

What drives house prices?

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House prices have more than tripled since 1992. After having fallen during the last part of 2002 and the beginning of 2003, house prices rose by more than 20 per cent from May 2003 to November 2004. We analyse factors underlying the pronounced rise in house prices using an empirical model. We find that interest rates, housing construction, unemployment and household income are the most important explanatory factors for house prices. The analysis indicates that house prices react quickly and strongly to changes in interest rates. Thus, a considerable portion of house price inflation since May 2003 can be explained by the fall in interest rates in the last two years. Conversely, the fall in interest rates will only make a modest contribution to house price inflation in 2005. An interest rate increase in line with the interest rate path in *Inflation Report 3/04* can in isolation lead to a 3-3½ per cent fall in house prices per year in 2006 and 2007. However, this interest rate path reflects an expected decline in unemployment and an expected increase in the growth of wage income. The model implies that house prices will increase by 2-4 per cent per year in the period 2005-2007 if interest rates, unemployment, income and housing construction develop in line with the analyses in *Inflation Report 3/04*. We find no evidence that house prices are overvalued in relation to a fundamental value determined by interest rates, income, unemployment and housing construction.

Introduction

Developments in house prices may be important for activity in the Norwegian economy. First, house prices affect activity in the construction sector. New housing construction projects will be profitable if house prices increase in relation to building costs. This stimulates housing investment. Second, house prices affect household demand. Higher house prices mean an increase in wealth for homeowners and some owners will want to extract some of this gain to increase consumption. This effect is amplified by the fact that homeowners increasingly have the possibility of raising mortgage-secured loans when house prices rise – at interest rates that are often far lower than for other types of loans.

Developments in house prices also affect household borrowing for house purchases. An increase in house prices will fuel debt accumulation for a long period (see Jacobsen and Naug 2004), reflecting the fact that only a small portion of the housing stock changes hands each year. Even if house prices gradually level off, there will be a long period when selling prices are higher than the last time the dwelling changed hands.

Mortgage-secured loans account for more than 80 per cent of banks' lending to households. If house prices decline, collateral values can fall below the value of the housing loan for some households. Banks' loan losses will increase if these households are unable to service their debt. As a result, banks may become more reticent about providing loans to households and house prices may fall further. A fall in house prices will also reduce household wealth and the possibility of raising a mortgage-secured loan. This will curb private consumption and the level of activity in the Norwegian economy.

Consumption may also become less interest rate sensitive than when households can borrow large amounts through mortgage-secured loans.

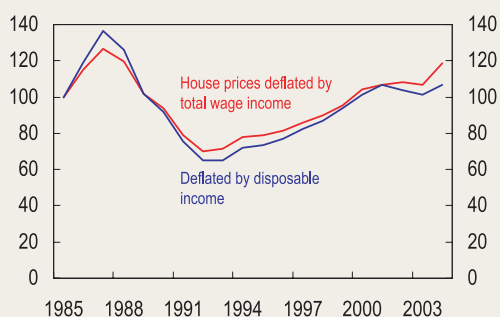
House prices have more than tripled since 1992. After having fallen during the last part of 2002 and the beginning of 2003, house prices rose by more than 20 per cent from May 2003 to November 2004. Developments in the housing market have contributed to a 10-11 per cent increase in household debt per year since 2000. The debt burden for low- and middle-income households is now close to 50 per cent higher than the last peak in 1987. The high accumulation of debt has made households more vulnerable to negative economic disturbances.

The sharp rise in house prices in the last year and a half may prompt the question of whether there is a bubble in the housing market, i.e. whether house prices are far higher than a fundamental value determined by interest rates, income and other fundamental explanatory factors for house prices. A house price bubble can arise if (i) many individuals want to purchase a dwelling today (putting an upward pressure on prices) because they expect house prices to rise in the period ahead and (ii) these expectations are not based on fundamentals. If there is a price bubble in the housing market, prices may fall sharply if price expectations change. Prices may show a particularly sharp decline if price expectations change as a result of a change in fundamentals. In this case, banks may experience that the value of the collateral falls below the value of the loan and that households increasingly have difficulty repaying (very high) debt. This can, as described above, lead to an economic downturn (see IMF (2003) and Borio and Lowe (2002)).

House price inflation since May 2003 may, however,

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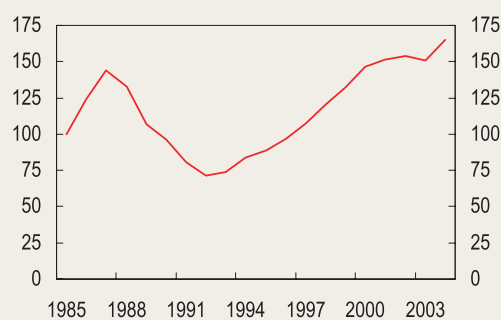
Chart 1 House prices deflated by total wage income and household disposable income. Index, 1985=100. Annual figures. 1985-2004¹⁾



¹⁾ Projections for 2004

Sources: Statistics Norway, Norwegian Association of Real Estate Agents (NEF), Association of Real Estate Agency Firms (EFF), FINN.no, ECON and Norges Bank

Chart 2 House prices deflated by the house rent index in the CPI. Index, 1985=100. Annual figures. 1985-2004¹⁾



¹⁾ Projections for 2004

Sources: Statistics Norway, NEF, EFF, FINN.no, ECON and Norges Bank

reflect changes in fundamentals. In particular, it is likely that the fall in interest rates since the end of 2002 has contributed to the rise in prices. The current low interest rate level is unlikely to continue, however. If interest rates have a strong impact on house prices, we would therefore expect house price inflation to be relatively subdued when interest rates gradually normalise. As long as interest rates increase gradually, there is nevertheless reason to believe that price adjustments will be fairly slow. Nor will house prices necessarily fall when interest rates gradually increase, since the interest rate increases may reflect rapid growth in wages and employment.

It follows that indicators and models that measure whether house prices are overvalued in relation to fundamentals, or whether the fundamentals have been responsible for the high house prices, may be useful when monitoring financial stability. Understanding how and to what extent house prices depend on various fundamentals is also important for projecting house price developments.

The ratio of house prices to income and the ratio of house prices to house rents is commonly used to measure whether house prices are overvalued in relation to long-term fundamental values (see, for example, *The Economist* (2003) and a box in *Financial Stability* 1/03). Such measures may indicate that house prices in Norway are high in relation to fundamentals (see Charts 1 and 2). These measures are incomplete, however, since they do not measure whether house prices are high (in relation to income or house rents) due to a bubble or due to developments in fundamentals. An alternative approach is to estimate an econometric model of house prices using fundamental variables as explanatory factors. Then, under certain conditions, one can use the deviation between actual and fitted house prices as a measure of whether or not house prices are overvalued in relation to fundamental explanatory factors. IMF (2004), Foley

(2004) and McCarthy and Peach (2004) have used such an approach.

