Financial variables and developments in the real economy

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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

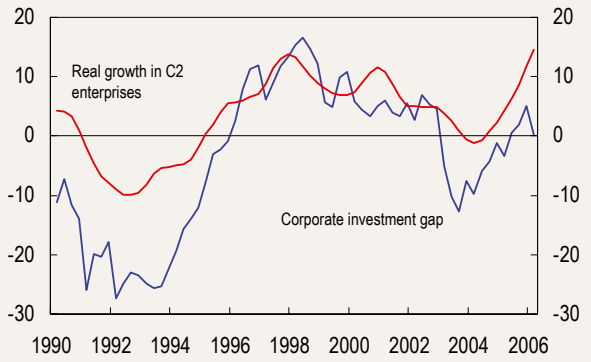
Enterprises often finance a share of the purchase sum with loans from credit institutions or by issuing bonds when making new investments. Alternatively, they can issue shares. An increase in corporate credit is registered in monthly credit statistics, and may thus provide information about developments 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

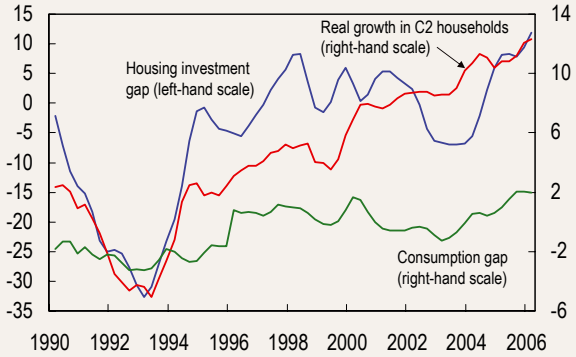
Households also debt-finance a share of the purchase sum when buying a home or durable consumer goods. Credit to households may thus potentially contain information about developments in consumption and housing investment. Households' foreign borrowing is limited, and C2 households are thus representative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

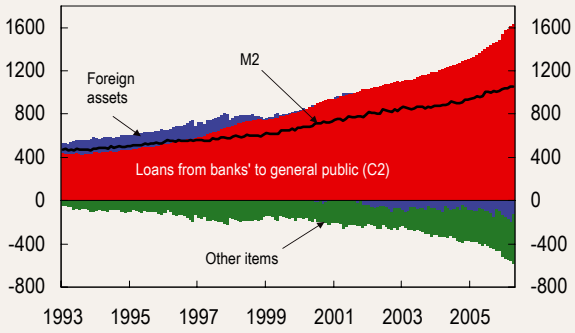
Chart 2 Consumption gap, housing investment gap and real growth in C2 households.[1] Per cent. 1990 Q1 – 2006 Q1



[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.

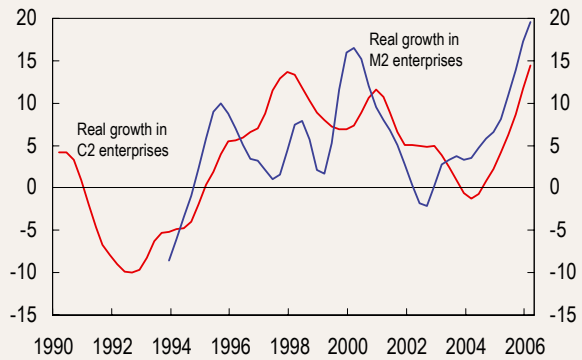
However, it is uncertain whether monetary growth contains information about developments in the real economy beyond that already contained in credit growth. The corollary to an increase in monetary growth is often an increase in credit growth (see Chart 3). This relationship seems to be clearest for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

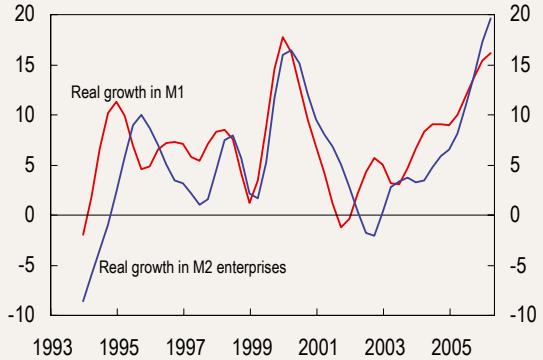
Chart 4 Real growth in M2 enterprises and C2 enterprises[1]. Per cent. 1990 Q1 – 2006 Q1



