bid and ask prices in order to maximise expected profit per unit of time. The dealer wants to set prices to avoid bankruptcy, but must also ensure that prices are not set in such a way that his inventory empties. In Garman's model, the dealer sets

[4] There are a number of different terms for the intermediary between buyers and sellers in the stock market: market-maker, broker, dealer, specialist. We have chosen to use the term dealer. Specialist refers specifically to a dealer on the New York Stock Exchange (NYSE). Each stock on the NYSE has just one specialist, who has a duty to buy or sell up to a particular volume and is also responsible for ensuring a well organised/stable market in these shares. Dealers in other markets do not always have such stringent obligations. For example, there are often several different dealers in a particular stock.

[5] Weaver et al. (2004) look at the effect of such agreements on the Stockholm Stock Exchange and find that companies entering into such agreements see a clear improvement in liquidity in the secondary market. They also find support for a positive price effect for companies entering into these agreements which can be attributed to this improved liquidity.

prices once, after which buyers and sellers arrive in the form of two independent Poisson processes[6]. Garman shows that it is optimal for the dealer to set different bid and ask prices, and that both prices will be functions of the frequency at which buyers and sellers arrive. Thus his model explains why there is a positive spread in a dealer market.

Amihud and Mendelson (1980) expand Garman's model into a multi-period model where the dealer balances his inventory over time by changing his prices in each period. This model shows that optimal bid and ask prices fall monotonically with the size of the dealer's inventory. In other words, the dealer lowers both bid and ask price in response to a growing inventory (and vice versa when his inventory shrinks). This behaviour is known as quote shading. Thus Amihud and Mendelson's model also means that the dealer sets a positive spread; what is new in this model is that the optimal pricing strategy also takes account of the dealer wanting to keep his inventory of shares at a given level. Madhavan and Smidt (1991, 1993) and Hasbrouck and Sofianos (1993) find empirical support for dealers actually having such a desired inventory level, but also for them appearing to be willing to move away from this desired position for long periods. One empirical implication of inventory effects and quote shading is that they lead to a return towards "normal" stock returns (mean reversion).

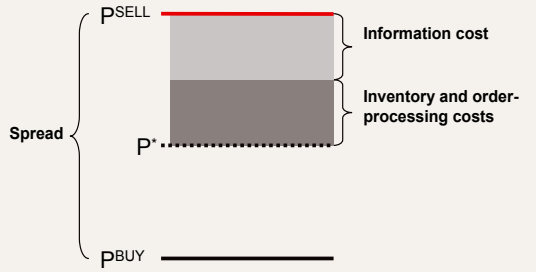
The main outcome of these inventory models is that dealers set bid and ask prices in such a way as to cover their order-processing and inventory-keeping costs.

2.3 Information models

The information models are to a great extent inspired by the insight of Bagehot (1971) that trading also entails a cost associated with some investors having better information than others. Like all other investors, informed investors can choose whether they want to trade or not, unlike the dealer who must always trade at the prices he sets. This means that, in cases where an informed investor wishes to trade, the dealer will always lose money. Copeland and Galai (1983) show that a dealer who cannot distinguish between informed and uninformed investors will always set a positive spread to compensate for the expected loss that he will incur if there is a positive probability of some investors being informed.

By expanding Copeland and Galai's model into a sequential trade framework, Glosten and Milgrom (1985) show how private information will be incorporated into prices over time. In their model, the dealer and other uninformed investors learn what the correct price is by observing the order flow. Thus the dealer takes account of information in the order flow when setting his prices. In this way, prices converge towards informationally efficient prices. However, the model says little about how quickly prices will converge on informational efficiency. Easley and O'Hara (1987) expand this framework to take account of a strategic element in the dealer's dilemma. In this model both informed and uninformed investors can choose between trading large or small volumes. If informed investors compete with one another, they will always want to trade large volumes in order to maximise their profit. The dealer can therefore set a different spread based on the behaviour of informed investors: investors placing small orders pay no spread, while investors wanting to make large trades have to pay a positive spread. If the informed investors know the dealer's strategy, they will want to mix their orders with those of uninformed investors (known as stealth trading). However, they will still tend towards large orders as they are also competing to exploit their private information before it is revealed and reflected in prices. In this case investors wanting to make small trades will also have to pay a positive spread, but this spread will be lower than that for large orders.

Figure 2 Composition of the dealer´s spread



P^{SELL} and P^{BUY} are the best prices (level 1) in the order book or the prices at which the dealer is willing to sell and buy respectively. The difference between these two prices is the spread. P* is the spread midpoint and what is often thought of as the equilibrium price. The distance between P* and P^{SELL} (or P^{BUY}) can be divided into one component compensating for the risk associated with selling to (buying from) a better-informed investor, and one component relating to inventory and order-processing costs.

The main outcome of the early studies of the transaction process is that the spread has one component relating to information costs and one relating to inventory costs. This is illustrated in Figure 2, where P* is the equilibrium price and P^{SELL} is the price which a *buyer* has to pay to cover the dealer's two cost components. Similarly, a *seller* has to sell at a price below the equilibrium price in order to cover the dealer's cost components, which will be the difference between P* and P^{BUY}.

A more recent group of information models assumes that liquidity providers can also behave strategically as a result of having market power or access to private information. The development of these models coincides with the emergence of order-based trading systems.

Several single-period models show how prices will depart from equilibrium prices under full competition if the number of liquidity providers is limited and infor-

[6] A Poisson process is a random process which describes the probability of a number of events (in this case the number of arrivals of buyers and sellers) of a particular type within a given time interval.

mation costs are ignored, see Klemperer and Meyer (1989), Biais, Foucault and Salanie (1998) and Roell (1999). Calcagno and Lovo (1998) show that dealers who have private information will introduce "noise" in their quotations to avoid disclosing this information, but that quotations and trades will nevertheless reveal some information to the market.

There are also dynamic models studying optimal strategies for liquidity providers in limit order markets. Parlour (1998) shows that liquidity providers in limit order markets face a trade-off between price and time priority. Foucault (1999) shows that it will be optimal for investors to provide liquidity through limit orders when the spread is high. Conversely, it will be optimal to consume liquidity through market orders when the spread is low.

The main outcome of these recent information models is that liquidity providers with market power will earn oligopoly rents. This prediction is supported by, among others, the empirical studies of Christie and Schultz (1994) and Christie et al. (1994), which led to the revelation of price-fixing by dealers on the NASDAQ exchange.

2.4 The size of transaction costs

Keim and Madhavan (1998) divide total transaction costs into an explicit component and an implicit component. Explicit costs consist primarily of brokers' commissions, while implicit costs include the spread, possible price impacts as a result of a trade, and the opportunity cost associated with not getting to trade at the desired time. A large part of the empirical microstructure research attempts to estimate transaction costs, especially the implicit costs of trading.

Estimating transaction costs is far from unproblematic. The different cost components are difficult to untangle from one another, and the data sets available typically consist of individual trades which are in many cases only parts of a larger transaction. We cannot therefore draw conclusions about total transaction costs based on estimates of unqualified cost components from different empirical studies. To be able to make a sensible estimate of transaction costs, detailed information about a trade is required right back to the time when the buyer or seller decided to trade. This is information which very few investors wish to share with the public. In recent years, there have nevertheless been several studies based on sufficiently detailed data from portfolio managers and investors. These data make it possible to estimate more precisely the cost associated with the entire transaction process, and so to obtain qualified cost estimates. The main outcome of these studies is that the implicit cost component may be considerable, relative to both explicit costs and realised portfolio returns, see Madhavan (1998).

3 The significance of market structure

On 19 October 1987, the Dow Jones index fell by 22.6 per cent without it being possible to point to any new information about companies' fundamental value.[7] This sparked off a lively debate about the significance of market structure and trading rules for price formation in the stock market. One important theme in the debate was the level of transparency, i.e. the amount of information about the transaction process to which participants in the market should have access. Christie and Schultz's revelation of price-fixing by NASDAQ dealers a few years later triggered fresh debate about market structure, this time with the emphasis on setting rules for providers of liquidity. The emergence of electronic limit order markets, where buyers and sellers provide liquidity themselves without having to go through a dealer, has contributed to further discussion of the role of dealers in the trading of securities. Another important theme has been the welfare implications of the stiff competition seen between traditional stock markets and new electronic market systems, including what stance the authorities should take on market fragmentation. One final theme is whether trading should be continuous or periodic. In a continuous trading system, participants can trade whenever they want; in a periodic system (auctions), trading is allowed only at specific points in time. Mendelson (1982) shows that periodic auctions are preferable from an efficiency perspective. This applies particularly to illiquid stocks when there is considerable uncertainty about fundamental value or the danger of a market downturn. In practice, however, it appears that demand for continuous trading is considerable.

If we look at existing stock markets around the world, there are major variations in market structure. While the US stock market consists of many different trading systems, most European countries have a centralised electronic trading system. Advances in electronic communications have meant that all major stock exchanges now operate with some form of limit order book. However, many exchanges remain dependent on dealers in various ways. When it comes to continuous versus periodic trading, the trend appears to be for markets to offer continuous trading while exploiting the efficiency of auctions at times when this is particularly important, such as at the opening or closing of the exchange and following special events when trading is suspended for a time.

3.1 Transparency

Dealer markets typically feature much lower levels of transparency than limit order markets. This goes for how much information is made public, who receives the information, and when the information is published. A

[7] The crash on Black Monday was almost twice as big as that on 29 October 1929, when the market fell by 11.7 per cent and triggered what would come to be known as the Great Depression.

number of theoretical studies have shown that increased transparency results in better liquidity and reduced transaction costs, see Admati and Pfleiderer (1991), Chowdhry and Nanda (1991), Forster and George (1992) and Benveniste et al. (1992). However, Madhavan (1995) shows that transparency can also reduce liquidity, because participants not wanting to reveal their interest in buying or selling will withdraw their orders from the market. Empirical and experimental studies have not come up with unambiguous results either when it comes to this issue. However, the literature is unanimous that participants trading on the basis of private information will prefer anonymous trading systems, while participants trading on the basis of pure liquidity needs – and particularly those who cannot signal this – will prefer high transparency. This means that changes in transparency will benefit some participants at the expense of others.

3.2 The dealer's role

The literature does not provide any unambiguous explanation of why so many stock exchanges are still largely based on dealers. One explanation is that it is too expensive for providers of limit orders to follow up the market. Another explanation is that dealers reduce the information costs in the market by having extensive contact with brokers (Benveniste et al. 1992). However, other studies argue that dealers increase information costs because they can trade at different times to other liquidity providers. For example, when a limit order is sent to the trading floor on the NYSE, the specialist can choose to step into the order and so stop it before it reaches the order book. A similar problem arises when opening the market, as the dealer can place his orders after all the other participants.

3.3 Market fragmentation

One noteworthy feature of many countries' stock markets is a persistently high degree of market fragmentation. In 2004, for example, NASDAQ's SuperMontage executed only around 17 per cent of the trading volume in the companies listed on NASDAQ, while the NYSE executed 78 per cent of trading by volume in the companies listed on the NYSE. In the USA, advances in electronic communications have meant that the traditional stock exchanges have run up against stiff competition from "alternative" trading systems, i.e. electronic limit order markets (ECNs) and crossing networks.

Crossing networks differ from other trading systems in that they do not contribute to price formation. Instead buyers and sellers agree to use a price from another marketplace, typically the closing price on the day the crossing transaction is carried out, or the value-weighted average price over the day.

Mendelson (1987) shows that market fragmentation can have both advantages and disadvantages. The disadvantages of fragmentation relate to reduced liquidity and increased price volatility in each submarket; the advantages relate to the increased quality of price signals. Thus the potential advantages of fragmentation do not apply to crossing networks, as they do not contribute to price formation.

Chowdry and Nanda (1991) argue that we should see the markets consolidating over time. This is because both informed and uninformed investors will benefit from flocking around a large exchange: informed investors because it is easier for them to hide their trades in a large order flow; uninformed investors because costs will be lower the more other uninformed investors there are in the order flow. Easley et al. (1996) argue that alternative marketplaces can survive in competition with a primary market by "skimming the cream" of the order flow, i.e. by offering uninformed investors a cheap alternative. A competing explanation is that a marketplace can complement the primary market by providing an opportunity for mutually beneficial transactions of large illiquid orders, see Seppi (1990). Several empirical studies find support for the hypothesis that alternative marketplaces compete with the primary market and "skim the cream" of the order flow, see Fong et al. (1999), Næs and Skjeltorp (2003) and Conrad et al. (2003). Chowdry and Nanda's arguments in favour of consolidation are based on an assumption of full competition in the market for liquidity providers. Two empirical studies find that fragmentation may be preferable for liquidity providers with market power, see Blume and Goldstein (1997) and Bessembinder and Kaufman (1997).

Næs and Skjeltorp (2003) find signs that crossing networks in the USA compete in the most liquid segment of the stock market. Simple simulations of trades carried out by the Norwegian Government Petroleum Fund in 1998 show that the transaction costs associated with crossing are very low. Based on extensive data from institutional investors in the US market, Conrad et al. (2003) came up with similar and more robust results. Transaction costs for trades through alternative trading systems are substantially lower than those for trades through traditional exchanges, especially for the most liquid shares. However, Næs and Ødegaard (2006) find that the cost savings achieved using crossing networks are partially offset by a cost associated with adverse selection. Informed investors in the network will reduce the probability of crossing good stocks, and increase the probability of crossing bad stocks. In line with this hypothesis, the authors find that the companies that cannot be bought in the network show a risk-adjusted excess return relative to the stocks that can be bought. These costs are not captured by the empirical measures of transaction costs used in the literature.

4 Long-term effects of the market's microstructure

In this section we look more closely at the literature studying the significance of market microstructure for long-term portfolio selection. This section is based largely on O'Hara (2003).

A market serves two important functions: one is to provide liquidity for buyers and sellers; the other is to ensure that new information is reflected in the prices of securities. For a market's microstructure to be able to impact on long-term portfolio selection, liquidity and/or underlying information risk must therefore impact on investors' long-term decisions.

4.1 Is there a liquidity premium?

There is an extensive body of literature concerning the relationship between transaction costs and expected stock returns. Theoretical studies generally find that transaction costs have insignificant effects on expected returns. The most cited work is Constantinides (1986). Constantinides looks at the effects of introducing a proportional transaction cost in a model where investors can invest in two assets and maximise the utility of an infinite consumption stream. Average demand for an asset falls sharply following the introduction of a transaction cost. Nevertheless, the transaction cost has only a second-order effect on the return on the asset in equilibrium. The expected utility of the future consumption stream is not sensitive to the deviations in asset allocation which the transaction cost entails.

Contrasting with these works are several studies which reveal an empirical relationship between returns and liquidity costs. The first and best-known of these studies is an article by Amihud and Mendelson dating from 1986 where they look at the relationship between stock returns, market risk (measured as beta) and spread for a selection of stocks on the NYSE during the period from 1961 to 1980. The data support the authors' hypothesis that expected return is an increasing and concave function of relative spread. The study links the liquidity premium to the level of the liquidity cost: stocks with high liquidity costs have higher returns than those with low liquidity costs. In the short term, if the cost associated with liquidity is high enough, this will obviously impact on the net return. But are these effects really big enough to influence returns in the longer term?

Amihud and Mendelson explain their results with a model where investors differ from one another by having different investment horizons. These investors buy and sell assets as part of a portfolio selection problem and have to pay transaction costs in the form of a spread. The model shows (i) that investors demand a higher return the higher the spread, and (ii) a clientele effect which moderates this excess return, especially for assets with the highest spread. Only investors with a long horizon will hold the most illiquid assets. In equilibrium, this means that return is an increasing and concave function of spread. Thus Amihud and Mendelson view spread as a kind of tax which some investors avoid by removing the stock from their portfolio, while others choose to pay this tax in return for compensation. The model also postulates that expected return net of transaction costs increases with the investment horizon, such that stocks with a high spread give their owners a higher net return. This means that investors with a long investment horizon can benefit from holding shares with a high spread.

Table 1 presents a much simplified version of Amihud and Mendelson's analysis applied to Norwegian data. The table shows the monthly return on five value-weighted portfolios of companies listed on the Oslo Stock Exchange, sorted by relative spread[8] during the period from 1980 to 2002.[9]

These data suggest that there may also be a liquidity premium in the Norwegian stock market. Average return, median return and maximum return are highest for the portfolio with the highest spread, and lowest for the portfolio with the lowest spread. Similarly, the minimum return is lowest/highest for the portfolio with the lowest/highest spread. The relationship between the standard deviation of the return and spread is less clear. Note that these figures have not been adjusted for market risk.