In this article, we try to answer the following questions:

- What are the most important fundamental explanatory factors for house prices?
- How quickly and strongly do house prices react to changes in these factors?
- Is there a price bubble in the housing market?
- What has driven developments in house prices in recent years?
- What will happen to house prices if interest rates and the Norwegian economy develop in line with the analyses in *Inflation Report* 3/04?

We estimate a model of house prices on quarterly data for the last 14 years. The analysis indicates that interest rates, housing construction, unemployment and household income are the most important explanatory factors for house prices. We find that house prices react quickly and strongly to changes in interest rates. Thus, a considerable portion of house price inflation since May 2003 may be explained by the fall in interest rates in the last two years. The model implies that house prices will increase by 2-4 per cent per year in the period 2005-2007 if interest rates, unemployment, income and housing construction develop in line with the analyses in *Inflation Report* 3/04. We find no evidence that house prices are overvalued compared with a fundamental value determined by interest rates, income, unemployment and housing construction.

In the next section, we discuss factors that may affect house prices. We then investigate the relevance of these factors by estimating a model of house prices (section 3). In sections 3 and 4, we use the model to discuss the questions raised above. The model was presented in *Financial Stability* 1/04.

2. What can affect house prices?

House prices are determined by housing supply and housing demand. Housing supply, measured by the housing stock, is fairly stable in the short term, since building new dwellings takes time and housing construction per year is low in relation to the total housing stock. In the short term, therefore, house prices will generally fluctuate with changes in demand. The housing stock will adapt to demand over time, however. A long-term model of house prices should therefore contain explanatory factors for developments in the housing stock, such as construction and building site costs and prices for new dwellings. Here, we restrict the analysis to explain house price movements for a given housing stock.

Housing demand consists of two components: household demand for owner-occupied dwellings and demand for dwellings as a pure investment instrument. It is reasonable to assume that the first component is clearly larger than the second. We will therefore place greatest emphasis on the demand for owner-occupied dwellings.

Households may consume housing services either by owning or renting a dwelling. In this analysis, we consider the demand for housing services from owner-occupied dwellings (including flats in housing cooperatives). We also assume that this demand is proportional to housing demand. The analysis is based on the following aggregate demand function:

$$(1) \quad H^D = f\left(\frac{V}{P}, \frac{V}{HL}, Y, X\right), \quad f_1 < 0, \quad f_2 < 0, \quad f_3 > 0,$$

where

H^D = housing demand

V = total housing costs for a typical owner

P = index of prices for goods and services other than housing

HL = total housing costs for a typical tenant (rent)

Y = households' real disposable income

X = a vector of other fundamentals that affect housing demand

f_i = the derivative of $f(\bullet)$ with respect to argument i

Equation (1) says that the demand for owner-occupied dwellings increases if income increases and decreases if housing costs in connection with ownership increase in relation to house rents or prices for other goods and services. The vector X contains observable variables which capture effects of demographic conditions, banks' lend-

ing policies and household expectations concerning future income and housing costs. Expectations concerning future income and housing costs are important because (a) housing is a consumer durable (b) the purchase of a dwelling is the most substantial purchase for most households during their lifetime and (c) most households debt-finance a substantial portion of the purchase when buying their first home or when trading up in the housing market. The content of X is discussed in more detail below.

The housing cost for an owner-occupier measures the value of goods which the owner-occupier relinquishes by owning and occupying a dwelling for a period. Somewhat simplified², the real housing costs for owners may be defined as:

$$(2) \quad \frac{V}{P} \equiv \frac{PH}{P} BK = \frac{PH}{P} \left[i(1-\tau) - E\pi - (E\pi^{PH} - E\pi) \right],$$

where

BK = housing cost per real krone (NOK) invested in a dwelling

PH = price for an average dwelling (in NOK)

i = nominal interest rate

τ = marginal tax rate on capital income and expenses

$E\pi$ = expected inflation (expected rise in P and HL , measured as a rate)

$E\pi^{PH}$ = expected rise in PH (measured as a rate)

The expression $[i(1-\tau) - E\pi]$ is the real after-tax interest rate. It measures the real interest costs associated with a housing loan and the real interest income lost by investing in a house. Higher interest rates mean increased interest costs and higher return when money is deposited in the bank. Thus, housing costs increase. The expression $[E\pi^{PH} - E\pi]$ is the expected real rise in house prices. Expected housing wealth increases if $[E\pi^{PH} - E\pi]$ increases. This means that the real housing costs for owners fall. Thus, it becomes relatively more advantageous to own a dwelling than to rent, and demand for owner-occupied dwellings rises.

Equation (2) may be simplified to:

$$(2') \quad \frac{V}{P} \equiv \frac{PH}{P} BK = \frac{PH}{P} \left[i(1-\tau) - E\pi^{PH} \right].$$

The variable BK is now the nominal after-tax interest rate minus the expected increase in nominal house prices.

Equations (1) and (2) describe the demand for owner-occupied housing. The variables in (1) and (2) will also affect the demand for housing as an investment instrument. It is reasonable to assume that this demand, like other demand, increases as income rises. If house rents increase in relation to house prices, it becomes more advantageous to invest in a dwelling for rental purposes.

² We disregard maintenance costs and tax advantages of owning one's own home.

Then, housing demand increases. Similarly, lower interest rates and/or higher $E\pi^{PH}$ will make it relatively more advantageous to invest in housing rather than to place money in bank deposits. This results in higher demand for dwellings as an investment instrument.

As described above, the housing supply is relatively stable in the short term. The house price PH is the price that ensures that housing demand is equal to housing supply. We insert (2) in (1) and then solve the equation for PH . We also use a semi-logarithmic function:

$$(3) \quad \ln PH = \beta_1 \ln P + (1 - \beta_1) \ln HL + \beta_2 \ln Y + \beta_3 BK + \beta_4 \ln H + \beta_5 g(X),$$

where

H = total housing stock

We then define real disposable income by:

$$(4) \quad Y = \frac{YN}{P^{\alpha_1} HL^{\alpha_2} PH^{\alpha_3}},$$

$$\alpha_1 + \alpha_2 + \alpha_3 = 1, \quad \alpha_1 < \beta_1, \quad \alpha_2 < \beta_2.$$

where

YN = nominal disposable income

Equation (4) takes into account that higher house prices reduce purchasing power in the housing market for households as a whole.³