[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

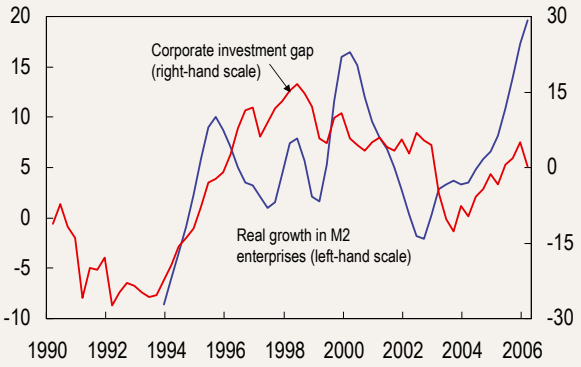


[1] The series are adjusted for seasonality and irregular components.

Source: Norges Bank

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

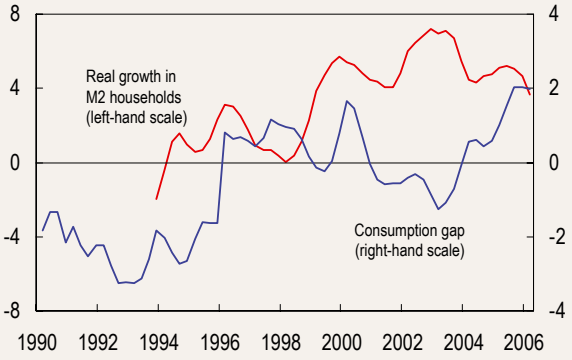
Chart 6 Corporate investment gap and real growth in M2 enterprises.[1)]
Per cent. 1990 Q1 – 2006 Q1



[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.

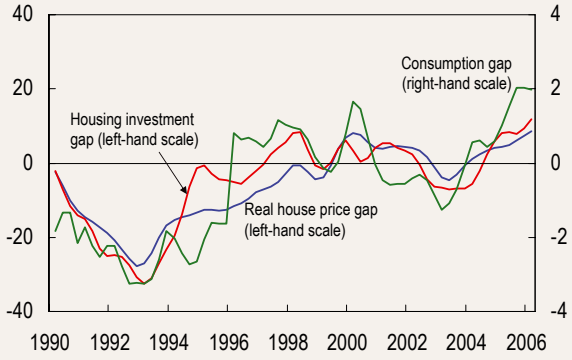
There seems to have been a close relationship between cyclical developments in real house prices and housing investment since the beginning of the 1990s (see Chart 8). Moreover, there seems to have been a positive relationship between the real house price gap and the consumption gap. Developments in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

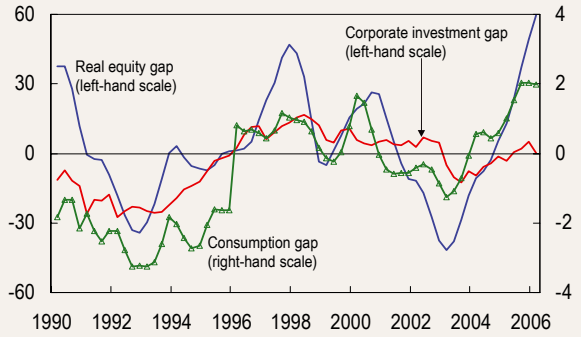
Chart 8 Real house price gap, consumption gap and housing investment gap.[1)] Per cent. 1990 Q1 – 2006 Q1



[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

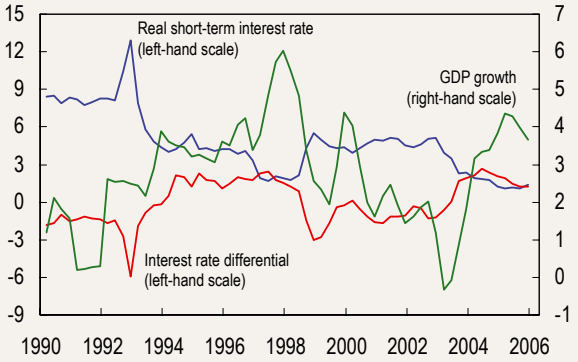
Chart 9 Real equity gap, corporate investment gap and consumption gap.[1] Per cent. 1990 Q1 – 2006 Q1



[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.