Amihud and Mendelson's article has been followed by numerous studies of the relationship between spread and return. Some find a link; others do not. One criti-

Table 1 The relationship between return and spread on the Oslo Stock Exchange (1980-2002)

Portfolio	Return (%)				
	Average	SD	Minimum	Median	Maximum
1 (lowest spread)	1.67	6.8	-27.3	19.93	19.9
2	2.43	7.6	-26.7	2.72	30.7
3	2.45	6.9	-18.7	2.38	25.2
4	3.07	7.8	-17.7	2.13	41.3
5 (highest spread)	3.55	7.7	-22.0	2.73	36.8

[8] Relative spread is the difference between the highest bid price and lowest ask price divided by the average of these two prices.

[9] The figures in the table were calculated by Bernt Arne Ødegaard at the Norwegian School of Management. The selection is limited to companies with a market value of more than NOK 1 million and a minimum number of days traded during the year of 20. Companies with a share price below NOK 10 have also been excluded. The portfolios have been constructed on the basis of the average relative spread the previous year.

cism that has been levelled at these studies is that the positive relationship between return and spread may be due to the return not being correctly risk-adjusted. The argument here is that the spread is derived from prices, and prices can be correlated with the asset's market risk (market beta), such that any relationship between spread and return may be due to error in measuring the company's risk.

If the level of liquidity costs is priced into the market, investors who have a long investment horizon – and are therefore less dependent on good liquidity – may earn a premium from investing in illiquid assets.

Another group of studies explores whether there is also a relationship between stock returns and fluctuations in liquidity costs, i.e. whether expected illiquidity in the market as a whole impacts on expected stock returns. The hypothesis is that liquidity costs vary with time for the market as a whole, and that investors demand compensation for carrying this market-related risk.

Amihud (2002) finds support for this view. He measures the market's liquidity as the average daily absolute return over (dollar) trading volume on the same day. Liquidity is good if this liquidity measure is low, as this means that more volume is needed to move prices, and vice versa. Amihud also assumes that investors expect this variable to follow an autoregressive process. The hypothesis is that a reduction in expected market liquidity has both an income effect and a substitution effect. All companies will see a drop in prices to compensate for reduced liquidity. However, since investors will tend to substitute away from the least liquid companies in favour of more liquid companies, there will also be an increase in some prices. Two other studies which explore whether expected return is a function of the variability in liquidity are Chordia et al. (2001) and Pástor and Stambaugh (2003). Chordia et al. test whether risk-averse investors demand a higher expected return from companies with high variability in company-specific liquidity, measured as volatility in trading volume. They do not find support for this hypothesis. In contrast, they find a significant negative relationship between return and variability in company-specific liquidity. Pástor and Stambaugh (2003) test whether systematic (rather than company-specific) liquidity risk is important for companies' expected returns. If systematic liquidity risk is priced, companies whose return is closely correlated with fluctuations in market liquidity will have a higher expected return than companies whose return has a low correlation with fluctuations in market liquidity. Pástor and Stambaugh find support for this hypothesis when volatility in market liquidity is measured as average volatility in order flows across all companies. Adjusted for market risk and exposure to other risk factors (size, book value relative to market value, and momentum), companies with the highest liquidity risk show an annual excess return of 7.5 per cent relative to companies with a low liquidity risk.

Although support has been found for a relationship between liquidity risk and expected return, these results still remain to be explained. So far, the literature has offered no simple, testable theories for how liquidity risk should be priced. Asymmetrical information can hardly be the main explanation, as it is hard to imagine any investors having private information about broad market movements. Pástor and Stambaugh (2003) suggest that investors care about liquidity risk because their wealth has a tendency to fall when the market becomes less liquid (and transaction costs rise). A drop in the value of their wealth can also result in a need to liquidate part of the portfolio at a time when it is expensive to trade. This will be particularly important where a portfolio with high liquidity exposure is debt-financed and the drop in the value of the investor's wealth forces expensive sales to cover margin requirements. One example of how important this liquidity risk can be is the collapse of Long Term Capital Management (LTCM) in 1998. LTCM had extremely high liquidity exposure in its global portfolio, which consisted of a short position in liquid instruments and a long position in less liquid instruments. The Russian debt crisis led to the company's portfolio falling dramatically in value, which resulted in the company being forced to liquidate an increasingly large part of its portfolio to meet margin requirements. Ultimately, the whole portfolio was liquidated. In the years prior to the debt crisis, this liquidity position yielded an extremely high realised return, which Pástor and Stambaugh believe to be a reflection of the high liquidity risk at LTCM.

4.2 The significance of information risk

Known pricing models, such as the capital asset pricing model (CAPM), consumption-based CAPM and arbitrage pricing theory (APT), all build on investors having symmetric information about expected return and risk for all assets in the market. One justification for this simplification has been that information is only important for the market as a whole. The price of a share is determined by the return's covariance with the return on all shares, as no investor will hold idiosyncratic risk in equilibrium. It can therefore be assumed that all participants have symmetric information, even though this is not necessarily the case for individual stocks.

One problem with this justification is that the balance between expected return and risk is dependent on being able to calculate the market's expectations. What if we do not have the same information? Whose expectations are we then calculating? O'Hara (2003) shows that, if information is asymmetrically distributed, and if those who do not have information know that others know more, we will not get an equilibrium where everyone holds the market portfolio. Uninformed investors will hold a larger share of assets which informed investors

expect to perform poorly. They will demand compensation for this, and we will then no longer have a situation where idiosyncratic risk is not priced.

There are several empirical studies which attempt to estimate the effect of information costs. Brennan and Subrahmanyam (1996) find a positive relationship between return and information costs, where information costs are measured as the coefficient in a regression which relates price changes to the size and sign of order flows (Kyle's lambda). In Kyle's model, lambda arises on account of informed investors behaving strategically, i.e. lambda is a measure of adverse selection. Brennan and Subrahmanyam argue that unfavourable selection is the primary cause of illiquidity, and use Kyle's measure as a proxy for these costs. Easley, Hvitkjaer and O'Hara (2003) look at the relationship between return and an estimate of the probability of informed trading (PIN). The PIN is estimated by looking at the relationship between the number of buy and sell orders during the course of a day. If there are no informed trades, this relationship should be close to 50/50. An excess of trades on one side of the market suggests informed trading. This measure proves to have an economically and statistically significant effect on return, even after correction for beta and Fama/French risk factors (size and book value relative to market value).[10]

It has long been claimed in investment theory that unequal access to information about a company is important for the company's capital costs, see, for example, Mayer and Majluf (1984). This does not tie in well with the pricing models from financial theory, because the distribution of information about individual companies represents idiosyncratic risk which is not supposed to play any role in expected return in equilibrium. O'Hara's model can explain this apparent discrepancy. The model can also help to explain the equity premium puzzle: if uninformed investors demand company-specific compensation for risk, they will hold more bonds in equilibrium. A third application is the home bias puzzle: investors in one country are poorly informed about assets abroad, and therefore demand compensation for holding foreign securities.

5 Summary

This article provides an overview of the financial literature which argues that market microstructure plays a role in the pricing of securities.

Studies of the transaction process and market structure have provided a significant insight into the composition and significance of transaction costs. The first theoretical models showed that the spread between bid and ask prices is determined by inventory costs and costs associated with asymmetric information. More recent models show that the spread will also reflect oligopoly rents if liquidity providers have market power. Market access and competition between providers of liquidity may impact on costs relating to market power, while transparency and equal terms between liquidity providers are important for information costs. However, there is no single market structure which is best for all participants. Empirical studies show that implicit cost components – including spread costs, price effects from trading, and opportunity costs from not trading – are both statistically and economically significant.

This section of the literature is of obvious interest to market participants wishing to minimise the cost of trading, and for authorities responsible for regulating the securities markets. Innovation in communications and computer technology has led to the rapid emergence of order-driven trading systems. This trend has spurred new theoretical research based on strategic liquidity providers with private information or monopoly powers. The emergence of transparent order-based trading systems has also meant that significantly better data has become available for research purposes, opening the door for numerous empirical studies of the efficiency and cost of order-based trading systems in the future.

Another – and very active – section of the literature argues that microstructure is also important for our understanding of fundamental economic decisions. This will be the case if information risk and/or differences in liquidity over time and between companies impact on long-term equilibrium prices in the market. Several empirical studies find a positive relationship between stock returns and various measures of liquidity costs. Some find that it is the level of liquidity which impacts on the return, while others find that it is systematic fluctuations in liquidity which are priced in the market. One theoretical study argues that idiosyncratic risk will be priced if information is asymmetrically distributed and rational participants demand compensation for informational disadvantages. This breaks radically with the well-known result of financial theory that idiosyncratic risk can be diversified away, and allows for the possibility of microstructure playing an important role in long-term returns on the stock market.

Contributing more knowledge about how private information affects long-term expected return is one of the most important challenges facing microstructure research. One important element of this work will be to find good empirical measures which can be used to test the hypothesis that the market prices information risk.

[10] A ten per cent increase in PIN gives a 2.5 per cent increase in return.

References

Admati, A.R. and P. Pfleiderer (1991): "Sunshine Trading and Financial Market Equilibrium", *Review of Financial Studies,* 4, pp. 443-481

Amihud, Y. and H. Mendelson (1980): "Dealership Market: Market Making with Inventory", *Journal of Financial Economics*, 8, pp. 31-53

Amihud, Y. and H. Mendelson (1986): "Asset Pricing and the Bid-Ask Spread", *Journal of Financial Economics,* 17, pp. 223-249

Amihud, Y. (2002): "Illiquidity and stock returns: cross section and time series effects", *Journal of Financial Markets,* 5, pp. 31-56

Anand, A.; C. Tangaard and D.G. Weaver (2004): "Paying for Market Quality", 2004, *Working Paper Rutgers Business School*

Bagehot, W. (1971): "The Only Game in Town", *Financial Analysts Journal*, 27, pp. 12-14

Benveniste, L.; A. Marcus and W. Wilhelm (1992): "What's special about the specialist?" *Journal of Financial Economics,* 32, pp. 61-86

Bernhardt, D. and E. Hughson (1997): "Splitting orders", *Review of Financial Studies,* 10, pp. 69-101

Bessembinder, H. and H. Kaufman (1997): "A cross-exchange comparison of execution costs and information flow for NYSE-listed stocks", *Journal of Financial Economics*, 46, pp. 293-319

Biais, B.; T. Foucault and F. Salanie (1998): "Floors, dealer markets and limit order markets", *Journal of Financial Markets,* 1, pp. 253-284

Biais, B.; D. Martimort and J. Rochet (2000): "Competing mechanisms in a common value environment", *Econometrica*, 68, pp. 799-838

Biais, B.; L. Glosten and C. Spatt (2004): "Market microstructure: A survey of microfoundations, empirical results, and policy implications", *CEPR Discussion Paper* No. 3288

Blume, M. and M. Goldstein (1997): "Quotes, order flow, and price discovery", *Journal of Finance,* 52, pp. 221-244

Brennan, M. and A. Subrahmanyam (1996): "Market microstructure and asset pricing: On the compensation for illiquidity in stock returns", *Journal of Financial Economics,* 41, pp. 441-464

Calcagno, R. and S. Lovo (1998): "Bid-ask price competition with asymmetric information between market makers". Working paper, CORE

Chordia, T.; R. Roll and A. Subrahmanyam (2000): "Commonality in liquidity", *Journal of Financial Economics,* 56, pp. 3-28

Chordia, T.; A. Subrahmanyam and V.R. Anshuman (2001): "Trading activity and expected stock returns", *Journal of Financial Economics,* 59, pp. 3-32

Chowdhry, B. and V. Nanda (1991): "Multimarket trading and market liquidity", *Review of Financial Studies,* 4, pp. 483-511

Christie, W.G. and P.H. Schultz (1994): "Why do Nasdaq market makers avoid odd-eighth quotes?" *Journal of Finance,* 49, pp. 1813-1840

Christie, W.G. and P.H. Schultz (1999): "The initiation and withdrawal of odd-eighth quotes among Nasdaq stocks: an empirical analysis", *Journal of Financial Economics*, 52, pp. 409-442

Conrad, J.; K.M. Johnson and S. Wahal (2003): "Institutional trading and alternative trading systems", *Journal of Financial Economics,* 70, pp. 99-134

Constantinides, G. (1986): "Capital market equilibrium with transaction costs", *Journal of Political Economy,* 94, pp. 842-862

Copeland, T. and D. Galai (1983): "Information Effects and the Bid-Ask Spread", *Journal of Finance*, 38, pp. 1457-1469

Demsetz, H. (1968): "The Cost of Transacting", *Quarterly Journal of Economics,* 82, pp. 33-53

Easley, D. and M. O'Hara (1987): "Price, Trade Size, and Information in Securities Markets", *Journal of Financial Economics,* 19, pp. 69-90

Easley, D.; S. Hvidkjaer and M. O'Hara (2002): "Is information risk a determinant of asset returns?", *Journal of Finance,* 57, pp. 2185-2222

Easley, D.; N. Kiefer and M. O'Hara (1996): "Creamskimming or profit-sharing? The curious role of purchased order flow", *Journal of Finance,* 51, pp. 811-833

Easley, D. and M. O'Hara (2003): "Microstructure and Asset Pricing", *Handbook of the Economics of Finance*

Fama, E.F. and K.R. French (1993): "Common Risk

Factors in the Returns on Stocks and Bonds", *Journal of Financial Economics,* 33, pp. 3-56

Fong, K.Y.L.; A. Madhavan and P.L. Swan (2001): "Why do Markets Fragment? A Panel-Data Analysis of Off-Exchange Trading", Working Paper EFA 0729

Forster, M. and T. George (1992): "Anonymity in Securities Markets", *Journal of Financial Intemediation,* 2, pp. 168-206

Foucault, T. (1999): "Order flow composition and trading costs in a dynamic limit order market", *Journal of Financial Markets,* 2, pp. 99-134

Garman, M. (1976): "Market Microstructure", *Journal of Financial Economics,* 3, pp. 257-275

Glosten, L. and P. Milgrom (1985): "Bid, Ask and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders", *Journal of Financial Economics,* 13, pp. 71-100

Glosten, L. (1994): "Is the electronic open limit order book inevitable?", *Journal of Finance,* 49, pp. 1127-1161

Harris, L. (1990): "Liquidity, Trading Rules, and Electronic Trading Systems", *Monograph Series in Finance and Economics,* 4, pp. 1-62

Harris, L. (2003): *Trading and Exchanges. Market Microstructure for Practitioners,* Oxford University Press

Hasbrouck, J. and D. Seppi (2001): "Common factors in prices, order flows, and liquidity", *Journal of Financial Economics,* 59, pp. 383-411

Hasbrouck, J. and G. Sofianos (1993): "The Trades of Market Makers: An Empirical Analysis of NYSE Specialists", *Journal of Finance,* 48, pp. 1565-1594

Heaton, J. and D. Lucas (1996): "Evaluating the effects of incomplete markets on risk sharing and asset prices", *Journal of Political Economy,* 104, pp. 443-487

Huberman, G. and D. Halka (2001): "Systematic liquidity", *Journal of Financial Research,* 24, pp. 161-178

Klemperer, P. and M. Meyer (1989): "Supply function equilibria in oligopoly under uncertainty", *Econometrica,* 57, pp. 1243-1277

Madhavan, A. (1995): "Consolidation, Fragmentation, and the Disclosure of Trading Information", *The Review of Financial Studies*, 8, pp. 579-603

Madhavan, A. (2000): "Market Microstructure: A Survey", *Journal of Financial Markets,* 3, pp. 205-258

Madhavan, A. and S. Smidt (1991): "A Bayesian Model of Intraday Specialist Pricing", *Journal of Financial Economics,* 30, pp. 99-134

Madhavan, A. and S. Smidt (1993): "An Analysis of Daily Changes in Specialists' Inventories and Quotations", *Journal of Finance,* 48, pp. 1595-1628

Mendelson, H. (1982): "Market behaviour in a clearing house", *Econometrica,* 50, pp. 1505-1524

Mendelson, H. (1987): "Consolidation, Fragmentation and Market Performance", *Journal of Financial and Quantitative Analysis,* 22, pp. 189-207

Næs, R. and J.A. Skjeltorp (2003): "Equity trading by institutional investors: Evidence on order submission strategies", *Journal of Banking and Finance,* 27, pp. 1779-1817

Næs, R. and B.A. Ødegaard (2006): "Equity trading by institutional investors. To cross or not to cross?" Forthcoming in *Journal of Financial Markets*

O'Hara, M. (2003): "Presidential address: Liquidity and price discovery", *Journal of Finance,* 58, pp. 1335-1354

Parlour, C. (1998): "Price dynamics in limit order markets", *Review of Economic Studies,* 11, pp. 789-816

Pastor, L. and R. Stambaugh (2003): "Liquidity risk and expected stock returns", *Journal of Political Economy,* 111, pp. 642-685

Roëll, A. (1999): "Liquidity in limit order book markets and single price auctions with imperfect competition", Working Paper, Princeton University

Seppi, D. (1990): "Equilibrium block trading and asymmetric information", *Journal of Finance,* 45, pp. 73-94

Vayanos, D. (1998): "Transaction costs and asset prices: a dynamic equilibrium model", *Review of Financial Studies,* 11, pp. 1-58

Vayanos, D. and J. Vila (1999): "Equilibrium interest rates and liquidity premium with transaction costs", *Economic Theory*, 13, pp. 509-539

Financial variables and developments in the real economy

Karsten R. Gerdrup, senior adviser in the Monetary Policy Department, Roger Hammersland, researcher in the Research Department and Bjørn E. Naug, senior adviser in the Economics Department[1]

This article examines whether financial variables are useful as leading indicators of the output gap and mainland GDP growth. Financial variables may be leading indicators either because they (a) are priced on the basis of expectations, (b) affect the economy with a lag or (c) are published earlier and more frequently than GDP figures. Moreover, they are not subject to significant revisions. We find that house prices, equity prices, credit growth, money growth, real exchange rates, real short-term interest rates and the difference between long- and short-term interest rates can serve as leading indicators of GDP growth and/or the output gap. The output gap is most strongly correlated with growth in domestic credit to enterprises (lagged 0–4 quarters) and cyclical fluctuations in equity prices (lagged 2–5 quarters). We include effects of equity prices and enterprise credit in an econometric forecasting model of GDP. The model takes into account that equity prices and credit growth may influence each other and that changes in GDP may feed back to financial variables. The model fits well and has stable coefficients.