By solving (3) and (4) we get the following expression for PH :

$$(5) \quad \ln PH_t = \varphi_1 \ln P_t + \varphi_2 \ln HL_t + \varphi_3 \ln YN_t + \varphi_4 BK_t + \varphi_5 \ln H_t + \varphi_6 g(X_t) + \varepsilon_t,$$

where

$$\varphi_1 = (\beta_1 - \beta_2 \alpha_1) / \gamma$$

$$\varphi_2 = (1 - \beta_1 - \beta_2 \alpha_2) / \gamma$$

$$\varphi_3 = \beta_2 / \gamma$$

$$\varphi_4 = \beta_3 / \gamma$$

$$\varphi_5 = \beta_4 / \gamma$$

$$\varphi_6 = \beta_5 / \gamma$$

$$\gamma = (1 - \beta_2 \alpha_3)$$

Subscript t denotes the period and ε_t is a stochastic disturbance that captures the effects of omitted, non-fundamental factors. We see that $\ln P$ and $\ln HL$ fall out of equation (5) if $(\beta_1 - \beta_2 \alpha_1) = (1 - \beta_1 - \beta_2 \alpha_2) = 0$. This requires that the income elasticity β_2 in equation (3) is greater than 1.

The variable BK_t in equation (5) contains the expected change in real house prices from period t to period $t+1$. This is an unobservable variable. We assume that price expectations depend on the observable (fundamental)

variables on the right-hand side of equation (5), the real rise in prices in period $t-1$ and a disturbance v_t which captures effects of psychology and other non-fundamental factors that may influence price expectations. We can then formulate the following relationship for house prices:

$$(6) \quad \ln (PH)_t = h(\text{fundamentals})_t + \theta(\text{real rise in prices})_{t-1} + v_t + \varepsilon_t$$

$$= h(\text{fundamentals})_t + (\text{deviation from fundamental value})_t$$

$$= (\text{fundamental value})_t + (\text{deviation from fundamental value})_t.$$

In equation (6), house prices may deviate from their fundamental value if $\theta \neq 0$ or if the disturbances v_t and ε_t deviate from zero. A positive and substantial deviation from the fundamental value is evidence of a price bubble in the housing market.⁴ Such a bubble may begin with a rise in house prices resulting from a change in fundamentals or a positive shift in price expectations ($v_t > 0$). If $\theta > 0$, which is plausible, an increase in real house prices will give rise to expectations of a continued increase in prices. It will then be relatively more advantageous to own a dwelling (see above). This increases housing demand and house prices today. Consequently, price expectations increase further and prices are pushed up further. This process may drive house prices far above their fundamental value if θ is large enough.⁵ It is reasonable to assume that $\theta < 1$, however, implying that the process dies out over time.

Note that house prices may also fluctuate substantially if interest rates or other fundamentals vary considerably. The fluctuations may be amplified by supply side factors. As described above, increased demand will only affect house prices (not the housing stock) in the short term. However, higher house prices will lead to the construction of more dwellings. This will put downward pressure on house prices over time, and the effect will be strengthened if demand has declined when the new dwellings are completed. Household expectations may also contribute to fluctuations in house prices. An interest rate reduction will normally result in expectations of a (more rapid) rise in real house prices. Consequently, it may pay to expedite planned house purchases. This may lead to a fairly substantial rise in house prices in the short term, with a fall in prices later on.

We argued above that housing demand depends on household expectations concerning their own income. Since expected house price inflation also affects household behaviour, households will also place emphasis on expected income growth for other households. Developments in the labour market are important for household expectations concerning their own and others' future income. Increased unemployment results in

³ Higher house prices reduce the purchasing power of first-time buyers and increase the purchasing power of those leaving the housing market (the effect is zero for other households as a whole). Those who leave the housing market, however, will not use this increased purchasing power to purchase a dwelling. Therefore, total purchasing power in the housing market falls when house prices rise.

⁴ The term "bubble" is defined in different ways in the literature. The above definition is used by IMF (2003, note 3), among others.

⁵ See Case and Shiller (2003, pages 299–300 and 337–338) for a more detailed discussion.

expectations of lower wage growth and increased uncertainty concerning future income and ability to repay debt (both one's own and that of others). This reduces the willingness to pay for owner-occupied dwellings. Therefore, we will test for effects of unemployment in the empirical analysis.

Since most households raise loans to purchase dwellings, banks' lending policies may be important for developments in house prices. Lending policies depend on banks' profitability, government regulations, customers' (expected) ability to repay debt and the collateral values of customers' dwellings.⁶

$$(7) L^s = h\left(O, REG, Y, U, \frac{PH}{P}\right),$$

$$h_1 > 0, \quad h_2 < 0, \quad h_3 > 0, \quad h_4 < 0 \quad h_5 > 0,$$

where

- L^s = banks' supply of credit to households
 O = banks' profitability
 REG = measure of government regulation of bank lending
 U = unemployment rate
 h_i = the derivative of $h(\bullet)$ with respect to argument i

Equation (7) says that the supply of credit is reduced if banks' profitability declines, if the government regulates (more strictly) the supply of credit, if customers' (expected) income declines or if collateral values fall. As explained above, increased unemployment will result in expectations of lower wage growth and increased uncertainty about future ability to repay debt. This will reduce the supply of credit to households.

We will test for effects of banks' lending policies by including household debt as an explanatory variable for house prices. The coefficient of this variable is, however, only identifiable if the supply of credit is limited by banks' profitability (O) or by government regulations (REG); the other variables in equation (7) are also included directly in the determination of house prices. The results in Jacobsen and Naug (2004) indicate that credit to households was limited by banks' profitability during the banking crisis at the beginning of the 1990s. They do not find evidence that credit to households has been limited by banks' profitability after 1993, however. It would appear, therefore, that the supply of credit has less independent effect on house prices now than before and during the deregulation of the credit market

in the mid-1980s and during the banking crisis that followed. If we do not find that household debt has a significant effect on house prices, this indicates that lending was not limited by government regulations or banks' profitability in the estimation period. Household debt has a significant positive effect in models of Norwegian house prices that are estimated on data from the 1980s and 1990s (see Eitrheim (1994) and Boug et al. (2002, Chapter 5.5)).⁷

Total housing demand will also depend on the size of the population and the number of individuals in the start-up phase.⁸ Housing demand in different parts of the country will depend on population movements. In Norway, net migration to central areas has been positive in recent years. This has affected regional house prices in various ways, but may also have changed average house prices for Norway as a whole.