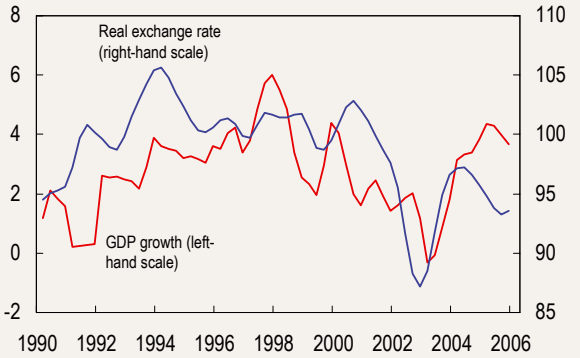
It is primarily interest rate expectations that influence the krone exchange rate and business and household demand. However, it is reasonable to assume that interest rate expectations have been closely linked to short-term interest rates over the past 10–15 years. We have therefore investigated whether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

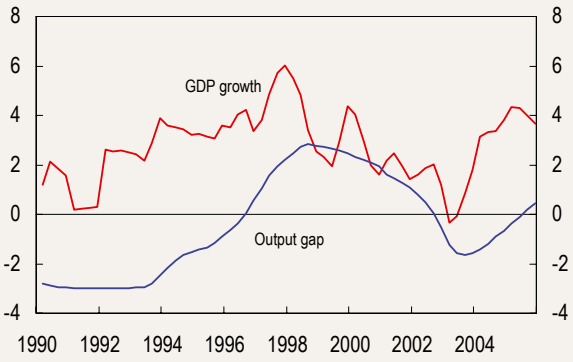
Chart 11 The real exchange rate and GDP growth.[1] Per cent.
1990 Q1 – 2006 Q1



[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.

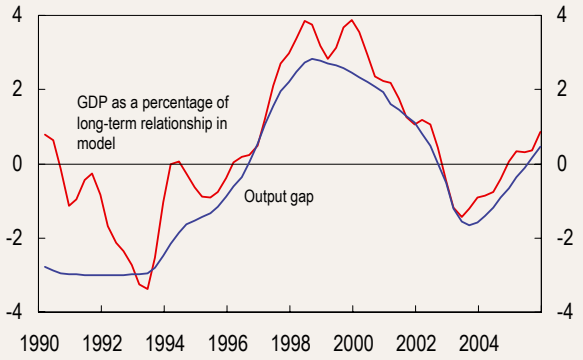
5.2 Preferred model

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

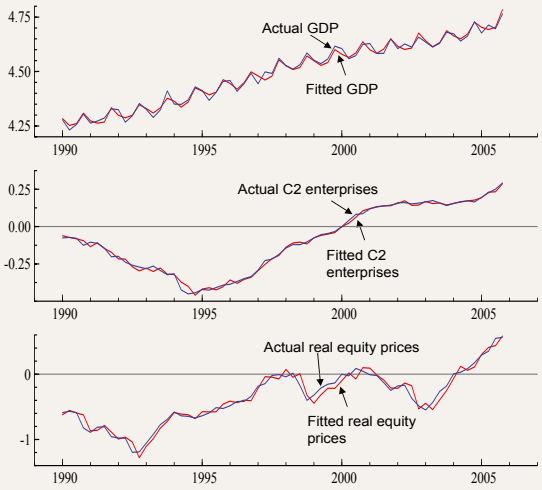
The variables have not been seasonally adjusted or corrected for noise. The seasonal pattern has been dealt with by including seasonal dummies (S1, S2 and S3).

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.

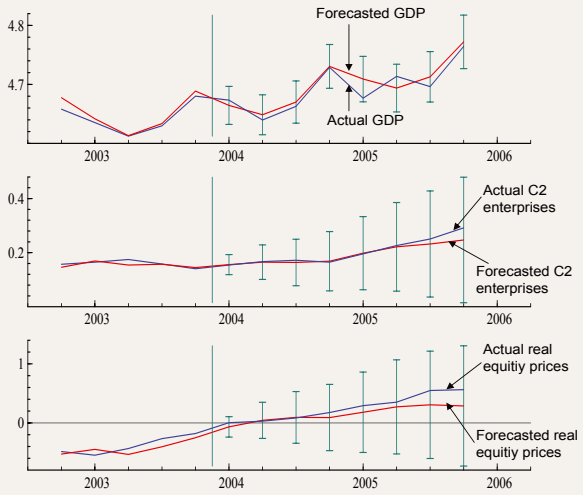
The two lagged level terms in the equation for GDP growth (1) and for growth in domestic real credit to enterprises (2) represent deviations from estimated long run relationships for respectively GDP and enterprises' domestic real credit. The first of these long-run relationships implies that GDP is 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.

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