1 Introduction

Norges Bank sets the key rate on the basis of output and inflation forecasts. In the projection process, the Bank assesses how the key rate will influence these variables during the projection period. A solid assessment of both the current economic situation and developments in the next few quarters is essential to making sound projections for economic developments over a longer period. The short-term analysis is based primarily on current statistics and other information about the economic situation, including information from Norges Bank's regional network[2] and other surveys[3]. The Bank also uses several models to project GDP growth in the next few quarters.[4]

The variables monitored by the Bank include developments in credit, money, house prices, equity prices, market rates and exchange rates. This article examines whether such financial variables[5] can be useful as leading indicators of GDP growth and the output gap.[6]

A number of arguments support the use of financial variables as predictors of the output gap and GDP growth in the next few quarters. First, measures of most financial variables are fairly accurate and they are not subject to significant revisions. Second, financial variables may be leading indicators of developments in the real economy. This may be because they are priced on the basis of expectations, because they affect the economy with a lag or because they are published earlier and more frequently than GDP figures. In efficient markets, equity prices, market rates and exchange rates are set continuously. Data on credit, money and house prices are updated monthly. House price figures are updated immediately after month-end, whereas data on credit and money are updated with a lag of roughly one month. By contrast, the national accounts are only published quarterly, with a lag of more than two months, and may be revised extensively (see e.g. Bernhardsen et al., 2006).

We discuss the data and possible relationships between financial variables and the real economy in Sections 2 and 3. In Section 4, we use a simple correlation analysis to assess whether financial variables can function as leading indicators of GDP growth and the output gap. In this analysis, we only consider the correlation between the output gap/GDP growth and one financial variable at a time. Since several of the financial variables appear to lead GDP growth and/or the output gap, we expand the analysis by estimating a model using several explanatory variables for GDP growth (Section 5). The model also takes into account that the financial variables may influence each other and that GDP may have feedback effects on the financial variables.

2 Financial variables as indicators and choice of data

2.1 Financial variables as indicators

The relationships between financial variables and the real economy are complex. Financial variables and the real economy may be driven by the same underlying forces, but they may also influence each other. Moreover, it may be difficult to differentiate between

[1] We would like to thank Kåre Hagelund, Øistein Røisland and Kjetil Olsen for valuable comments. Enquiries regarding the article may be addressed to Karsten Gerdrup.

[2] See Kallum et al. (2005) for further details concerning Norges Bank's regional network.

[3] Examples of other surveys are Statistics Norway's business tendency survey and TNS Gallup's Consumer Confidence Index.

[4] See Kloster and Solberg-Johansen (2006).

[5] To simplify the presentation, we will hereafter use the term financial variables to refer to credit, money, house prices, equity prices, market rates and exchange rates.

[6] The output gap is defined as the difference between actual output and potential output, which is the level of output that is consistent with stable inflation over time. We examine empirical relationships between financial variables and Norges Bank's estimate of the output gap.

cause and effect. There is reason to believe, however, that some financial variables may be leading indicators of GDP growth and the output gap. In that case, it may be useful to employ these financial variables in forecasting.

We use correlation analysis and econometric methods to assess whether financial variables can function as leading indicators (information variables) of GDP growth and the output gap. This approach can be related to Astley and Haldane (1995) who write:

"The logic of information variables is that they need not have any well-defined structural relation with the final targets; they need only possess systematic, leading indicator information over them. … Of course, some of our results may indeed have structural content."

Husebø and Wilhelmsen (2005) used correlation analysis to examine whether 30 macroeconomic variables lead, lag or coincide with the output gap. However, they do not consider any financial variables other than interest rates and exchange rates.

Our analysis can also be related to empirical studies of relationships between asset prices, interest rates and output growth (see e.g. Goodhart and Hofmann (2000), Mayes and Virén (2001) and English et al. (2005)). These studies show that asset prices can provide information about developments in output and prices. In the first study, the authors find that real equity prices, real exchange rates and real short-term interest rates are significant right-hand-side variables (with one lag) in a model for forecasting the output gap in Norway. English et al. (2005) also include different measures of credit and money to predict developments in output and prices.

2.2 The data

The output gap is estimated as mainland GDP at constant prices as a percentage of potential output. We use the same measure of the output gap that was presented in Inflation Report 1/06. In section 3, we also present gaps for private consumption, housing investment and mainland business fixed investment. These gaps are estimated as the real value of these variables (adjusted for seasonality and noise) as a percentage of the variables' estimated trends. The trends are estimated using a Hodrick-Prescott filter (λ=40000).

Table 1 presents an overview of the financial variables examined in this article. The series for credit, money, house prices and equity prices have been deflated by the CPI-ATE (consumer prices adjusted for tax changes and excluding energy products). In our examination of potential relationships between financial variables and the real economy in section 3 and in the correlation analysis in section 4, we have adjusted GDP and the financial variables (except interest rates) for noise and seasonality[7] to ensure that these factors do not influence results and conclusions. We have also made seasonal adjustments and filtered out noise in the CPI-ATE. We employ the four-quarter rise in the CPI-ATE (unadjusted) to estimate real short-term interest rates. Thus, we measure all the financial variables in real terms, with the exception of the difference between 5-year nominal government bond yields and 3-month nominal money market rates.

In sections 3 and 4, we use four-quarter growth in aggregate figures for real credit and real money. We include both the level of the series and the four-quarter rise in real house prices and real equity prices. We detrend the level series to express cyclical developments. The trend in real house prices seems to fluctuate over time. We have estimated this trend using a Hodrick-Prescott filter (λ=40000). The real equity prices, on the other hand, appear to rise by a constant percentage over time, which is the same as saying that the logarithm of real equity prices has a linear trend. We have estimated the trend of the logarithm of real equity prices using the linear least square method. Finally, we have estimated a real house price gap and real equity price gap which express real house prices and real equity prices as a percentage of trend. We also include the level of the real exchange rate and its four-quarter rise. Since the real exchange rate is stationary, we have not de-trended the level series.

The econometric analysis in section 5, however, is based solely on unadjusted variables, i.e. variables that have not been de-trended or adjusted for noise or seasonality. Instead, we control for such factors by including a linear trend in the model, by including seasonal dummies and by allowing the inclusion of variables that are lagged several quarters.

We confine the correlation analysis in section 4 to the period 1993–2005. This is because it is likely that the relationships between the real economy and financial variables have changed over time, making information from earlier periods less relevant for forecasting future developments. Figures for the 1980s are influenced by the liberalisation of money, credit and capital markets and other economic policy changes. Moreover, there was a banking crisis in Norway in the period 1988–1993. Since 1993, the economic situation has been more stable. It is therefore likely that the relationships between the real economy and financial variables have been more stable since 1993 than over a longer period.

Nevertheless, we use data from 1990 when we estimate a simultaneous equation model in section 5. The background for this is that we use a model with several variables and lags, and therefore need somewhat longer data series (i.e. several degrees of freedom) to estimate fairly precisely the coefficients in the model. This may be justified by the fact that we can take structural breaks into account in an econometric study, thus benefiting from data for a somewhat longer period.

[7] More specifically, we have used Census X12 to adjust for noise and seasonality.

Table 1 Financial variables in the analysis[1]

Real credit	Total credit from domestic sources to the public, deflated by the CPI-ATE[2] (C2). The public is defined as municipalities,non-financial enterprises and households. (See http://www.norges-bank.no/front/statistikk/en/k2/)
	Credit from domestic sources to non-financial enterprises, deflated by the CPI-ATE[2] (C2 enterprises).
	Credit from domestic sources to households, deflated by the CPI-ATE[2] (C2 households).
	Total credit from domestic and foreign sources to the mainland public, deflated by the CPI-ATE[2] (C3 mainland Norway) Credit to enterprises in petroleum-related and shipping sectors are excluded. Credit to households and the local government sector are included. (See http://www.norges-bank.no/front/statistikk/en/k3/)
	Total credit from domestic and foreign sources to mainland enterprises, deflated by the CPI-ATE[2] (C3 mainland enterprises).
Real money	Narrow monetary aggregate, deflated by the CPI-ATE[2] (M1). M1 measures the money-holding sector's stock of Norwegian banknotes and coins as well as the sector's deposits in transaction accounts in Norges Bank and in commercial and savings banks (in NOK and foreign currency). Deposits in transaction accounts include deposits that may be converted immediately to cash or from which payments can be made directly without incurring any costs other than normal transaction and establishment fees. The money-holding sector refers to the public and financial enterprises other than banks and government lending institutions. (See http://www.norges-bank.no/front/statistikk/en/pengemengden)
	Broad money, deflated by the CPI-ATE[2] (M2). M2 measures the money-holding sector's stock of M1 and other bank deposits (in NOK and foreign currency) as well as the sector's holdings of certificates of deposit. Locked-in deposits (pension savings in banks, youth home equity savings plans etc.) are not included.
	Non-financial enterprises' money holdings, deflated by the CPI-ATE[2] (M2 enterprises).
	The household sector's money holdings, deflated by the CPI-ATE[2] (M2 households).
Real house prices	Price index from the Norwegian research institute ECON and The Norwegian Association of Real Estate Agents (NEF) for resale detached houses, multi-dwelling houses and flats, deflated by the CPI-ATE[2].
Real equity prices	Oslo Stock Exchange Benchmark Index (merged with the all-share index in 2001), deflated by the CPI-ATE[2]. The series is from EcoWin.
Short-term real interest rates	Three-month money market rates less the four-quarter rise in the CPI-ATE[2].
Interest rate differential	5-year nominal government bond yields less 3-month nominal money market rates.
Real exchange rates	The import-weighted nominal krone exchange rate (I-44) is multiplied by an index for consumer prices among Norway's most important trading partners and deflated by Norwegian consumer prices. The I-44 is a geometric mean of 44 exchange rates. The weights are calculated on the basis of imports from 44 countries, covering 97 per cent of total imports. The index is set at 100 in 1995. A rise in the index indicates a depreciating krone exchange rate. (See http://www.norges-bank.no/english/statistics/exchange/help.html)

[1] All variables are quarterly figures.
[2] CPI-ATE is a term for consumer prices adjusted for tax changes and excluding energy products.

3 Potential relationships between financial variables and the real economy

This section discusses possible relationships between real variables and financial variables. The section also includes a discussion of the information content of the various monetary and credit aggregates.

Credit

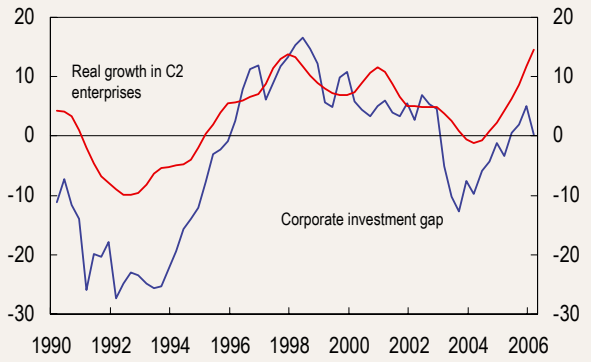
Enterprises often finance a share of the purchase sum with loans from credit institutions or by issuing bonds when making new investments. Alternatively, they can issue shares. An increase in corporate credit is registered in monthly credit statistics, and may thus provide information about developments in business fixed investment before the national accounts are published. There is also reason to believe that credit is to some extent extended to enterprises before larger fixed investments are actually made. Credit figures may thus contain leading information about developments in the real economy.

We look at two measures of credit to enterprises, C2 enterprises[8] and C3 mainland enterprises. These measures have advantages and drawbacks. A share of mainland enterprises borrows in foreign markets to finance fixed investments in Norway. This is captured in C3 mainland enterprises, but not in C2 enterprises. Since the share of foreign debt in C3 varies over time, C2 enterprises may provide less information about developments in the real economy than C3 mainland enterprises. On the other hand, foreign credit, and hence C3 mainland enterprises, is published with a lag of around two months, i.e. more than one month later than C2 enterprises. In addition, C3 mainland enterprises is more uncertain than C2 enterprises because the figures for foreign credit are revised more extensively and more frequently than the figures for domestic credit (see Bø et al., 2003). C2 is revised only to a limited extent and the degree of revision has been gradually reduced in recent years.

To the extent that growth in credit to enterprises is accounted for by factors other than fixed investment, input goods or the like, this measure may be less indicative of developments in the real economy. Such factors may also entail variation as to which measure of credit, C2 enterprises or C3 mainland enterprises, is the most relevant. For example, several Norwegian enterprises used foreign funding to acquire foreign companies in 2000. Growth in C3 mainland enterprises was then considerably higher than growth in C2 enterprises. Insight into the background data for large enterprises' borrowing can increase the information value of credit growth in relation to that presented in the analysis in this article.

There has been a positive relationship between growth in domestic real credit to enterprises and cyclical developments in mainland business fixed investment since the beginning of the 1990s (see Chart 1). For example, growth in real domestic credit to enterprises picked up sharply in 1992 and was followed by a marked increase in mainland business investment. Growth in both credit and investment was sluggish in 2003–2004 during the downturn in the Norwegian economy. It appears that real credit growth in the enterprise sector can function as a leading or coincident indicator of developments in output.

Chart 1 Corporate investment gap and real growth in C2 enterprises.[1)]
Per cent. 1990 Q1 – 2006 Q1



[1)] Fixed investment in non-financial enterprises in mainland Norway as a percentage of trend. The trend is estimated with a HP-filter (λ=40000) also using data from the 1980s. The series are adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

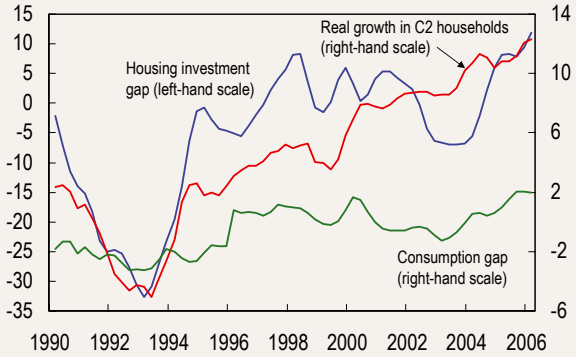
Households also debt-finance a share of the purchase sum when buying a home or durable consumer goods. Credit to households may thus potentially contain information about developments in consumption and housing investment. Households' foreign borrowing is limited, and C2 households are thus representative of the lion's share of households' total credit.