3. An empirical model of house prices

We model a price index for resale homes as a whole. The price index used is published monthly by the Norwegian Association of Real Estate Agents and the Association of Real Estate Agency Firms. The statistics are prepared by the Norwegian research institute Econ Analyse and financed by the internet marketplace FINN.no. The index measures the average house price per square metre, adjusted for effects of size, type and location (see ECON 2004). The monthly figures only go back to January 1997, but annual figures have been estimated for the period 1985-2004 and quarterly figures for the period 1990-1996. The model below is estimated on quarterly data from 1990 to the first quarter of 2004 (the last observation that was available when the model was constructed).⁹

We tested for effects of the following variables:

- households' total (nominal) wage income¹⁰
- indices for house rent paid and total house rent in the consumer price index (CPI)
- other parts of the CPI adjusted for tax changes and excluding energy products (CPI-ATE)¹¹
- various measures of the real after-tax interest rate
- the housing stock (as measured in the national accounts)
- the unemployment rate (registered unemployment)
- backdated rise in house prices
- household debt

⁶ See Stiglitz (1992, Sections 6.2–6.3) for a theoretical discussion.

⁷ IMF (2004) reports positive effects of credit growth in a house price equation for 18 OECD countries estimated on annual data from 1971 to 2003. Similar effects have been found in studies of British and Swedish house prices (see Hendry (1984), Meen (1990), Pain and Westaway (1997), Muellbauer and Murphy (1997), Holly and Jones (1997) and Barot and Yang (2002)). In all of these studies, credit was regulated in large parts of the estimation period.

⁸ IMF (2004) finds positive effects of total population (for given income) in a house price equation for 18 OECD countries (see note 7). Muellbauer and Murphy (1997) report such effects for the UK, and Barot and Yang (2002) find population effects in equations for Swedish and British house prices. The house price equations in Holly and Jones (1997), Pain and Westaway (1997) and Foley (2004) contain effects of the population's age mix.

⁹ We have estimated quarterly figures from 1997 by taking the average of the monthly figures in each quarter.

¹⁰ Tax-motivated fluctuations in share dividends have had a considerable effect on measured developments in household disposable income in recent years. These fluctuations in share dividends have probably had little impact on household demand for dwellings. We therefore use wage income instead of disposable income as an explanatory variable.

¹¹ Housing demand is unlikely to be appreciably affected by short-term fluctuations in inflation that are due to tax changes or fluctuations in energy prices.

- the total population
- the shares of the population aged 20-24 and 25-39
- various measures of relocation/centralisation
- TNS Gallup's indicator of households' expectations concerning their own financial situation and the Norwegian economy (the consumer confidence indicator)

The list of explanatory factors is long compared with the number of observations during the sample period. In addition, we included both current and lagged variables to take account of possible lags in household behaviour. As a result, it was not feasible to include all the explanatory factors in one house price equation (with a meaningful result). We therefore estimated a number of models in which we included only some of the variables. Then we simplified these models by imposing restrictions that were not rejected by the data and that simplified the interpretation of the dynamics.

House rents and other consumer prices generally had coefficients and *t*-values close to zero. In addition, models with a nominal interest rate showed a better fit than models with a real interest rate; inflation had coefficients and *t*-values close to zero in models in which we included the nominal interest rate and inflation as separate explanatory variables, and the coefficient of inflation had the wrong sign in most models. The model in this section therefore expresses a relationship between nominal house prices, nominal income, nominal interest rates and other variables.¹² In Table 2 of the Appendix, we show a model in which the real house price depends on real income, real interest rates and other variables in the long term.¹³

The insignificant effects of house rents may reflect the fact that rents in housing cooperatives accounted for an important share of house rent indices in the CPI during most of the estimation period. This, coupled with the fact that many house rents have been strongly regulated, suggests that caution should be exercised in using time series of the relationship between house prices and house rents in the CPI to assess whether house prices are high or low in relation to market rents.¹⁴ We do not have long time series for market rents.

The discussion in Section 2 showed that both actual and expected interest rates are important to housing demand. We therefore tested for effects of banks' lending rates and various market rates: the three-month,

twelve-month, three-year and five-year rates. Banks' lending rates had a strongly significant effect in all models, whereas the effects of market rates were (clearly) insignificant in models in which banks' lending rates were also included. This may indicate that both house prices and the difference between market rates and banks' lending rates depend positively on the economic outlook: the estimated effect of market rates may (to some extent) capture effects of a changed economic outlook. It is therefore likely that the effect of interest rate expectations is undervalued in the estimated equations. The insignificant effects of market rates may also reflect the fact that the interest rate was used to stabilise short-term developments in the krone exchange rate during much of the 1990s. Households may then (to a greater extent than now) have used observed interest rates as an estimate of future interest rates. This also implies that it is difficult to identify effects of interest rate expectations on house prices.

We did not find significant effects of household debt on house prices, either when we included the debt variable throughout the estimation period or when we included only a debt effect for the period 1990-1993. In isolation, this indicates that credit for household purchases of dwellings was not limited by banks' profitability during the estimation period. As discussed in Section 2, it is nevertheless likely that other loans to households were limited by banks' profitability in the period 1990-1993.

We find no evidence that population movements or demographic factors have a strong direct impact on house prices as a whole. However, demographic changes will influence house prices by influencing wage income in the economy, which forms a part of the preferred model. As demographic factors change slowly over time, it may be difficult to identify effects of such factors over a relatively short estimation period.

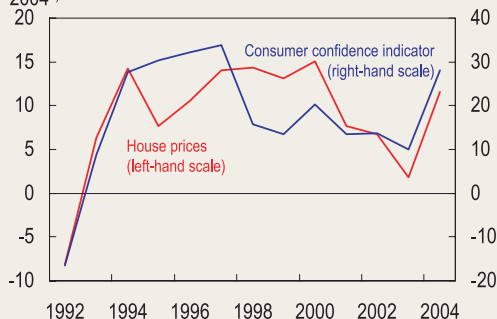
We attempted to capture effects of expectations by including TNS Gallup's indicator of households' expectations concerning their own financial situation and the Norwegian economy. This indicator is strongly correlated with developments in house prices (see Chart 3). However, it is also strongly correlated with the interest rate level and the unemployment rate, which are specified as separate explanatory variables. We therefore chose to adjust TNS Gallup's consumer confidence indicator for effects of the interest rate and unemployment.

¹² It is usual to use nominal interest rates instead of real interest rates in empirical house price models (see for example Meen (1990), Hall, Psaradakis and Sola (1997) and the model in IMF (2004) (mentioned in notes 7 and 8 above)). However, most studies in the literature estimate relationships between real house prices and real income.

¹³ In principle, one would not expect the level of inflation to influence real prices and other real economic variables. However, the model in this section implies that higher inflation results in a change in real house prices if wage growth and the nominal after-tax interest rate increase as much as the inflation rate. The long-term income elasticity is greater than 1, so that increased consumer prices result in higher real house prices if wages increase as much as consumer prices. This model property (and the results that have produced it) may be related to the fact that house prices are excluded from the CPI, but at the same time have a bearing on households' purchasing power in the housing market (see discussion of equation (4)). The model is estimated over a period where inflation (adjusted for tax changes and excluding energy products) was between 1 and 3 per cent for all years except 1990. It may be reasonable to assume that during this period households expected inflation of about 2½ per cent over time, and that their behaviour in the housing market was based on this assumption. The estimated inflation effect on real house prices therefore does not necessarily influence the forecasting properties of the model. The model in the Appendix implies that real house prices are independent of consumer prices in the long term (as long as the full effect of changed consumer prices is reflected in wages).

¹⁴ It may be reasonable to assume that the relationship between house prices and market rents is stable in the long term. If house prices increase in relation to a long-term equilibrium value between house prices and house rents, it will be relatively more profitable to rent than to own. At the same time, the return on buying dwellings for rental purposes will decline. Both factors will contribute to pushing house rents up and house prices down. See Leamer (2002), Krainier (2003), The Economist (2003), McCarthy and Peach (2004) and a box in Financial Stability 1/03 for a more detailed discussion of the relationship between house prices and house rents. An econometric analysis in Inflation Report 3/03 indicates that the house rent index in the CPI depends positively on house prices.

Chart 3 Developments in house prices and an indicator of households' expectations of their own financial situation and the Norwegian economy¹⁾. Per cent, Annual figures, 1992 - 2004²⁾

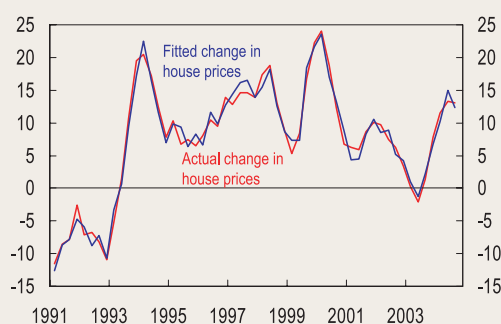


¹⁾ Provides an indication of the share with a positive assessment of the current situation and outlook for the future less the share with a negative assessment.

²⁾ Projections for 2004

Sources: TNS Gallup, NEF, EFF, finn.no, ECON and Norges Bank

Chart 4 Actual and fitted house prices. Percentage change over 4 quarters



Sources: NEF, EFF, finn.no, ECON and Norges Bank

First, we estimated a model of the consumer confidence indicator with the interest rate and unemployment as explanatory variables (see Table 3 in the Appendix). Then we calculated the difference between the actual and fitted value of the consumer confidence indicator for each period. This difference measures a shift in expectations that is due to factors other than changes in the observed values of the interest rate and the unemployment rate. Shifts of this nature may, for example, occur as a result of a change in political conditions, a change in the outlook for the Norwegian economy or negative shocks such as war, terror and a fall in stock markets.

The preferred model is shown in Table 1. The model is an error correction model of the logarithm of house prices. It contains effects of total wage income, the housing stock, the unemployment rate, banks' after-tax lending rate and the adjusted consumer confidence indicator. The expression in square brackets measures the deviation from an estimated long-term relationship between house prices, interest rates, unemployment, income and the housing stock. The coefficient of -0.12 indicates that house prices rise (fall) by 0.12 per cent in quarter t if house prices are 1 per cent lower (higher) than the estimated long-term relationship in quarter $t - 1$ (all else being equal).

Chart 4 shows that the model fits well over the estimation period 1990 Q2 – 2004 Q1. It also succeeds reasonably well in predicting four-quarter growth in 2004 Q2 and Q3.¹⁵ The model in Table 1 fits somewhat bet-

ter than the model for real house prices in the Appendix.

The model implies that house prices will increase by $\frac{1}{2}$ per cent in the first year and by $1\frac{3}{4}$ per cent in the long term if wage income increases permanently by 1 per cent and the other explanatory factors remain unchanged.¹⁶ However, a rise in house prices will result in increased housing construction and housing stock over time. According to the model, house prices will decline by $1\frac{3}{4}$ per cent in the long term if the housing stock, as measured in the national accounts, increases by 1 per cent.¹⁷ In the period 1999-2003, the housing stock and wage income increased on average by 2 per cent and 5 per cent per year respectively. If the housing stock and wage income grow at the pace prevailing for the last five years, house prices will increase by about 5 per cent per year for given values of the interest rate, the unemployment rate and the (adjusted) consumer confidence indicator. Since these variables are stationary, this means that house prices will rise in pace with wage income in the long term. This is confirmed if we exclude the housing stock from the model. The estimated income elasticity then falls to 1.22. This estimate is not significantly different from 1 at the 10 per cent level.¹⁸

According to the model, house prices will fall by $2\frac{1}{4}$ per cent in the first quarter and by $3\frac{1}{4}$ per cent in the long term if banks' lending rates increase by 1 percentage point and the other explanatory factors remain unchanged.¹⁹ The effect after 2-4 quarters is $\frac{1}{4}$ per cent stronger than the long-term effect (see Chart 5). This may indicate that interest rate changes have a strong

¹⁵ The values for interest rates and income for 2004 Q3 are based on projections from *Inflation Report* 3/04.

¹⁶ The house price equation in the Appendix has a long-term income elasticity of $2\frac{1}{4}$. It is usual to find income elasticities of between $1\frac{1}{2}$ and $3\frac{1}{2}$ in house price models that contain effects of the housing stock (see for example Hendry (1984), Meen (1990), Muelbauer and Murphy (1997), Pain and Westaway (1997), McCarthy and Peach (2004) and Foley (2004)).

¹⁷ The housing stock and wage income are strongly correlated when adjustment is made for seasonal variation. The effects of the housing stock and wage income are therefore very imprecisely estimated if we allow the variables to be included with separate coefficients. However, we cannot reject a hypothesis that the two variables have the same coefficient with opposite signs (the test has a p-value of 0.27). We have therefore chosen to impose a condition that income and the housing stock shall have the same long-term effect with opposite signs. In the model in the Appendix, we have imposed a condition that the coefficient of the housing stock shall be $\frac{3}{4}$ of the coefficient of wage income (with the opposite sign). The housing stock will then have approximately the same long-term coefficient in the two models.

¹⁸ It is usual to find income elasticities of around 1 in house price models that do not include effects of the housing stock or other supply side factors (see for example Holly and Jones (1997) and the equation for 18 OECD countries in IMF (2004)).

¹⁹ The model in Table 1 has approximately the same interest rate effects as the house price equation in the Appendix. IMF (2004) finds that, on average, real house prices in 18 OECD countries will fall by $3\frac{1}{2}$ per cent in the long term if the nominal interest rate increases by 1 percentage point and other explanatory factors remain unchanged.