Housing investment and growth in real credit to households picked up sharply in pace with the cyclical upswing in 1993 (see Chart 2). There was a close relationship between these variables in the 1990s. There also seems to have been some correlation between private consumption and growth in real credit to households during that period. Chart 2 indicates, however, that growth in real credit to households has provided little information about developments in housing investment and private consumption since the end of the 1990s. The reason may be that a large portion of household borrowing has been used for purchases of resale homes in an environment of sharply rising house prices. Such purchases imply a transfer of a home from one household to another and does not itself entail a change in growth in overall consumption or fixed investment.

According to Jacobsen and Naug (2004), household credit is heavily influenced by developments in house prices with a considerable lag. Developments in real credit to households may therefore be less suitable as a leading indicator than developments in real credit to enterprises.

[8] C2 comprises to a limited extent credit to companies in the petroleum and shipping industries, because a large portion of their loans are raised abroad.

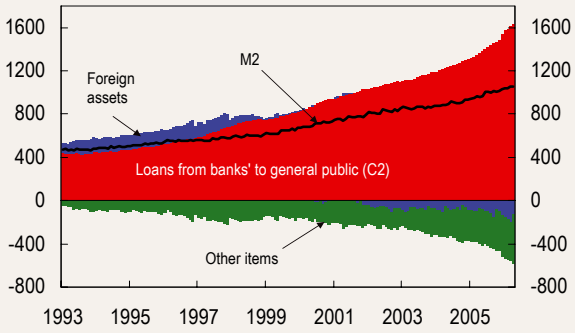
Chart 2 Consumption gap, housing investment gap and real growth in C2 households.[1] Per cent. 1990 Q1 – 2006 Q1



[1] Private consumption and housing investment as a percentage of trend. The trends are estimated with a HP-filter (λ=40000) also using data from the 1980s. The series are adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

Chart 3 Broad money (M2) and counterparts to broad money. In billions of NOK. December 1992 – April 2006



Source: Norges Bank

Money

Developments in monetary aggregates (M1 and M2) can probably also be used as indicators of demand for goods and services. Increased growth in output may in isolation engender higher demand for money in order to execute a rising number of transactions. An increase in money is registered in monthly statistics on monetary aggregates and can provide information about developments in the real economy at an earlier point in time than the national accounts.

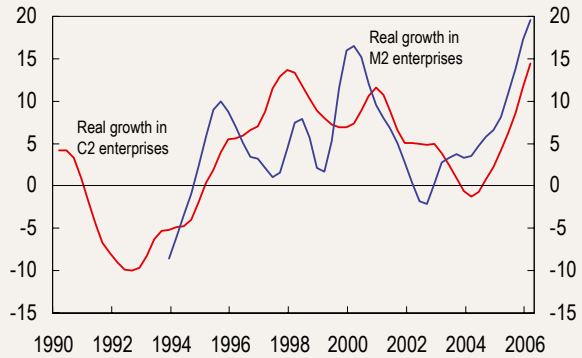
However, it is uncertain whether monetary growth contains information about developments in the real economy beyond that already contained in credit growth. The corollary to an increase in monetary growth is often an increase in credit growth (see Chart 3). This relationship seems to be clearest for enterprises (see Chart 4).

M1 and M2 can contain different information about developments in output. M1 comprises cash holdings and deposits in transaction accounts, while M2 also includes bank deposits that bear a resemblance to savings. There may thus be a closer relationship between M1 and short-term developments in output than for M2. However, according to Chart 5, it seems that M1 captures more or less the same developments as M2 enterprises. The reason for this may be that enterprises hold a large portion of their cash holdings in transaction accounts and not in high-interest accounts or the like.

There seems to be some correlation between enterprises' money holdings and fixed investment (see Chart 6). On the other hand, it is difficult to find relationships between households' money holdings and private consumption. For example, households' money holdings increased to a fairly limited extent up to 1998 despite a sharp rise in private consumption (see Chart 7). In following periods, households' money holdings have increased markedly also when consumption has been relatively weak.

Overall, the analysis implies that M2 enterprises, and possibly M1, can potentially function as a leading or coincident indicator of output growth, but not necessarily contain more information than enterprises' credit growth.

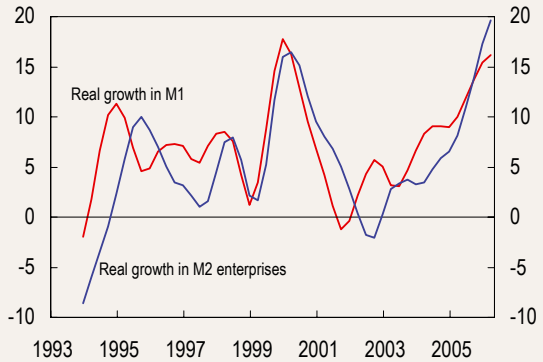
Chart 4 Real growth in M2 enterprises and C2 enterprises[1]. Per cent. 1990 Q1 – 2006 Q1



[1] The series are adjusted for seasonality and irregular components.

Source: Norges Bank

Chart 5 Real growth in M1 and M2 enterprises.[1] Per cent. 1993 Q4 – 2006 Q1

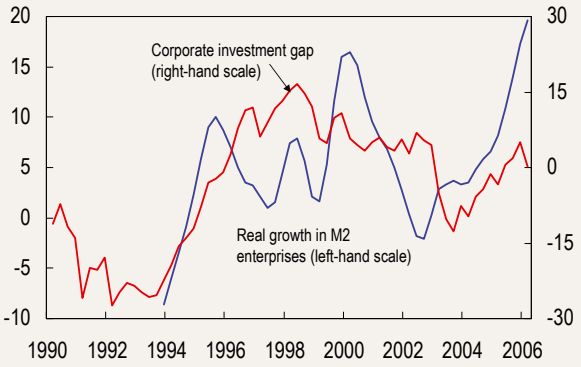


[1] The series are adjusted for seasonality and irregular components.

Source: Norges Bank

[9] See also Langbraaten (2001) for a review of the relationship between asset prices and the real economy.

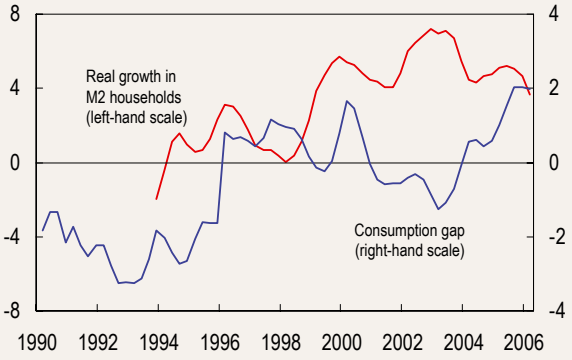
Chart 6 Corporate investment gap and real growth in M2 enterprises.[1)]
Per cent. 1990 Q1 – 2006 Q1



[1)] Fixed investment in non-financial enterprises in Mainland Norway as a percentage of trend. The trend is estimated with a HP-filter (λ=40000) also using data from the 1980s. The series are adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

Chart 7 Consumption gap and real growth in M2 households.[1)]
Per cent. 1990 Q1 – 2006 Q1



[1)] Private consumption as a percentage of trend. The trend is estimated with a HP-filter (λ=40000) also using data from the 1980s. The series are adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

House prices

Housing demand is partly influenced by household expectations concerning developments in the Norwegian economy. As it normally takes time to increase the overall stock of housing through construction when housing demand rises, increased housing demand will immediately translate into increased house prices. House prices may thus reflect actual and expected demand pressures and be a leading or coincident indicator of GDP and the output gap (see also Langbraaten and Lohrmann 2001).

Furthermore, house prices may amplify developments in the real economy through several channels:[9]

- The wealth channel: House prices have an impact on household wealth. Increased house prices may thus motivate home-owners to increase consumption.
- Credit channel: Increased house prices influence the collateral value of dwellings and thus increase household borrowing possibilities. The interest rate conditions attached to loans can also be improved if banks assess the value of the collateral as higher in relation to the loan amount than earlier.
- Investment channel: Housing starts are stimulated when resale home prices rise in relation to prices for new dwellings.
- Expectations channel: Changes in house prices may influence household expectations and hence household demand.

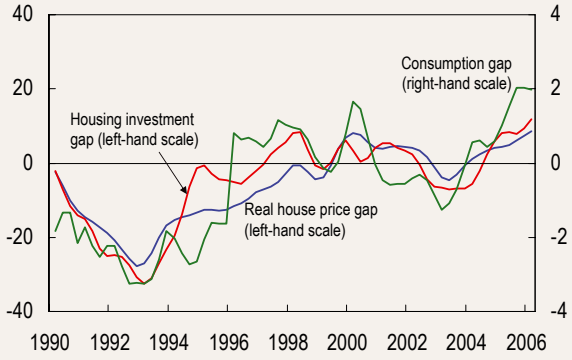
There seems to have been a close relationship between cyclical developments in real house prices and housing investment since the beginning of the 1990s (see Chart 8). Moreover, there seems to have been a positive relationship between the real house price gap and the consumption gap. Developments in real house prices may therefore potentially be an indicator of developments in the real economy.

Equity prices

Equity prices are influenced by interest rate expectations and expectations concerning enterprises' future earnings, and consequently depend on expected developments in the real economy. Equity prices can thus be a leading indicator of output growth. Like house prices, equity prices influence economic developments through several channels:

- Wealth channel: Equity prices influence household wealth. A rise in equity prices may therefore motivate shareholders to increase consumption.
- Credit channel: Equity prices can influence access to and the costs of debt-financing, partly because there is asymmetric information between the borrower and lender. Asymmetric information implies that the lender may find it difficult to distinguish between sound and unsound borrowers in the loan approval process ("adverse selection"). A lender also faces the risk that a business will engage in

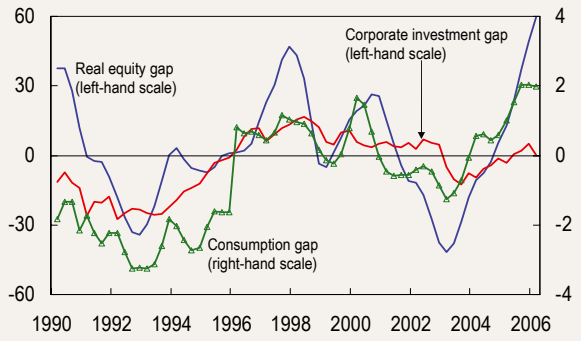
Chart 8 Real house price gap, consumption gap and housing investment gap.[1)] Per cent. 1990 Q1 – 2006 Q1



[1)] Real house prices, private consumption and housing investment as a percentage of trend. The trends are estimated with a HP-filter (λ=40000) also using data from the 1980s. We have used house price data from the RIMINI (a macro model earlier used in Norges Bank) data base for the 1980s. The series are adjusted for seasonality and irregular components.

Sources: ECON/NEF, Norges Bank and Statistics Norway

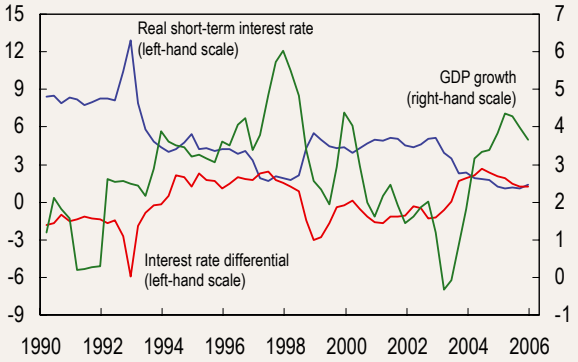
Chart 9 Real equity gap, corporate investment gap and consumption gap.[1] Per cent. 1990 Q1 – 2006 Q1



[1] Real equitiy prices, fixed investment in non-financial enterprises in Mainland Norway and private consumption as a percentage of trend. The trends are estimated with a HP-filter (λ=40000) also using data from the 1980s. The series are adjusted for seasonality and irregular components.

Sources: EcoWin, Norges Bank and Statistics Norway

Chart 10 Real short-term interest rate, the differential between 5-year nominal government bond yields and 3-month nominal money market interest rate, and GDP growth[1]. Per cent. 1990 Q1 – 2006 Q1



[1] GDP Mainland Norway is adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

more risky projects after loan approval ("behavioural risk"). Asymmetric information also exists between lenders and households, but such conditions are of greater relevance for enterprises because their credit is often used for projects that generate highly uncertain returns. When a lender is to assess the risk associated with a given enterprise, the borrower's financial wealth and collateral are taken into account (see, for example, Kiyotaki and Moore (1997) and Bernanke and Gertler (1989). A sharp fall in equity prices may imply that the borrower is not granted a loan even if the borrower is willing to pay a very high interest rate.[10] In the analysis in this article, the credit channel can also be captured in that we consider credit growth as an individual indicator of developments in the real economy.

- Investment channel: Changes in equity prices may motivate corporate management to increase or reduce fixed investment. When equity prices advance and the market value of enterprises' implemented real capital exceed the cost of procuring the same new real capital, it can be interpreted to mean that new real capital is worth more to the owners of the enterprise than it costs. The owners will then wish to make new investments ("Tobin's Q" is greater than one).
- Expectations channel: Equity prices may influence expectations about the future and thereby decisions concerning consumption and fixed investment.

There seems to have been a positive correlation between the real equity price gap, the enterprise investment gap and the consumption gap since the beginning of the 1990s (see Chart 9). Furthermore, real equity prices seems to function as a leading indicator of investment, while this variable is more like a coincident indicator of private consumption.

10 See also Stiglitz and Weiss (1981).

Short-term real interest rates

Real interest rates provide an indication of the costs of increasing consumption and about the alternative costs of fixed investment. When real interest rates rise, the cost of consumption increases and investors requires a higher rate of return. This has an adverse impact on consumption and fixed investment. An increase in interest rates also leads to a stronger krone and an associated deterioration in competitiveness, resulting in lower output and investment.

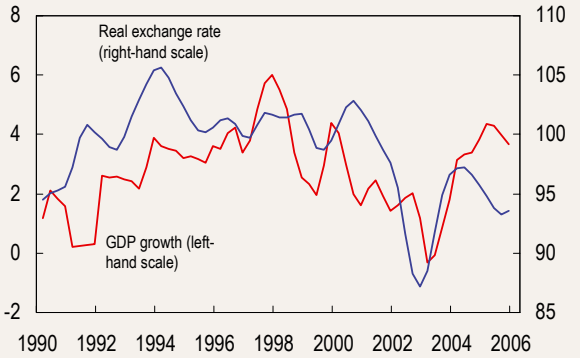
It is primarily interest rate expectations that influence the krone exchange rate and business and household demand. However, it is reasonable to assume that interest rate expectations have been closely linked to short-term interest rates over the past 10–15 years. We have therefore investigated whether the short-term real interest rate is a good leading indicator of developments in the real economy.

Chart 10 shows that the correlation between GDP growth and short-term real interest rates has been negative since 1990 and that short-term real interest rates can function as an indicator for developments in the real economy.

Differential between long-term and short-term interest rates

In efficient financial markets, long-term interest rates will reflect participants' short-term interest rate expectations. These expectations are influenced by expectations concerning economic growth and inflation. For the US, several empirical studies indicate that an inverted yield curve (lower long-term than short-term interest rates) can function as a leading indicator of future recessions (see Stock and Watson (2001) and box in *Inflation Report* 1/06). The background for this is that weaker growth prospects can generate expectations that short-term interest rates will be lower in the future than at present. If short-term interest rates are widely expected to rise as a result of higher inflation expecta-

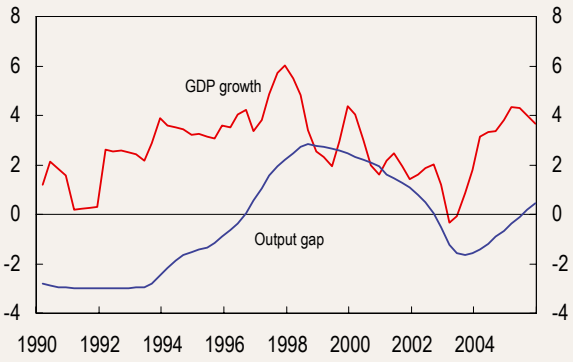
Chart 11 The real exchange rate and GDP growth.[1] Per cent.
1990 Q1 – 2006 Q1



[1] The series are adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

Chart 12 Output gap[1] and GDP growth[2]. Per cent.
1990 Q1 – 2005 Q4



[1] GDP Mainland Norway as a percentage of potential output.
[2] GDP Mainland Norway is adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

tions and not as a result of higher growth expectations, the interest rate differential will weaken as a leading indicator of developments in the real economy.

Long-term interest rates can also be influenced by risk premiums. Holding interest-bearing instruments with a long residual maturity entail the risk that the real return will be lower than assumed, e.g. if inflation turns out to be higher (ex post) than assumed (ex ante). As a consequence, long-term interest rates may rise when investors become increasingly uncertain about developments in for example inflation ahead. This may also weaken the relationship between the interest rate differential and future output.

However, as shown in Chart 10, there seems to have been a positive correlation between the interest rate differential and GDP growth since 1990. Moreover, the chart indicates that the interest rate differential can function as a leading indicator or a coincident indicator of developments in the real economy.

The exchange rate

The Norwegian krone is floating and is influenced by factors such as expectations concerning future interest rate differentials between Norway and other countries. The competitiveness of Norwegian enterprises weakens when the value of the Norwegian krone increases. This has a negative impact on output and investment. A depreciation of the krone has the opposite effect. Chart 11 shows that there has been correlation between the real exchange rate and GDP growth since 1990. It would thus appear that the real exchange rate can function as an indicator of developments in the real economy.

4 Correlation analysis

There is a relationship between GDP growth and the output gap, but there is no clear-cut statistical correlation between the two series. An increase in GDP growth is associated with an increase in the output gap. However, if potential output is expected to increase more than GDP growth, the output gap will still fall. The correlation between GDP growth and the output gap may therefore be weak or negative in periods. Chart 12 shows that there may be a tendency for GDP to shift from low growth to high growth or the opposite shortly ahead of a shift in the output gap. The correlation coefficient[11] between the output gap and GDP growth lagged 8 quarters was 0.70 in the period from 1993 to the end of 2005. This was also the highest correlation coefficient when looking at the output gap in relation to GDP growth lagged 1–8 quarters. The correlation between the output gap and GDP growth in the same quarter was only 0.22.

It is uncertain whether financial variables function best as leading indicators of GDP growth or the output gap. We have therefore constructed two tables: Table 2 shows the correlation coefficients between each financial variable and GDP growth, while Table 3 shows the correlation between each variable and the output gap. In addition to estimating the correlations where two series are dated in the same period, we have estimated correlations where the financial variables are lagged 1–8 quarters and projected 1–8 quarters ahead in relation to GDP growth or the output gap. A financial variable can be said to be a leading indicator if the correlation coefficient is highest and has the right sign when the variable is lagged in relation to GDP growth or the output gap. A financial variable can in principle be said to be a coincident indicator if the correlation coefficient is highest and has the right sign when the variable is dated at the same point in time as GDP growth or the output gap. In such cases, the financial variables can still be considered as leading indicators since they are updated faster and more frequently than GDP figures. A financial variable can be said to be a lagging indicator if the correlation coefficient is highest and has the right sign when the variable is dated ahead in relation

[11] The correlation coefficient varies between minus one and plus one. When it is close to one of the extremes, there is a strong negative or positive correlation between the two series. When it is close to zero, there is little correlation between them.

Table 2 Correlation coefficient between financial variables and four-quarter growth in GDP Mainland Norway. 1993 Q1 - 2005 Q4

	Leading indicator (-)									Lagging indicator (+)							
	-8	**-7**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	***0***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
C2 real growth	-0.33	-0.29	-0.25	-0.23	-0.20	-0.16	-0.11	-0.05	*0.01*	0.06	**0.08**	0.06	0.00	-0.08	-0.16	-0.22	-0.28
C2 enterprises, real growth	-0.31	-0.26	-0.23	-0.19	-0.14	-0.05	0.04	0.15	*0.26*	0.37	0.47	0.55	**0.57**	0.55	0.49	0.42	0.35
C2 households, real growth	-0.27	-0.26	-0.24	-0.23	-0.23	-0.22	-0.21	-0.19	*-0.16*	-0.16	-0.19	-0.26	-0.33	-0.40	-0.42	-0.43	-0.42
C3 Mainland Norway, real growth	-0.48	-0.41	-0.34	-0.29	-0.24	-0.18	-0.13	-0.08	*-0.03*	0.02	0.09	0.16	**0.17**	0.13	0.08	0.04	0.03
C3 mainland enterprises, real growth	-0.50	-0.42	-0.34	-0.25	-0.11	0.04	0.14	0.17	*0.17*	0.20	0.29	0.40	**0.43**	0.38	0.33	0.29	0.31
M1, real growth	-0.02	0.11	0.15	0.09	0.04	0.09	0.24	0.38	***0.41***	0.36	0.27	0.17	0.09	0.07	0.09	0.13	0.15
M2, real growth	-0.10	-0.09	-0.17	-0.31	-0.42	-0.47	-0.43	-0.29	*-0.15*	-0.03	**0.01**	-0.02	-0.09	-0.12	-0.10	-0.08	-0.07
M2 enterprises, real growth	-0.24	-0.15	-0.11	-0.11	-0.10	-0.06	0.01	0.10	*0.16*	0.23	**0.26**	0.25	0.23	0.23	0.25	0.24	0.18
M2 households, real growth	-0.21	-0.21	-0.26	-0.35	-0.43	-0.49	-0.54	-0.59	*-0.64*	-0.63	-0.57	-0.49	-0.46	-0.41	-0.34	-0.26	-0.18
House prices, real growth	-0.09	-0.08	-0.06	-0.01	0.06	0.18	0.36	0.55	***0.66***	0.61	0.37	0.10	-0.05	-0.04	0.10	0.26	0.34
House prices, gap	-0.47	-0.47	-0.45	-0.44	-0.40	-0.32	-0.23	-0.13	*-0.06*	-0.04	-0.06	-0.09	-0.10	-0.08	-0.03	0.02	**0.06**
Equity prices, real growth	0.11	0.16	0.20	0.25	0.33	0.46	0.60	**0.67**	*0.62*	0.41	0.14	-0.10	-0.24	-0.30	-0.29	-0.26	-0.26
Equity prices, gap	-0.29	-0.23	-0.18	-0.10	0.04	0.26	0.49	0.67	***0.76***	0.74	0.69	0.60	0.49	0.38	0.29	0.23	0.16
Short-term real interest rate	-0.06	-0.07	-0.08	-0.10	-0.17	-0.32	-0.43	-0.46	***-0.48***	-0.36	-0.20	-0.03	0.15	0.27	0.35	0.39	0.45
Interest rate differential	0.41	0.42	0.41	0.39	0.40	0.50	**0.58**	**0.58**	*0.52*	0.33	0.10	-0.13	-0.31	-0.40	-0.40	-0.35	-0.34
Real exchange rate, growth	-0.03	0.09	0.19	0.28	0.38	**0.43**	0.41	0.31	*0.17*	0.02	-0.09	-0.15	-0.17	-0.16	-0.13	-0.08	0.00
Real exchange rate, level	-0.11	-0.05	0.04	0.16	0.28	0.39	0.45	0.47	*0.45*	0.43	0.42	0.42	0.42	0.42	0.43	0.47	**0.51**

Sources: ECON/NEF, Norges Bank and Statistics Norway

Table 3 Correlation between financial variables and the output gap. 1993 Q1 - 2005 Q4

	Leading indicator (-)									Lagging indicator (+)							
	-8	**-7**	**-6**	**-5**	**-4**	**-3**	**-2**	**-1**	***0***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
C2 real growth	0.49	0.55	0.59	0.63	0.65	0.66	**0.67**	0.66	*0.64*	0.61	0.58	0.54	0.50	0.45	0.41	0.37	0.33
C2 enterprises, real growth	0.66	0.73	0.78	0.83	0.86	0.89	**0.90**	**0.90**	*0.88*	0.83	0.78	0.70	0.60	0.47	0.33	0.17	0.00
C2 households, real growth	0.28	0.31	0.34	0.35	**0.36**	**0.36**	**0.36**	0.34	*0.33*	0.30	0.26	0.23	0.20	0.19	0.21	0.23	0.27
C3 Mainland Norway, real growth	0.42	0.50	0.58	0.65	0.69	0.72	0.74	**0.76**	***0.76***	**0.76**	0.75	0.74	0.72	0.69	0.65	0.61	0.56
C3 mainland enterprises, real growth	0.43	0.53	0.63	0.71	0.75	**0.78**	**0.78**	0.76	*0.76*	0.73	0.72	0.69	0.65	0.59	0.50	0.40	0.28
M1, real growth	0.37	**0.39**	0.38	0.35	0.32	0.28	0.25	0.21	*0.17*	0.13	0.08	0.04	-0.08	-0.17	-0.22	-0.24	-0.24
M2, real growth	-0.30	-0.30	-0.29	-0.27	-0.23	-0.18	-0.12	-0.05	*0.09*	0.18	**0.21**	**0.21**	0.15	0.10	0.07	0.07	0.07
M2 enterprises, real growth	0.25	0.34	0.41	0.45	**0.47**	**0.47**	0.46	0.44	*0.41*	0.38	0.35	0.32	0.23	0.12	0.01	-0.09	-0.17
M2 households, real growth	-0.47	-0.44	-0.39	-0.35	-0.30	-0.23	-0.16	-0.06	*0.05*	0.16	0.27	0.37	0.42	0.48	0.54	0.60	**0.64**
House prices, real growth	**0.64**	0.63	0.62	0.61	0.60	0.57	0.52	0.43	*0.30*	0.14	-0.01	-0.08	-0.09	-0.06	-0.04	-0.04	-0.07
House prices, gap	0.28	0.35	0.41	0.47	0.53	0.57	0.61	0.63	***0.64***	**0.64**	0.62	0.61	0.59	0.57	0.55	0.53	0.51
Equity prices, real growth	**0.42**	0.39	0.34	0.29	0.23	0.16	0.05	-0.08	*-0.23*	-0.36	-0.46	-0.49	-0.48	-0.45	-0.41	-0.39	-0.39
Equity prices, gap	0.55	0.64	0.72	0.78	0.82	**0.83**	0.79	0.71	*0.59*	0.44	0.30	0.18	0.06	-0.04	-0.14	-0.23	-0.32
Short-term real interest rate	**-0.69**	-0.67	-0.64	-0.61	-0.56	-0.50	-0.42	-0.29	*-0.10*	0.08	0.21	0.31	0.37	0.41	0.43	0.46	0.49
Interest rate differential	**0.58**	0.51	0.43	0.35	0.27	0.17	0.06	-0.09	*-0.36*	-0.53	-0.66	-0.75	-0.81	-0.83	-0.80	-0.76	-0.71
Real exchange rate, growth	-0.10	-0.04	0.01	0.05	**0.06**	0.04	-0.04	-0.13	*-0.21*	-0.26	-0.26	-0.23	-0.16	-0.08	-0.02	0.00	0.00
Real exchange rate, level	0.20	0.21	0.24	0.26	**0.27**	0.25	0.20	0.13	*0.05*	0.00	-0.05	-0.08	-0.10	-0.11	-0.12	-0.15	-0.20

Sources: ECON/NEF, Norges Bank and Statistics Norway

to GDP growth or the output gap. Such a financial variable can nevertheless functions as a leading indicator if the correlation coefficient has the right sign and is relatively high when the financial variable is lagged in relation to GDP growth or the output gap. In Table 2 and 3, the maximum correlation coefficients for each financial variable (assuming right sign) are highlighted in bold print.

The correlations between GDP growth and the lagged values of the various aggregates for growth in real credit and real money were low or negative in the period from 1993 to the end of 2005 (see Table 2). Of these variables only real growth in M1 seems to be indicative of future or current GDP growth. The correlation was strongest for growth in M1 in the same quarter (0.41) and the previous quarter (0.38). These results may reflect that M1 is a narrow monetary aggregate that may be closely linked to activity in the real economy in the short term. Real growth in C2 enterprises and C3 mainland enterprises lagged behind GDP growth in the period under study.

Some of the aggregates for credit growth seem, however, to function well as leading indicators of the output gap (see Table 3).[12] Real growth in C2 enterprises and C3 mainland enterprises seem to be particularly indicative of developments in the output gap several quarters ahead. The correlation between the output gap and growth in C2 enterprises lagged 1–3 quarters was 0.9 in the period under study. As expected, the correlation between real growth in C2 households and the output gap is considerably weaker than the correlation between the output gap and credit growth for enterprises. C2 households nevertheless seems to function as a leading indicator to some degree. Real growth in total C2 and C3 mainland Norway contains effects from both households and enterprises in addition to local government, and seems on the whole to function well as a leading indicator. Real growth in M1 and M2 enterprises also show a positive correlation with the output gap as a leading indicator, but the correlations are clearly weaker than for most of the credit aggregates.

The correlations between real equity prices and GDP growth were high in the period (see Table 2). This applies both when we look at the real equity price gap and the rise in real equity prices. Both indicators show the strongest correlation with GDP growth when they are measured in the same quarter or in the previous quarter. The real equity price gap also seems to be indicative of developments in the output gap a period ahead, and can probably function as a leading indicator of the output gap (see Table 3). The correlations between the output gap and the real equity price gap lagged 3–4 quarters was as high as 0.83 in the period 1993–2005.

As expected, there was a negative correlation between the real short-term interest rate and GDP growth and the output gap in the period under study. The real short-term interest rate can function as a leading indicator of developments in output growth up to 1–2 quarters ahead and as a leading indicator of the output gap up to 8 quarters ahead. This can be interpreted to mean that a shift in Norges Bank's monetary policy stance rapidly translates into a change in output growth, which will be followed by a change in the output gap in the same direction.

The differential between long-term and short-term interest rates was positive and showed a correlation with GDP growth and the output gap in the period 1993–2005. Table 2 seems to indicate that the interest rate differential functions as a leading indicator of GDP growth to a greater degree than the real short-term interest rate.

There was a positive correlation between the real exchange rate (level or increase) and both GDP growth and the output gap in the period. The increase in the real exchange rate seems to function as a leading indicator of output growth (higher real exchange rate implies, as mentioned, that the Norwegian krone depreciates). On the other hand, the real exchange rate does not appear to provide much information about the output gap. The explanation for this may be that a strong real exchange rate may reflect favourable developments in the real economy and expectations of wider interest rate differentials against other countries. Even if a stronger exchange rate in isolation contribute to lower output growth, these simple correlations indicate that this is not sufficient to trigger a shift in the real economy from expansion to recession.

5 A forecasting model for mainland GDP

5.1 Method

The correlations indicate that several financial variables are indicative of developments in future output. Such a simple correlation analysis is subject to certain limitations, however. First, it only shows the correlation between GPD growth/output gap and one financial variable at a time (lagged or projected ahead). Second, it does not take into account that the financial variables can lead output as a result of interaction between the financial variables. Third, the analysis does not to a sufficient extent (for forecasting purposes) take into account that there may be feedback effects from output to the financial variables.[13]

We therefore extended the analysis by estimating a Simultaneous Equation Model, SEM, for GDP and financial variables. The model takes into account that several financial variables can lead GDP with various lags. It also takes into account interactions between financial variables and possible feedbacks from GDP to financial variables. The model therefore contains an equation for mainland GDP and equations for all the financial variables incorporated in the model. We estimate a pure forecasting model, i.e. the model is not to

[12] Olsen et al. (2003) found that domestic credit growth (C2) can function well in real time as an alternative to the output gap in a Taylor rule for monetary policy.

[13] Such feedback effects are partly captured in that we estimate correlations between GDP growth/output gap and the financial variables in the subsequent quarter.

be used in policy analysis. This reflects that we do not take into account all of the important factors that can influence GDP and financial variables.

The list of financial variables in Table 1 is long in relation to the number of observations in the estimation period 1990–2005. In addition, we wanted to include several lags of each variable. As a consequence, it was not possible in practice to include all the financial variables in a single model. We therefore estimated a number of models where we included a selection of variables. We then simplified these models by imposing restrictions that were not refuted by the data and that facilitated the interpretation of the dynamics and the estimated long-term relationships. The aim was to construct models with a high goodness of fit, reasonable interpretation and stable coefficients. The model below is the one that best satisfied these criteria. Alternatively, we could have given more weight to incorporating variables lagged many quarters so that we could have used this equation alone to forecast GDP several quarters ahead.

We use the logarithm of the level series for the financial variables and mainland GDP. The series are not trend-adjusted. However, we include a linear trend in the GDP equation. The deviation between GDP and the estimated trend effect can be interpreted as a measure of the output gap.