Table 1 A model of house prices

$$\begin{aligned} \Delta houseprice_t = & 0.12 \Delta income_t - 3.16 \Delta (INTEREST \cdot (1-\tau))_t - 1.47 \Delta (INTEREST \cdot (1-\tau))_{t-1} + 0.04 EXPEC_t \\ & (1.94) \qquad (7.04) \qquad (3.27) \qquad (3.09) \\ & - 0.12 [houseprice_{t-1} + 4.47 (INTEREST \cdot (1-\tau))_{t-1} + 0.45 unemployment_t - 1.66 (income - housingstock)_{t-1}] \\ & (5.69) \qquad (2.54) \qquad (3.48) \qquad (8.63) \\ & + 0.56 + 0.04 S1 + 0.02 S2 + 0.01 S3. \\ & (3.42) \quad (3.35) \quad (1.80) \quad (0.73) \end{aligned}$$

$R^2 = 0.8773$, $\sigma = 0.014166$, $DW = 2.57$.

Estimation period: 1990 Q2 – 2004 Q1.

Estimation method: Least squares method

Absolute t -values are given in brackets under the estimates.

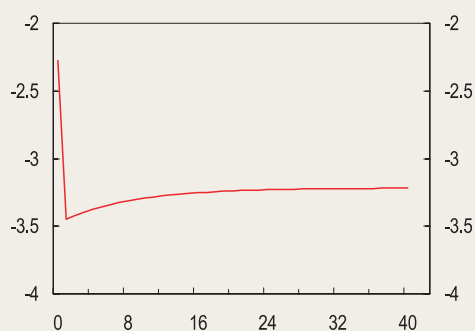
Δ is a difference operator: $\Delta X_t = (X_t - X_{t-1})$.

The variables are defined as (small letters indicate that variables are measured on a logarithmic scale):

- houseprice* = Price index for resale homes. Sources: NEF, EFF, finn.no and ECON
- INTEREST* = Banks' average lending rate. Source: Norges Bank
- τ = Marginal tax rate on capital income and expenses (0.28 since 1992)
- EXPEC* = $(E-F) + 100 \cdot (E-F)^3$
- E* = Indicator of household expectations concerning their own financial situation and the Norwegian economy. Measured as rate, total over two quarters. Source: TNS Gallup
- F* = Value of *E* that may be explained by developments in the interest rate and unemployment. Calculated from an estimated model of TNS Gallup's consumer confidence indicator (see Table 3)
- unemployment* = Unemployment rate. Source: The Directorate of Labour
- income* = Total wage income in the economy. Source: Statistics Norway
- housingstock* = Housing stock at constant prices. Source: Statistics Norway
- Si* = Variable which is equal to 1 in quarter *i*, otherwise zero.
- R^2 = Share of the variation in the left-side variable that is explained by the model
- σ = Standard deviation of regression residuals
- DW* = Durbin Watson test statistic

The expression in square brackets measures the deviation between the house price in the last quarter and an estimated long-term relationship between house prices, the interest rate, the unemployment rate, wage income and the housing stock. The data from TNS Gallup extend back to 1992 Q3. The variable *EXPEC* is therefore equal to zero from 1990 Q2 to 1992 Q3.

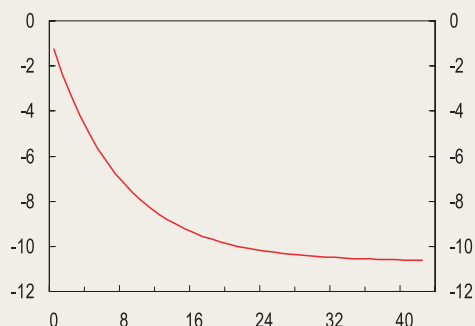
Chart 5 Change in house prices when banks' lending rate rises permanently by one percentage point. Percentage change in the first 40 quarters after the rise



Source: Norges Bank

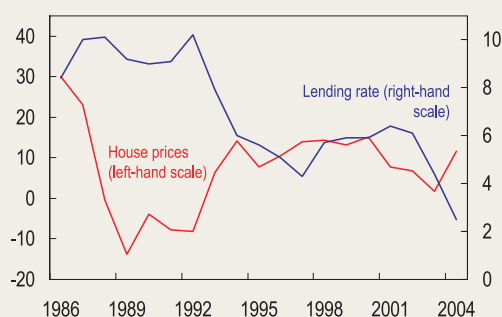
impact on household expectations in the short term (see the expectations model in the Appendix). In isolation, a higher interest rate leads to expectations that house prices will fall. Households wishing to enter the housing market or trade up may then choose to postpone their purchase. This may lead to house prices falling more in the short term than in the long term when interest rates rise. Similarly, a fall in interest rates will lead to expectations of rising house prices. It will then be relatively more favourable to buy a dwelling immediately rather than later. This may lead to prices rising more in the short term than in the long term. Interest rates are measured at the end of each quarter. The strong short-term effect may therefore indicate that housing demand reacts

Chart 6 Change in house prices when unemployment rises permanently from 4 to 5 per cent. Percentage change in the first 40 quarters after the rise



Source: Norges Bank

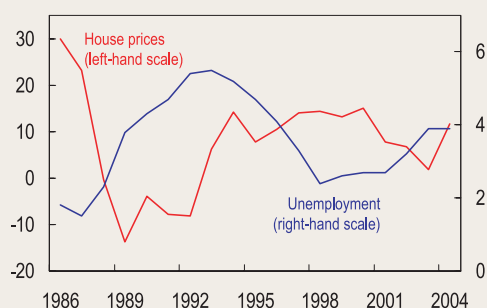
Chart 7 Developments in house prices and the level of banks' lending rate after tax. Per cent. Annual figures. 1986-2004¹⁾



¹⁾ Projections for 2004

Sources: NEF, EFF, finn.no, ECON and Norges Bank

Chart 8 Developments in house prices and the unemployment rate. Per cent. Annual figures. 1986-2004¹⁾



¹⁾ Projections for 2004

Sources: NEF, EFF, finn.no, ECON and Norges Bank

to changes in market rates before lending rates are changed.

The model in Table 1 implies that house prices will fall by about 11 per cent over time if the unemployment rate should increase permanently from 4 to 5 per cent.²⁰ The adjustment is relatively slow (see Chart 6). This may be because unemployment changes relatively slowly: it can take time for households to realise that unemployment has settled at a higher level. However, the expectations model in the Appendix indicates that changed unemployment is rapidly reflected in households' overall expectations concerning their own financial situation and the Norwegian economy. In isolation, this implies that house prices should react rapidly to changes in unemployment. A more detailed analysis (not shown) indicates that a change in unemployment is reflected more rapidly in households' expectations regarding the Norwegian economy than regarding their own financial situation. The developments in Chart 6 may therefore indicate that households place greater emphasis on the outlook for their own financial situation than on the outlook for the Norwegian economy when there is a change in unemployment.