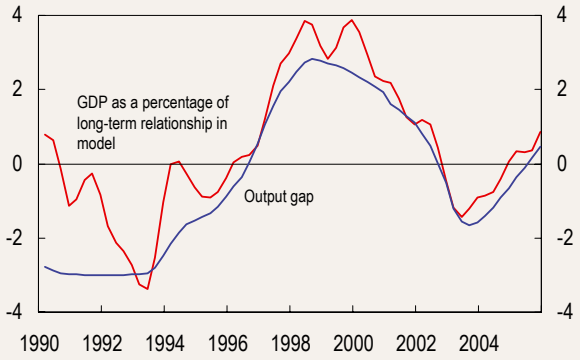
5.2 Preferred model

The preferred model contains three equations and three endogenous variables: real credit to enterprises (C2), real equity prices and mainland GDP (see box). The model thus contains the two financial variables that show the strongest correlation with future values of GDP growth and/or the output gap, as indicated in Tables 2 and 3. We did not find evidence of a structural break in the coefficients as we started estimating in 1990 rather than in 1993. The model has stable coefficients over the estimation period.

The model's GDP relationship (see equation (1) in the box) indicates that growth in domestic real credit to enterprises is informative about GDP growth in the same quarter. The equation also contains effects of GDP growth and growth in credit to enterprises in the previous quarter. If GDP growth is higher than trend growth, estimated at 2.9% here, this will contribute to a positive "output gap". The model is an equilibrium correction model so that a positive output gap in the previous quarter will contribute to lower GDP growth. The output gap, as estimated here, is fairly similar that presented in *Inflation Report* 1/06 from 1996 (see Chart 13).

In the model, growth in domestic real credit to enterprises is influenced by credit growth in the previous quarter and by a long-term relationship that posits that the ratio of real enterprise credit to real equity prices is constant over time (see equation (2) in box). This

Chart 13 Output gap from *Inflation Report* 1/06 and GDP mainland Norway[1] as a percentage of long-term relationship in the model. Per cent. 1990 Q1 – 2005 Q4



[1] GDP mainland Norway is adjusted for seasonality and irregular components.

Sources: Norges Bank and Statistics Norway

implies that enterprises' real credit will increase by 1 per cent in the long term if real equity prices increase by 1 per cent.

The model therefore indicates that real equity prices work through channels that are captured in the real credit to enterprises. These channels can be the consumption channel, credit channel, investment channel and expectations channel (see section 3 for further details). The model thus reveals more complex relationships than indicated by the correlation analysis in Tables 2 and 3.

In the model, real equity prices are positively influenced by GDP growth in the same quarter and in the preceding quarter and by the rise in real equity prices in the preceding quarter. A disturbance to GDP growth will thus influence real equity prices, which in turn will influence real credit growth for enterprises. This will feed back to GDP growth.

Chart 14 shows that the model provides relatively good fit to GDP, real domestic credit to enterprises and real equity prices. Moreover, the model predicts GDP growth 8 quarters ahead fairly well when it is estimated using data up to and including the fourth quarter of 2003 and is simulated dynamically to end-2005 (see Chart 15). The model also predicts developments in real credit to enterprises fairly well the first six quarters of the forecast period, but does not capture the increase in enterprises' real credit in the latter half of 2005. This may be because enterprises have shifted funding from foreign to domestic sources. Total real credit growth for enterprises (C3 mainland enterprises) was lower in 2005. Nor was the model able to predict all of the sharp increase in real equity prices in 2004 and 2005. This may be because equity prices have been influenced by factors that are not included in the model, and perhaps high oil prices in particular. The forecast errors for credit and equity prices are small, however, seen in the context of the uncertainty surrounding the projections, at 95% prediction intervals in the charts.

A Simultaneous Equation Model for Norwegian mainland GDP, real credit to enterprises and real equity prices

$$(1)\quad \Delta gdp_t = \underset{(0.126)}{0.36}\Delta c2_t - \underset{(0.104)}{0.402}\Delta gdp_{t-1} + \underset{(0.075)}{0.135}\Delta c2_{t-1} - \underset{(0.12)}{0.535}\left(gdp - 0.0073TREND - 3.90\right)_{t-1} + \underset{(0.002)}{0.009} - \underset{(0.008)}{0.05}S1 - \underset{(0.008)}{0.09}S2 - \underset{(0.007)}{0.06}S3$$

$$(2)\quad \Delta c2_t = \underset{(0.091)}{0.34}\Delta c2_{t-1} - \underset{(0.0078)}{0.038}\left(c2 - s - 0.50\right)_{t-1} - \underset{(0.0029)}{0.0046} + \underset{(0.005)}{0.023}S1$$

$$(3)\quad \Delta s_t = \underset{(1.594)}{4.213}\Delta gdp_t + \underset{(1.133)}{3.57}\Delta gdp_{t-1} + \underset{(0.113)}{0.272}\Delta s_{t-1} - \underset{(0.023)}{0.041} + \underset{(0.104)}{0.31}S1 + \underset{(0.17)}{0.52}S2 + \underset{(0.11)}{0.37}S3$$

LR test for overidentifying restrictions: $Chi^2(19) =$ 25.449 [0.1463]

System Diagnostics:

Vector test for autocorrelation of orden 1-4:	F(36,127)	=	0.99291 [0.4907]
Vector test for Normality:	$Chi^2(6)$	=	9.9818 [0.1254]
Vector test for heteroscedasticity:	F(120,192)	=	1.1507 [0.1925]

Estimation period: 1990 Q1 – 2005 Q4
Estimation method: Full information maximum likelihood (FIML)
The standard deviations of the coefficients are quoted in parenthesis below the coefficient estimates.
Δ is a difference operator and measures quarterly growth: $\Delta X_t = (X_t - X_{t-1})$.

The variables are defined by (small letters indicate logs of variables):

gdp	=	mainland GDP
c2	=	Domestic credit to enterprises deflated by CPI-ATE
s	=	Equity prices deflated by CPI-ATE
TREND	=	Linear trend

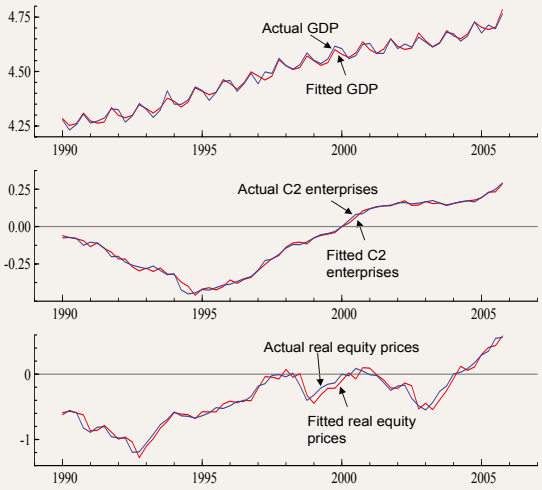
The variables have not been seasonally adjusted or corrected for noise. The seasonal pattern has been dealt with by including seasonal dummies (S1, S2 and S3).

The F-test for the overidentifying restrictions shows that the preferred dynamic simultaneous equation model (SEM) is a valid simplification of an exactly identified model version.[1] The model is stable and standard vector tests do not indicate presence of autocorrelation, normality and heteroscedasticity.

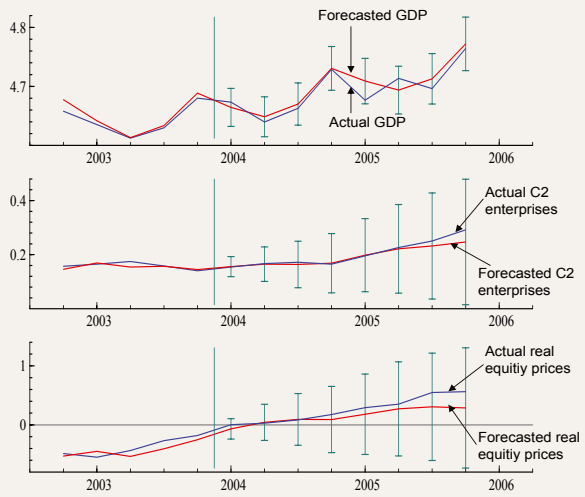
The two lagged level terms in the equation for GDP growth (1) and for growth in domestic real credit to enterprises (2) represent deviations from estimated long run relationships for respectively GDP and enterprises' domestic real credit. The first of these long-run relationships implies that GDP is a trend stationary variable with a yearly growth rate of approximately 2.9%. The second relationship implies a stationary real credit to equity price ratio. This implies that a one percent increase in real equity prices will feed into an equivalent one percent increase in domestic real credit to enterprises in the long run.

[1] The reduced form representation of the exactly identified simultaneous equation model is of order 2 and constitutes a valid reduction of a data congruent VAR of order 6.

Figur 14 Actual and fitted values of GDP Mainland Norway, C2 enterprises and real equity prices. Logarithmic scale. 1990 Q1 – 2005 Q4



Figur 15 Forecasted values of GDP Mainland Norway, C2 enterprises and real equity prices eight quarters ahead from 2004 Q1. Logarithmic scale. 2003 Q1 – 2005 Q4



6 Summary

In this article, we have examined whether financial variables are indicative of future developments in the real economy. A simple (bivariate) correlation analysis showed that house prices, equity prices, credit growth, money growth, real exchange rates, short-term real interest rates and the differential between long-term and short-term interest rates can be leading indicators of GDP growth and/or the output gap.

The analysis was broadened to simultaneous equation modelling. Real equity prices and real domestic credit to enterprises were incorporated in the preferred indicator model in addition to mainland GDP. Developments in equity prices in this model provide information about the long-term level of real credit to enterprises. The model therefore indicates that real equity prices work through channels that are captured in real credit to enterprises. The model provided fairly good fit to GDP, real domestic credit to enterprises and real equity prices. Moreover, the model predicts GDP growth 8 quarters ahead fairly well when it is estimated using data up to and including the fourth quarter of 2003 and simulated dynamically to the end of 2005.

References

Astley, M. S. and A. G. Haldane (1995): "Money as an Indicator", Bank of England, Working Papers No. 35

Bernanke, B. and M. Gertler (1989): "Agency costs, net worth, and business fluctuations", *American Economic Review* no. 79, pp. 14–31

Bernhardsen, T., Ø. Eitrheim, A. S. Jore and Ø. Røisland (2006): "Real time data for Norway: Challenges for monetary policy", *North American Journal of Economics and Finance* no. 16, pp. 333–349

Bø, O., J. I. Røstadsand and E. Tørum (2003): "The reliability of today's financial macroindicators", *Economic Bulletin* 3/03

English, W., K. Tsatsaronis and E. Zoli (2005): "Assessing the predictive power of measures of financial conditions for macroeconomic variables", BIS Papers No. 22, April

Goodhart, C. and B. Hofmann (2000): "Financial variables and the conduct of monetary policy", Sveriges Riksbank Working Paper No. 12

Husebø, T. A. and B-R Wilhelmsen (2005): "Norwegian business cycles 1982–2003", Staff Memo, Norges Bank

Jacobsen, D.-H. and B. Naug (2004): "What influences the growth of household debt?", *Economic Bulletin* 3/04

Olsen, K., J. F. Qvigstad and Ø. Røisland (2003): "Monetary policy in real time. the role of simple rules", BIS Papers No. 19, October

Kallum, J.-R., M. B. Sjåtil and K. Haugland: "Norges Bank's regional network", *Economic Bulletin* 3/05

Kiyotaki, N. and J. Moore (1997): "Credit cycles", *Journal of Political Economy* no. 105, pp. 211–248

Kloster, A. and K. Solberg-Johansen (2006): "Forecasting in Norges Bank", *Economic Bulletin*, 3/06

Langbraaten, N. (2001): "Formuespriser – konsekvenser for pengepolitikken?" ("Asset prices – consequences for monetary policy"), *Penger og Kreditt* 4/2001

Langbraaten, N. and H. Lohrmann (2001): "Formuespriser og konjunkturer – internasjonale erfaringer" ("Asset prices and business cycles – international experience"), *Penger og Kreditt* 1/2001

Mayes, D. and M. Virén (2001): "Financial Conditions Indexes", Bank of Finland Discussion Paper No. 2001–17

Stiglitz, J. E. and A. Weiss (1981): "Credit rationing in markets with imperfect information", *American Economic Review* no. 71, pp. 393–410

Stock, H. J. and M. W. Watson (2001): "Forecasting output and inflation: The role of asset prices", NBER Working Paper 8180

Order flow analysis of exchange rates

Dagfinn Rime, senior adviser in the Research Department of Norges Bank and Elvira Sojli, PhD student at Warwick Business School[1]

Norges Bank recently started to collect new foreign exchange statistics.[2] These statistics provide an overview of which foreign currencies various market participants buy and sell against NOK. Participants' purchases and sales (order flow) are an important variable in exchange rate analysis using microstructure models. Order flow analysis has proved to be helpful in understanding changes in the exchange rate in the short term and the new statistics are well suited for this type of analysis. This article provides an overview of the theory behind order flow analysis and uses the data collected to date to illustrate some concepts.

1 Why order flow analysis?

According to economic theory, exchange rates ought to be determined by a number of macroeconomic conditions. The theory of purchasing power parity posits that the level of the exchange rate between two countries should be the same as the relative price level between the two countries. The theory of uncovered interest parity postulates that the exchange rate today should not systematically deviate from the differential between the exchange rate and interest rate 'some time ago' (depending on the maturity of the interest rates). When combined to create a macro model, for example the Mundell-Fleming model, exchange rates are also determined by GDP growth. Interest rates, inflation, and economic growth are often called *macro fundamentals*.

Empirical studies show that macro fundamentals can explain movements in the exchange rate relatively well, particularly over longer time horizons such as six months or a year, but their explanatory power is lower for daily or weekly horizons. Sometimes, exchange rates seem to live a life of their own, as if completely detached from macro fundamentals.[3]

Exchange rate deviations from fundamentals can be substantial and persist over a sufficiently long period to be significant. What causes such deviations and why do macro fundamentals not 'function' in the short term? This article discusses exchange rate determination in the short term: hence, why exchange rates may deviate from what is believed to be the macro equilibrium exchange rate. Order flow analysis has proved to be useful in establishing this connection and the discussion is therefore based on the theory underlying order flow analysis: the theory of financial market microstructure. Microstructure theory looks at participants in the market and the constraints they face. The application of microstructure theory to the foreign exchange market is a relatively new field of research (late 1990s), and the main contribution to date has been provided by focusing on possible differences in participants' expectations.

That expectations regarding securities prices differ is not new. Insiders in the stock market have been studied for years. Different expectations in the foreign exchange market may, however, seem slightly odd. After all, vast empirical research and the bulk of theory show that exchange rates are determined by macro fundamentals in the long term. Is it not the case that macro fundamentals can be equally well observed by all market participants all the time, and thereby pin down homogeneous expectations? We will therefore look more closely at what might give rise to different expectations in the exchange rate market and how this is captured by order flows. The theory will also be illustrated by an empirical analysis based on the data reported to Norges Bank in the new foreign exchange transaction statistics (see Meyer and Skjelvik, 2006).

2 Different expectations = different information?

When discussing possible sources of differences in expectations, the following expression of the exchange rate may be useful. An exchange rate is determined by:

$$P_t = \frac{E\left[P_{t+1}\left(F_{t+1}\right) \mid \Im_t\right]}{1 + r_t + \rho_t} \qquad (1)$$

where P is the exchange rate (e.g. NOK per EUR), which is a function of expectations regarding discounted future macro fundamentals F and the information set $\Im$, at time on which these expectations are based.[4] E is the ex-pectations operator, r is the interest rate and ρ is a risk premium. The equation implies that today's price is the discounted value of tomorrow's expected price, where tomorrow's expected price is determined by the information available today and anticipated changes in macro fundamentals.

Determining what the correct value of the exchange rate is today is an extremely difficult task because there is so much information that market participants ought to know: What is today's GDP? Or what is the rate of

[1] We would like to thank Bent Vale and Knut Funderud Syrtveit for their useful comments.

[2] The new foreign exchange transaction statistics are described in more detail by Meyer and Skjelvik (2006) in Economic Bulletin 2/2006.

[3] The literature on the exchange rate determination puzzle is extensive and dates back to the early 1980s (Meese and Rogoff, 1983; Cheung, Chinn and Garcia-Pascual, 2003). For those interested, we recommend the overview articles by Frankel and Rose (1995) or Taylor (1995). For a more detailed book about exchange rates, see Sarno and Taylor (2002) and for an introduction to order flow analysis, see Lyons (2001).

[4] Uncovered interest parity is a form of equation (1) where the interest rate is a proxy for fundamentals and can be expressed as follows: $P_t = E\left[P_{t+1} \mid \Im_t\right]\left(1+r^*\right)\Big/\left(1+r+\rho\right)$ where r is the Norwegian interest rate, r* is the foreign interest rate and the risk premium ρ is the excess return required at home in order not to invest abroad.

inflation? Who knows what is 'expected' or what that might imply for GDP or inflation tomorrow, or in a month's time? Difficult? Let us continue: Who knows what the correct discount rate is for exchange rates? And to make things even more difficult: how can you know how exchange rates will *react* to macro fundamentals (the functional form in the expectation, the 'correct' model), when there is insufficient supporting empirical evidence? Finally: Who knows which information set can be used to answer these questions?

A number of disappointing empirical results show that few people are fortunate enough to have the answers to all these questions (see overview articles mentioned in footnote 3). And yet every day, market participants have to base their decision on some form of information when setting their prices (market-makers) or taking a position (investors). We will look more closely at how they might make this decision in the next section and focus on possible reasons for differing expectations in the remainder of the section.

First we would like to clarify one question. Given that it is so difficult to determine the exchange rate, are different expectations necessarily the best way to explain why movements in the exchange rate deviate from what is indicated by macro fundamentals? Understandably, it is difficult to determine the fundamental exchange rate when everyone has equal access to insufficient and uncertain information. But, if participants have rational expectations, they should not make systematic errors, which they seem to do in the short term in the foreign exchange market (when not using the information set used by the market itself). It might be that not all market participants have rational expectations. If that is the case, it seems reasonable to assume that they would also have different expectations. Microstructure theory is based on rational expectations, but the most important results may also apply to bounded rational expectations that can be modelled.

Another reason for different expectations could be that if it is true that public information – information that is the same for everyone – is basically of little use in the short term (as indicated by empirical studies), it would be natural to look for other sources of information that are not necessarily publicly available. This is precisely what most of the world's foreign exchange banks do today and it is also the reason why Norges Bank has started to collect the new foreign exchange transaction statistics.

The information that banks collect and process is called *customer order flows,* which comprise customers' disaggregated purchases and sales of foreign currency. Norges Bank's statistics on foreign exchange transactions provide an overview of how much different customer groups buy and sell. If a customer buys EUR from NOK, we say that the order flow is positive, and if he sells EUR, the order flow is negative. This makes it possible to measure whether there is buying or selling pressure in the market, even though there is of course a purchase for every sale and vice versa.[5] The idea is that the parties to the transaction fulfil different roles. One offers liquidity and the other buys liquidity. Banks set the price and thereby offer liquidity (they make money from the service by selling at a higher rate than they bought). Customers are willing to pay for liquidity and it is therefore assumed that they have a well-founded reason for doing so. It is this well-founded reason that we hope to capture by studying order flows. As there are no disclosure requirements in the foreign exchange market, information concerning customer order flows is a bank's private information.

Information about customer order flows may well be a bank's private information, but information also has to be useful in order to justify collecting and processing it. So, to understand what can be learned from order flows, let us go back to equation (1). We can divide what we learn according to whether it gives us information about the numerator (information set, functional form, etc.) or the denominator (risk premium). The first is the most important, as it comprises information about returns in a world populated by risk-neutral participants. It is therefore referred to as risk-free evaluation information, or just return information. Information about the relevant risk premium is called discount information. Private information about returns or discount rates may either be concentrated on a few participants, e.g. insider information in the stock market, or dispersed among participants. We can therefore draw a two-by-two matrix of what we have learned, if anything, about order flows (see Table 1).

The cells in the table illustrate our reasoning. A leak from the authorities concerning future economic policy would be return-relevant information, and leaks are

Table 1 Possible types of information in order flows.

	Return information	**Discount information**
Concentrated private information	• Leaks from the authorities • Bank with monopolies in important customer segments	*Not so relevant*
Dispersed private information	• Micro elements in trade balance • Behaviour patterns in connection to macro news	• Risk assessment • Risk compensation

[5] Order flows are not the same as excess demand. Excess demand does not necessarily result in actual transactions. Order flows measure the direction of the actual transactions, i.e. it is a vote count of what the equilibrium price ought to be.

often targeted at a very small number of participants (upper left-hand corner). This would correspond to insider information in the stock market and even though such information is considered to be of little relevance in the foreign exchange market, it can be used to illustrate how order flows influence exchange rates.

Assume that the market-maker in a bank suspects that he is dealing with a customer who has this kind of insider information.[6] The customer in question wants to trade in foreign currency and the market-maker quotes the buying and selling prices. If the customer then buys EUR, the market-maker takes this as an (uncertain) signal that the customer in question has information which implies that EUR will increase in value in relation to NOK (EUR appreciates, NOK depreciates). Based on this new information, the market-maker revises his price upwards. He has tried to extract the information underlying the customer's transaction decision by looking at what he actually does.

However, most people believe that concentrated private information is not particularly relevant in the foreign exchange market, but the various bits of information that could help to establish the correct exchange rate are dispersed among many participants. The problem is aggregating the various pieces of information in order to establish the correct exchange rate. This is the task of the market-maker.

Evans and Lyons have studied this in a series of papers. In an article in *Journal of Political Economy* in 2002, they assume that order flows provide information about the necessary risk premiums required to clear the market (lower, right-hand corner). This is the other extreme (insider information being the first). Let us assume that someone sells NOK and buys EUR for reasons that have nothing to do with fundamental economic conditions. Evans and Lyons (2002) show that order flows can still provide valuable information, in that they reveal the risk premium required to return to equilibrium. The market-maker, who receives NOK in the first instance, is often subject to constraints and does not want to hold the position. There are no customers seeking to buy NOK at the current exchange rate, so in order to make buying NOK and selling EUR attractive to customers, the exchange rate has to change. If the NOK exchange rate depreciates slightly, other customers may be interested in selling EUR and buying NOK, as they believe they are being compensated for the risk of holding NOK, which they did not want in the first place, by selling at a higher exchange rate.

Evans and Lyons (2003) show that order flows can also reflect return-relevant information that is dispersed among participants. Again, let us illustrate with a plausible example, this time related to the lower, left-hand corner in Table 1. The most recent productivity figures are high. In a world where all expectations and information are the same, the exchange rate would simply jump to a new equilibrium level. But in a world with different expectations, market-makers have to interpret the news. Were expectations too high or too low and what are the implications for the exchange rate? A possible equilibrium is one where the dominant perception around the news' implications for the exchange rate is the one that will ultimately determine the exchange rate. How do market-makers identify the dominant view? By counting the votes of the market! Those who believe that the exchange rate will appreciate are most likely to buy EUR, and those who think it will depreciate will sell EUR. If the order flow is positive (purchases exceed sales), this tells market-makers that the dominant view in the market is that the exchange rate will appreciate on the basis of the new information. Evans and Lyons (2003) find that order flows, in particular, can help to explain a substantial share of the reaction to such announcements, contrary to what one might believe, if the market agreed on how the announcement should be interpreted.

One final example studied in Evans and Lyons (2005) is based on the assumption that macro figures are an aggregate of an array of micro information and are announced with a lag. Is it, for example, possible that a bank with a large number of customers in the import and export business might get an early indication of what the next trade balance figures are likely to be? If the bank has more or less a monopoly in a customer segment that is important to the trade balance, for example, a monopoly on oil business transactions, it is possible that it has concentrated private information about the next trade balance figures (upper left-hand corner in Table 1). On the other hand, if the bank is one of many in the market, it is more likely that order flows will reflect dispersed micro elements of information that will be aggregated and published as macro fundamentals (lower left-hand corner). Using data from Citibank, Evans and Lyons show that financial customers' order flows can predict macro 'shocks' one quarter in advance!

Some analysts may raise the following objections to the above: Buying and selling foreign currency is nothing more than good old-fashioned supply and demand and price adjustments are simply made to achieve equilibrium. There is of course some truth to this, but that is forgetting that securities prices also have a role in aggregating information. It is this role that we have highlighted and that we believe is most important. In the majority of foreign exchange market models, where all parties have equal information, exchange rates will *jump* when new information becomes available. This jump will create a new equilibrium without the need for any exchange rate transactions (supply and demand curves jump by the same amount). There is quite simply too much trading in the foreign exchange market for a perspective based on symmetric information to be reasonable. Another objection to the interpretation that order flows correlate with exchange rates might be that only transactions based on technical analysis drive

[6] The market-maker is defined here as dealers in the interbank market and dealers who receive customer orders.

the exchange rate. In technical analysis, the decision to trade is based on historical information and such feedback trading may of course be part of the explanation for the importance of order flows. However, several papers have shown that the causality direction is from order flows to exchange rates. The opposite would be the case if technical analysis was the dominant underlying factor.[7]

3 An example based on foreign exchange transaction statistics

The examples above give a simple empirical prediction: if there is net buying pressure for EUR (positive order flow), the exchange rate will rise (the krone depreciates). The results of Evans and Lyons (2002) are noteworthy: using daily data over a 4-month period, they can explain over 60 per cent of movements in the Deutche mark/dollar exchange rate. Naturally, exchange rates are not only driven by order flows, so the interest rate differential is also included in the regression equation. The interest rate differential, however, can only explain 1 per cent of the changes. Other studies have confirmed Evans and Lyons' findings, albeit with lower levels of explanatory power.[8]

However, in order for information to be useful in a financial context, the effect of order flow cannot "disappear", it has to be permanent. To understand this, imagine a random walk model for securities prices. In such a model, a shock would have a permanent effect. The price jumps when the shock occurs and after the shock, expected prices are the same as the current prices. The effect from the shock does not dissipate. The price in a random walk model is a function of cumulative shocks. Similarly, the level of the exchange rate must be a function of cumulative customer order flows. Hence, the exchange rate and cumulative customer order flows can be said to be cointegrated.

The random walk comparison above results in several postulates. New information is by definition, unexpected. It is the information that drives the exchange rate and not the exchange rate that drives the information. Customer order flows should be exogenous in relation to the exchange rate. Furthermore, it is the unexpected elements of order flow that drives exchange rate fluctuations. The expected elements will already be impounded in the price.

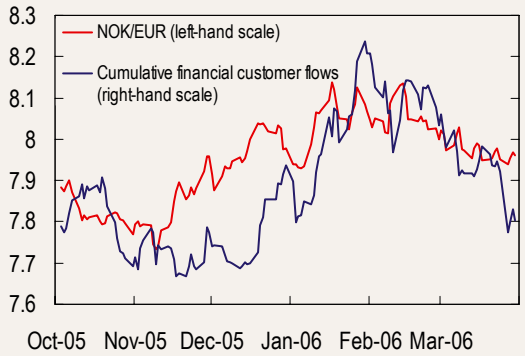
The final postulate is the following: If there is no uncertainty, there is nothing to learn from order flows and consequently order flows have no explanatory power. This implies that the effect from order flow will vary according to uncertainty in the market, which may make it difficult to find stable coefficients over longer periods of time. In longer data series than the one used here, it may be important to take into account the possibility of such instability.

Bearing this in mind, we test the model on the first 129 daily observations in the new statistics on foreign exchange transactions (see Meyer and Sjelvik (2006) for a more detailed description of the data). The sample size is relatively small, so this should only be taken as an illustration and not a complete model ready for use in analysis. Several Norwegian and foreign banks report their purchases and sales in foreign currency against NOK, in transactions with a number of defined customer groups. Since earlier studies show that the explanatory power of transactions initiated in the financial sector (excluding banks) is good, we will focus on this group's trading in NOK/EUR.[9] The order flow variable used is the sum of all spot and forward transactions. Some of the spot transactions may be secured with (reverse) forward transactions and by adjusting for this, we get a proxy for unsecured, speculative spot transactions. The 3-month interest rate differential against the euro area, is used as a proxy for macro fundamentals.

Chart 1 shows the fluctuations in the level of the NOK/EUR exchange rate and the cumulative order flow from financial customers. From the chart we notice that financial customer's order flow and the NOK exchange rate appear to be cointegrated and that there might be a long-term relationship between them. The depreciation until the end of January 2006 was followed by a build-up of EUR holdings, which were then gradually reduced as the exchange rate appreciated (accumulated NOK).

Tests confirm that order flow and exchange rate are cointegrated, the interest rate differential (not stationary in this selection) and exchange rates are cointegrated,

Chart 1 NOK/EUR exchange rate and cumulative order flow from financial customers



We have excluded values on the right-hand scale for financial customers as this is not publicly available data.

Source: EcoWin and Norges Bank.

[7] Danielsson and Love (2006) show that if the possibility of technical analysis is taken into account when measuring order flows, the effect of order flows that are not based on technical analyses, is in fact greater!

[8] Rime (2001a, b), Evans (2002), Payne (2003), Bjønnes and Rime (2005), Bjønnes, Rime and Solheim (2005), Froot and Ramadorai (2005), Marsh and O'Rourke (2005), Danielsson and Love (2006), Killeen, Lyons, Moore (2006), Danielsson and Love (2006), Rime, Sarno and Sojli (2006).

[9] See Fan and Lyons (2003), Bjønnes, Rime and Solheim (2005) and Marsh and O'Rourke (2005).

and the exchange rate, order flow and interest rate differential are cointegrated.[10] The preferred model is presented in Table 2.

The cointegrating relationship is shown at the top of the table and the equilibrium correction VAR in the lower part. All figures in brackets are t-statistics. The interest rate has a strong effect in the cointegrating relationship. If Norwegian interest rates rise by 0.25 percentage point and European interest rates remain unchanged, the NOK/EUR exchange rate appreciates by 4 per cent. The effect from order flows is smaller. If financial customers buy EUR equivalent to NOK 1 billion, the exchange rate depreciates by 0.27 per cent. Is that a little? A billion is of course a substantial amount of money, but for a group as a whole it is far from an inconceivable amount. In addition, compared with an average daily movement of 0.01 per cent in the exchange rate, order flow induced fluctuation are relatively substantial and are also substantial compared with other studies. The trend ought to capture the effect of other variables that are not included in the model.

The first line in the equilibrium correction VAR is the equilibrium correction term. It is the residual term from the previous day's co-integration equation. The minus sign in front of the error correction value means that if the exchange rate level yesterday was higher than implied by the interest differential, order flow and trend, there will be a downward adjustment today. As the error correction term is not significant in the equation for the interest differential, the interest differential does not respond to deviations from the cointegration equation. The interest rate differential is thus said to be weakly exogenous. Order flow is possibly also weakly exogenous, but this conclusion should be viewed with caution as it is not exogenous in other models not presented here. We see from the penultimate line that the model can explain 19 per cent of the daily fluctuations in the NOK/EUR exchange rate. This may not be high, but it is higher than the results of many other foreign exchange rate studies. In this analysis we have not separated expected order flow from the unexpected one.

Given the fluctiations in market conditions and investors' appetite for risk, order flow coefficients might not be stable. One way of dealing with the problem of unstable coefficients is to adjust the order flow with a variable that captures uncertainty in the market. Although uncertainty in the market is not an observable variable, there are several possible candidates. We have multiplied order flow by the differential between the highest and lowest quoted exchange rate in the course of the day, divided by the average differential for the whole selection. The idea is that days with a wider than average gap between the highest and the lowest exchange rate are characterised by greater uncertainty. There was little qualitative difference in the results when we included such an adjustment.

4 Conclusion

In recent years, order flow analysis has produced some promising results in terms of explaining movements in the exchange rate. The new statistics on foreign exchange transactions mean that Norges Bank now has high quality statistics that can be used for order flow analysis of the Norwegian foreign exchange market.

Order flows are central to microstructure theory as they are thought to be a variable that exposes the

Table 2 Cointegrating relationships and vector-equilibrium correction model

log(NOK/EUR) = 2.09 – 0.16 • Interest Diff + 0.0027 • Fin. Order Flow – 0.0002 • trend
(–9.52) (2.37) (4.09)

	Δ log(NOK/EUR)	Δ Interest Diff	Δ Fin. Order Flow
Equilibrium correction	–0.25938	–0.38212	18.20015
	(–5.02)	(–1.07)	(1.80)
Δ logNOK/EUR (–1)	0.30719	0.31234	48.20678
	(3.68)	(0.53980)	(2.96)
Δ Interest Diff (–1)	0.03286	–0.02112	3.16451
	(2.26)	(–0.21)	(1.12)
Δ Fin. Order flow (–1)	–0.00004	–0.00323	–0.46771
	(–0.09)	(–1.17)	(–6.00)
Constant term	0.00014	–0.00231	0.00506
	(0.56)	(–1.36)	(0.11)
Explanatory degree (adj. R^2)	0.19	–0.01	0.26
NB/selection	127	6.10.2005 – 31.03.2006	

log(NOK/EUR) is the logarithm of the NOK/EUR exchange rate at end-of-day (source: EcoWin).
Interest Diff. is the difference between the Norwegian and Euro area 3-month interest rate.
Fin. Order Flow is the cumulative order flow for financial customers. Greek Δ indicates first differential. Figures in brackets are t-statistics.