The model in Table 1 contains a positive effect from the calculated expectations variable. The effect implies that house prices react primarily to large shocks to expectations. Small changes in the expectations variable may reflect noise in the data, since the variable is based on a model that is estimated on data from a sample survey. The expectations variable may capture effects due to changed expectations regarding unemployment. A changed labour market outlook may therefore have a more rapid impact on house prices than the estimated unemployment effects would imply.

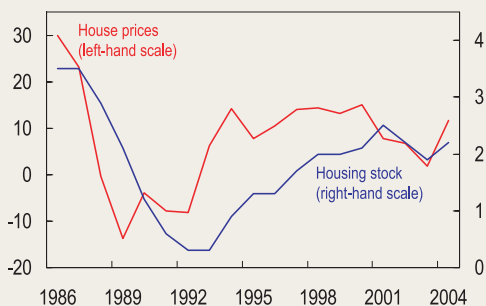
4. What drives house prices?

Chart 4 above shows that the model in Table 1 fits well. In this section, we first use the model to discuss what has driven developments in house prices in recent years. Then we use the model to discuss whether house prices are overvalued in relation to fundamental explanatory factors. Finally, we use the model to estimate how house prices will develop in the period ahead if developments in the interest rate and the Norwegian economy are in line with the analyses in *Inflation Report 3/04*.

The analysis in Section 3 indicates that house prices will rise approximately in pace with household (wage) income in the long term. However, Chart 1 above showed that the ratio of house prices to income has increased substantially since the trough in 1992. The house price model and Charts 7-9 indicate that this reflects developments in interest rates, unemployment and the housing stock. Charts 7 and 8 show that the price fall in the early 1990s was accompanied by high interest rates and high unemployment. The price fall also result-

²⁰ The effect of unemployment is weaker in the house price model in the Appendix than in the model in Table 1. This reflects the fact that unemployment increased in the early 1990s and that inflation and house prices fell at the same time. In the model in the Appendix we have imposed the condition that inflation and the nominal after-tax interest rate shall have the same coefficient with opposite signs. The coefficient of inflation has the wrong sign if the coefficients of the interest rate and of inflation are estimated freely. The model in the Appendix therefore implies that the fall in inflation in the early 1990s contributed more to reducing house prices than what follows from a "free" estimation and from the model in Table 1. Conversely, the estimated effect of unemployment is weaker in the model in the Appendix than in the model in Table 1.

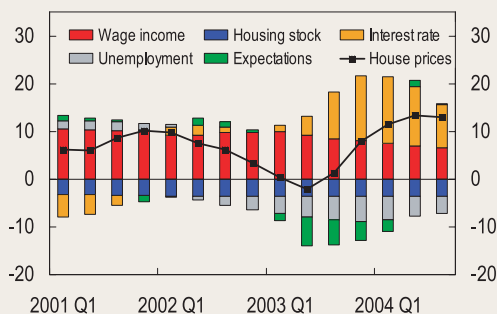
Chart 9 House prices and housing stock. Percentage rise. Annual figures. 1986-2004¹⁾



¹⁾ Projections for 2004

Sources: Statistics Norway, NEF, EFF, finn.no, ECON and Norges Bank

Chart 10 House prices and estimated contributions from wage income, housing stock, unemployment, interest rate and expectations variable. Contribution in percentage points to 4-quarter growth



Sources: NEF, EFF, finn.no, ECON and Norges Bank

ed in a very low level of housing construction in the first half of the 1990s (see Chart 9). The interest rate and the unemployment rate fell markedly from 1992 to 1997/1998. As a result, house prices rose far more than income. The low level of housing construction also contributed to the growth in house prices.

Chart 10 decomposes the rise in house prices in the period 2001 Q1 - 2004 Q3. The decomposition is based on the estimated model and developments in the explanatory variables.²¹ The calculations show that housing construction pushed down the four-quarter rise by 3-4 percentage points in the period 2001 to 2004 Q3. Growth in wage income pushed up the four-quarter rise by 9-10 percentage points in the first two years of the period. In the last two years, increased unemployment and lower growth in wage income have dampened developments in house prices. In 2003, developments in house prices were further dampened by a negative shock to household expectations in the first half of 2003. This was probably attributable to unexpectedly weak developments internationally, fear of terror, war in Iraq, the spread of SARS, the strong krone exchange rate in early 2002 and poorer prospects for the Norwegian economy.²² The interest rate reductions since December 2002 have pushed up house price inflation by reducing interest expenses, boosting optimism and generating expectations of higher house prices. However, the contribution to the four-quarter rise declined strongly from 2004 Q1 to 2004 Q3.

The above analysis indicates that developments in house prices in recent years can be largely attributed to changes in fundamentals. The expectations variable used can capture effects of non-fundamental factors, but we find no evidence that shocks to expectations have

contributed to pushing house prices up appreciably in the last two years (the contribution from the variable for 2003 is negative (see Chart 10)). Nor do we find significant effects due to lagged changes in house prices. This indicates that households only to a limited extent use the observed rise in house prices as an indicator of future house price inflation.²³ This reduces the risk of house prices becoming overvalued in relation to fundamentals (see discussion in Section 2). However, the model implies that house prices will rise more in the short term than in the long term if interest rates fall. This overshooting does not represent a house price bubble (as we have defined the concept 'bubble'), but it may have negative effects on the economy. However, the estimates imply that the overshooting is relatively moderate even if interest rates fall to the same extent as in recent years.

The analysis so far does not provide evidence that house prices are overvalued compared with fundamentals. However, we have attempted to construct a model that provides the best possible explanation for house price inflation using fundamental variables. If some of the price rise of the past year and a half had reflected a bubble in the housing market, this could (to some extent) have been captured by the interest rate and other explanatory variables in the model.²⁴ One would then have expected the coefficients in the model to be unstable, however. In particular, one would have expected the model to underpredict house price inflation over the past year and a half if it was estimated over a shorter period and simulated forward. Chart 11 shows the results of such an experiment. Here we have estimated the model with data up to and including 2000 Q3, and simulated the model up to and including 2004 Q3.²⁵ Chart 12 shows that the model predicts both the price

²¹ The decomposition method is described in Jacobsen and Naug (2004).