[10] The interest rate differential for longer horizon interest rates is, however, not cointegrated with the exchange rate in this sample.

'motive' of the participant initiating the transaction. By observing order flows, market-makers who determine the exchange rate can access the information of traders. They can thus aggregate information, which they previously did not have, into the exchange rate.

Order flow analysis was applied to the first data set from the foreign exchange transaction statistics. The series is relatively short, but the results partly supported the theory and provide hope that future analyses may help us to better understand the functioning of the foreign exchange market.

References

Bjønnes, G.H., D. Rime and H.O.A. Solheim (2005): "Liquidity provision in overnight foreign exchange market", *Journal of International Money and Finance*

Bjønnes, G.H. and D. Rime (2005): "Dealer Behaviour and Trading Systems in Foreign Exchange Markets", *Journal of Financial Economics*

Cheung, Y.-W., M.D. Chinn and A.G. Pascual (2003): "Recent Exchange Rate Models: In-Sample Fit and Out-of-Sample Performance", in P. De Grauwe (ed.) Exchange Rate *Modelling: Where Do We Stand?* Cambridge University Press, Cambridge

Danielsson, J. and R. Love (2006): "Feedback trading", *International Journal of Finance and Economics*

Evans, M.D.D. (2002): "FX trading and exchange rate dynamics", *Journal of Finance*

Evans, M.D.D. and R.K. Lyons (2002): "Order flow and exchange rate dynamics", *Journal of Political Economy*

Evans, M.D.D. and R.K. Lyons (2003): "How is macro news transmitted to exchange rates", NBER WP 9433

Evans, M.D.D. and R.K. Lyons (2005): "Exchange rate fundamentals and order flow", UC Berkeley WP

Fan, M. and R.K. Lyons (2003): "Customer Trades and Extreme Events in Foreign Exchange", in P. Mizen (ed.), *Monetary History, Exchange Rates and Financial Markets: Essays in Honour of Charles Goodhart,* Edward Elgar: Northampton, MA, USA

Frankel, J.A. and A.K. Rose (1995): "Empirical research on nominal exchange rates", in G.M. Grossman and K. Rogoff (ed.), *Handbook of International Economics,* vol. 3, chap. 33, North-Holland, Amsterdam

Froot, K. and T. Ramadorai (2005): "Currency Returns, Institutional Investor Flows, and Exchange Rate Fundamentals", *Journal of Finance*

Killeen, W.P., R.K. Lyons and M.J. Moore (2006): "Fixed versus Flexible: Lessons from EMS Order Flow", *Journal of International Money and Finance*

Lyons, R.K. (2001): *The Microstructure Approach to Exchange Rates,* MIT Press, Cambridge, MA, 2001

Marsh, I. and C. O'Rourke (2005): "Customer Order Flows in Foreign Exchange Markets: Do They Really Contain Information?" Working Paper, Cass Business School

Meese, R.A. and K. Rogoff (1983): "Empirical Exchange Rate Model of the Seventies: Do They Fit Out of Sample", *Journal of International Economics*

Meyer, E. and J. Skjelvik (2006): "Statistics on foreign exchange transactions – new insight into foreign exchange markets", *Economic Bulletin*, 2/2006

Payne, R. (2003): "Informed Trade in Spot Foreign Exchange Markets: An Empirical Investigation", *Journal of International Economics*

Rime, D. (2001a): "Private or Public Information in Foreign Exchange Markets? An Empirical Analysis", unpublished paper

Rime, D. (2001b): "US exchange rates and currency flows", unpublished paper

Rime, D; L. Sarno and E. Sojli (2006): "Exchange Rate Forecasting, Order Flow and Macroeconomic Information", unpublished paper, Norges Bank and Warwick Business School

Sarno, L. and M. Taylor (2002): *The Economics of Exchange Rates,* Cambridge University Press

Taylor, M. (1995): "The economics of exchange rates", *Journal of Economic Literature*

Tables

Norges Bank publishes more detailed and updated statistics on the Internet (www.norges-bank.no). The advance release calendar on the website shows when new figures for the statistics in question will be released.

Standard symbols:

. Category not applicable
.. Data not available
... Data not yet available
– Nil
0 } Less than half the
0.0 } final digit shown

Table 1. Norges Bank. Balance sheet. In millions of NOK

	31.12.2004	31.12.2005	30.06.2006	31.07.2006
Financial assets	**1 287 865**	**1 744 576**	**1 846 342**	**1 864 795**
International reserves	268 360	318 163	307 986	319 337
Investments for the Government Pension Fund - Global	1 015 471	1 397 896	1 504 419	1 528 358
Other assets	4 034	28 517	33 937	17 100
Liabilities and capital	**1 287 865**	**1 744 576**	**1 846 342**	**1 864 795**
Foreign liabilities	51 167	63 333	92 630	95 951
Deposits Government Pension Fund - Global	1 015 471	1 397 896	1 504 419	1 528 358
Notes and coins in circulation	47 595	51 910	50 299	49 267
Other domestic liabilities	126 330	162 815	140 779	133 405
Capital	47 302	68 622	58 215	57 814

Source: Norges Bank

Table 2. Norges Bank. Investments for Government Pension Fund - Global. In millions of NOK

	31.12.2004	31.12.2005	31.03.2006	30.06.2006
Total investments	**1 015 471**	**1 397 896**	**1 483 619**	**1 504 420**
Fixed income securities	631 256	682 024	785 047	746 861
Equities	407 673	576 683	603 624	600 826
Lending (reverse repos etc.)	380 117	558 979	556 186	689 872
Borrowing (repos etc.)	-406 194	-438 717	-456 642	-529 545
Other investments	2 619	18 927	-4 596	-3 594

Source: Norges Bank

Table 3. Banks. Balance sheet. In millions of NOK

	31.12.2004	31.12.2005	30.06.2006	31.07.2006
Financial assets	**1 805 276**	**2 137 696**	**2 445 358**	**2 410 630**
Cash and deposits	87 227	128 597	195 162	153 669
Bonds and notes	147 597	162 837	198 329	196 201
Loans to the general public	1 303 655	1 542 685	1 690 706	1 707 810
Other loans	155 110	191 168	213 466	211 197
Other assets	111 688	112 409	147 694	141 752
Liabilities and capital	**1 805 276**	**2 137 686**	**2 445 358**	**2 410 630**
Deposits from the general public	844 782	928 042	1 041 622	1 038 425
Other deposits from residents	83 408	108 502	113 068	97 080
Deposits from non-residents	209 277	309 878	409 114	413 540
Bonds and notes	422 410	499 899	548 284	540 844
Other liabilities	134 799	169 237	197 059	183 852
Capital and profit / loss	110 600	122 127	136 211	136 889

Source: Norges Bank

Table 4. Banks. Loans and deposits by public sectors. In millions of NOK

	31.12.2004	31.12.2005	30.06.2006	31.07.2006
Loans to:	**1 303 655**	**1 542 685**	**1 690 706**	**1 707 810**
Local government (incl. municipal enterprises)	2 832	2 562	2 539	2 573
Non-financial enterprises	362 765	436 977	500 524	506 436
Households	938 058	1 103 147	1 187 643	1 198 801
Deposits from:	**844 782**	**928 042**	**1 041 622**	**1 038 425**
Local government (incl. municipal enterprises)	34 731	37 661	46 114	44 757
Non-financial enterprises	268 049	314 773	363 410	366 871
Households	542 002	575 608	632 099	626 797

Source: Norges Bank

Table 5. Profit/loss and capital adequacy. Per cent of average total assets

	2004	2005	2006 Q 1	2006 Q 2
Interest income	4,2	4,4	4,5	4,7
Interest expenses	2,4	2,7	3	3,1
Net interest income	1,8	1,7	1,5	1,5
Operating profit before losses	1,1	1,2	1,1	1,1
Losses on loans and guarantees	0,1	-0,1	-0,1	-0,0
Ordinary operating profit (before taxes)	1,1	1,3	1,2	1,1
Capital adequacy	12,2	11,9	11,6	11,4
- of which core capital	9,8	9,5	9,2	8,9

Source: Norges Bank

Table 6. Banks. Average interest rates on NOK loans and deposits. Per cent per annum

	30.09.2005	31.12.2005	31.03.2006	30.06.2006
1. Loans (1)	3,93	4,02	4,07	4,23
2. Deposits (2)	1,48	1,62	1,78	1,97
Interest margin (1 - 2)	2,46	2,40	2,29	2,26

Source: Norges Bank

Table 7. Securities registered with the Norwegian Central Securities Depository (VPS), by issuing sector. Nominal values. In millions of NOK

	Interest-bearing securities		Equities	
	31.12.2005	30.06.2006	31.12.2005	30.06.2006
Total	**718 550**	**758 167**	**134 050**	**139 240**
Central government	207 622	224 195	0	0
Banks	245 637	243 985	32 282	32 246
Other financial institutions	67 489	64 997	20 224	20 240
Public non-financial enterprises	29 773	33 937	17 522	17 522
Private non-financial enterprises	62 818	70 803	52 718	56 761
Other resident sectors	71 428	68 232	197	197
Non-residents	33 784	52 016	11 107	12 274

Sources: Norwegian Central Securities Depository and Norges Bank

Table 8. Securities registered with the Norwegian Central Securities Depository (VPS), by holding sector. Estimated market values. In millions of NOK

	Interest-bearing securities		Equities	
	31.12.2005	30.06.2006	31.12.2005	30.06.2006
Total	**747 764**	**778 943**	**1 529 404**	**1 770 381**
Central government	46 137	52 012	466 511	528 452
Banks	105 117	121 701	13 728	21 854
Insurance companies	288 338	281 609	42 334	40 587
Mutual funds	95 637	101 124	55 723	57 419
Other financial enterprises	8 534	7 893	27 366	30 107
Private non-financial enterprises	36 408	34 441	266 592	328 321
Households	35 610	36 447	77 094	75 901
Other resident sectors	42 659	41 388	17 647	22 443
Non-residents	89 326	102 326	562 410	665 298

Sources: Norwegian Central Securities Depository and Norges Bank

Table 9. Credit indicators and money supply. In billions of NOK and per cent

	Stock	Growth last 12 months. Per cent		
	31.07.2006	31.05.2006	30.06.2006	31.07.2006
C2, credit from domestic sources	2 451	13,7	14,4	14,4
C2, households	1 483	13,0	12,9	12,7
C2, non-financial enterprises	790	17,4	19,4	19,7
C2, local government	178	5,2	6,1	6,1
Total credit from domestic and foreign sources, C3 [1]	2 928	11,7	13,4	…
Narrow money M0	68	9,0	23,6	-1,7
Broad money M2	1 174	11,9	13,0	12,3
M2, households	663	6,3	5,9	4,7
M2, non-financial enterprises	377	32,1	36,5	35,1

[1] C3 as at 30.06.2006

Source: Norges Bank

Table 10. Household financial account. Transactions in billions of NOK

	2003	2004	2005 Q 4	2006 Q 1
Currency and deposits	26,4	28,0	-7,1	15,3
Equities and primary capital certificates	28,7	39,8	4,5	-0,8
Mutual fund shares	2,6	-0,5	30,3	-8,7
Insurance technical reserves	54,1	52,3	14,9	25,2
Other assets	36,0	28,2	11,3	12,5
Net acquisition of financial assets	147,9	147,8	53,8	43,5
Loans from banks	92,3	113,8	29,5	30,5
Other loans	18,1	17,6	20,6	4,3
Other liabilities	-0,3	3,4	1,8	-7,9
Net incurrence of liabilities	110,1	134,8	52,0	26,9
Net financial investments	37,8	13,0	1,9	16,6

Source: Norges Bank

Table 11. Consumer price indices. 12-month growth. Per cent

	2005:12	2006:06	2006:07	2006:08
Norway (CPI)	1,8	2,1	2,2	1,9
Norway, adjusted for tax and excluding energy products	0,9	0,8	0,6	0,4
US	3,4	4,3	…	…
Euro area	2,2			…
Germany	2,1	2,0	…	…
UK	2,2	3,3	…	…
Sweden	0,9	1,5	…	…

Sources: Statistics Norway and IMF

Tables previously published in *Economic Bulletin*

The Statistical Annex in *Economic Bulletin* has been reduced with effect from no. 1/06. The following is a list of tables published up to and including no. 4/05, with website references.

Financial institution balance sheets
http://www.norges-bank.no/english/balance/
1. Norges Bank. Balance sheet

http://www.norges-bank.no/front/statistikk/en/
2. Norges Bank. Specification of international reserves
3. State lending institutions. Balance sheet
4. Banks. Balance sheet
5. Banks. Loans and deposits by sector
6. Mortgage companies. Balance sheet
7. Finance companies. Balance sheet

http://www.ssb.no/emner/10/13/10/forsikring_en/
8. Life insurance companies. Main assets
9. Non-life insurance companies. Main assets

http://www.norges-bank.no/front/statistikk/en/
10a. Mutual funds' assets. Market value
10b. Mutual funds' assets under management by holding sector. Market value

Securities statistics
http://www.norges-bank.no/front/statistikk/en/
11. Shareholding registered with the Norwegian Central Securities Depository (VPS), by holding sector. Market value
12. Share capital and primary capital certificates registered with the Norwegien Central Securities Depository, by issuing sector. Nominal value
13. Net purchases and net sales (-) in the primary and secondary markets of shares registered with the Norwegian Central Securities Depository, by purchasing purchasing/selling and issuing sector. Market value
14. Bondholdings in NOK registered with the Norwegian Central Securities Depository, by holding sector. Market value
15. Bondholdings in NOK registered with the Norwegian Central Securities Depository, by issuing sector. Nominal value
16. Net purchases and net sales (-) in the primary and secondary markets for NOK-denominated bonds registered with the Norwegian Central Securities Depository, by purchasing, selling and issuing sector. Market value
17. NOK-denominated short-term paper registered with the Norwegian Central Securities Depository, by holding sector. Market value
18. Outstanding short-term paper, by issuing sector. Nominal value

Credit and liquidity trends
http://www.norges-bank.no/front/statistikk/en/
19. Credit indicator and money supply
20. Domestic credit supply to the general public, by source
21. Composition of money supply
22. Household financial balance. Financial investments and holdings, by financial instrument

http://www.norges-bank.no/cgi-bin/pml.cgi
23. Money market liquidity

Interest rate statistics
http://www.norges-bank.no/english/statistics/interest_rates/interest_rates.html
24. Nominal NOK interest rates

Not published on Norges Bank's website
25. Short-term interest rates for key currencies in the Euro-market

http://www.norges-bank.no/english/statistics/interest_rates/interest_rates.html
26. Yields on Norwegian bonds

Not published on Norges Bank's website
27. Yields on government bonds in key currencies

http://www.norges-bank.no/front/statistikk/en/
28. Banks. Average interest rates and commissions on utilised loans in NOK to the general public at end of quarter
29. Banks. Average interest rates on deposits in NOK from the general public at end of quarter
30. Life insurance companies. Average interest rates by type of loan at end of quarter
31. Mortgage companies. Average interest rates, incl. commissions on loans to private sector at end of quarter

Profit/loss and capital adequacy data
http://www.norges-bank.no/english/financial_stability/
32. Profit/loss and capital adequacy: banks
33. Profit/loss and capital adequacy: finance companies
34. Profit/loss and capital adequacy: mortgage companies

Exchange rates
http://www.norges-bank.no/english/statistics/exchange/
35. The international value of the krone and exchange rates against selected currencies. Monthly average of representative market rates

Not published on Norges Bank's website
36. Exchange cross rates. Monthly average of representative exchange rates

Balance of payments
http://www.ssb.no/english/subjects/09/03/ur_en/
37. Balance of payments

http://www.ssb.no/english/subjects/09/04/finansutland_en/
38. Norway's foreign assets and liabilities

International capital markets
http://www.bis.org/publ/qtrpdf/r_qt0512.htm
39. Changes in banks' international assets
40. Banks' international claims by currency

Foreign currency trading
http://www.norges-bank.no/front/statistikk/en/vhandel/
41. Foreign exchange banks. Foreign exchange purchased/sold forward with settlement in NOK

The underlying data is no longer available
42. Banks' foreign exchange position

B-blad/Economique

Returadresse:
Norges Bank
Postboks 1179 Sentrum
N-0107 Oslo
Norway

Economic Bulletin No. 3 - October - 2006

ISSN 0029-1676