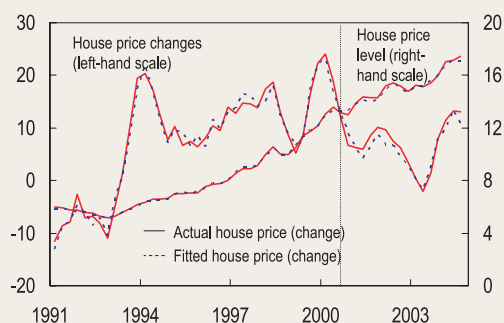
²² Norges Bank adjusted its projection for the unemployment rate (registered unemployed) for 2004 from 3½ per cent in Inflation Report 3/02 to 4½ per cent in *Inflation Report* 2/03.

²³ The IMF (2004) house price equation for 18 OECD countries contains strong, positive effects of the lagged rise in real house prices (the rise in prices the previous year).

²⁴ It is reasonable to assume that there was no price bubble in the housing market in May/June 2003. House prices had then fallen for more than nine months, and the decline was related (according to our analyses) to a negative shock to household expectations.

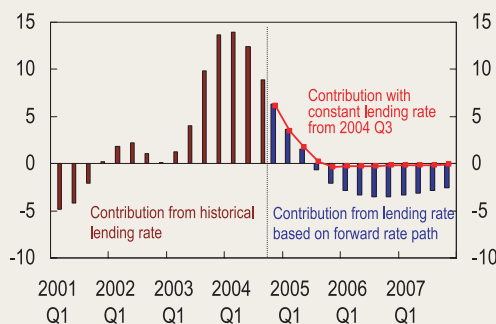
²⁵ We use the actual values of the explanatory factors (but the simulated values of house prices) in the forecast period.

Chart 11 Actual and fitted house price (NOK 1000/sq.m.). Level and percentage change over 4 quarters



Sources: NEF, EFF, finn.no, ECON and Norges Bank

Chart 12 Estimated contribution from banks' lending rate to house prices. Contribution in percentage points to 4-quarter change based on history, constant interest rate from 2004 Q3 and the forward rate path in *Inflation Report 3/04*



Source: Norges Bank

level and house price inflation reasonably well. This indicates that house prices are not overvalued in relation to the fundamental explanatory variables in the model.

House prices may nevertheless move slowly in the period ahead as a result of developments in fundamentals. First, housing investment has increased recently. This will exert downward pressure on house prices in the period ahead. Second, house prices may move slowly when interest rates gradually normalise. Our model implies that the fall in interest rates since December 2002 will only generate moderate impulses to house price inflation in 2005 (see Chart 12). The chart also shows the isolated effect on house prices in the period ahead if the interest rate increases in line with the interest rate path in *Inflation Report 3/04*. In isolation, such a development could lead to a fall in house prices of 3-3½ per cent per year in 2006 and 2007. However, this interest rate path reflects expectations of a decline in unemployment and increase in the growth of wage income. The model implies that house prices will increase by 2-4 per cent per year in the period 2005-2007 if unemployment, wage income and housing investment also move in line with the analyses in *Inflation Report 3/04*.²⁶ Wage income is estimated to increase by more than 4 per cent in each of the years 2005-2007. The ratio of house prices to wage income will therefore decline without a fall in house prices.

5. Conclusion

House prices have more than tripled since 1992. After falling during the last part of 2002 and the beginning of 2003, house prices rose by more than 20 per cent from May 2003 to November 2004. We have analysed factors behind the rise in house prices, using an econometric model. We find that interest rates, housing construction, unemployment and household income are the most important explanatory factors for house prices. The

analysis indicates that house prices react quickly and strongly to changes in interest rates. Thus, the fall in interest rates in recent years can explain a substantial portion of house price inflation since May 2003. We find no evidence that house prices are overvalued compared with a fundamental value determined by interest rates, income, unemployment and housing construction.

Our estimates indicate that the fall in interest rates will only make a moderate contribution to house price inflation in 2005. An interest rate increase in line with the interest rate path in *Inflation Report 3/04* may in isolation lead to a 3-3½ per cent fall in house prices per year in 2006 and 2007. However, this interest rate path reflects an expected decline in unemployment and an expected increase in wage income growth. The model implies that house prices will increase by 2-4 per cent per year in the period 2005-2007 if developments in interest rates, unemployment, income and housing construction are in line with the analyses in *Inflation Report 3/04*. If unemployment and/or income should move on a weaker trend than projected in the *Inflation Report*, the rise in interest rates may be less pronounced. The switch to inflation targeting has reduced the possibility that households will be exposed to a double shock in the form of both higher unemployment and higher interest rates, such as they experienced in the early 1990s.

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²⁶ The same result is obtained if we use the alternative house price model in the Appendix.

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Appendix

Table 2 An alternative model of house prices

$$\begin{aligned} \Delta houseprice_t = & 0.22 \Delta income_t - 3.10 \Delta (INTEREST \cdot (1-\tau))_t - 1.38 \Delta (INTEREST \cdot (1-\tau))_{t-1} + 0.05 EXPEC_t \\ & (3.37) \quad (6.84) \quad (2.91) \quad (3.46) \\ & - 0.17 [realhouseprice_{t-1} + 4.19 REALINTEREST_{t-1} + 0.23 unemployment_t - 2.26 (realincome - 0.75 housingstock)_{t-1}] \\ & (7.43) \quad (3.31) \quad (2.49) \quad (12.01) \\ & - 0.21 + 0.02 SI + 0.01 S2 + 0.01 S3. \\ & (5.67) \quad (2.10) \quad (1.35) \quad (1.15) \end{aligned}$$

$$R^2 = 0.87334, \sigma = 0.0143945, DW = 2.47.$$

Estimation period: 1990 Q2 – 2004 Q1.

Estimation method: Least squares method

Absolute *t*-values are given in brackets under the estimates.

The variables are defined in Table 1 (small letters indicate that variables are measured on a logarithmic scale), with the following exceptions:

realhouseprice = *houseprice* - *consumerprice*

consumerprice = Consumer price index adjusted for tax changes and excluding energy products.

Source: Statistics Norway

REALINTEREST = *INTEREST*(1- τ) less the average four-quarter change in *consumerprice* over three years

realincome = *income* - *consumerprice*

Table 3 A model of households' expectations concerning their own financial situation and the Norwegian economy

$$\begin{aligned} \Delta E_t = & - 0.07 - 12.96 \Delta (INTEREST \cdot (1-\tau))_t - 0.43 \Delta unemployment_t - 0.11 E_{t-1} \\ & (0.39) \quad (6.68) \quad (2.47) \quad (1.06) \\ & - 0.40 INTEREST \cdot (1-\tau)_{t-1} - 0.03 unemployment_{t-1} + 0.21 SI + 0.10 S2 + 0.22 S3. \\ & (0.42) \quad (0.82) \quad (4.57) \quad (4.49) \quad (5.61) \end{aligned}$$

$$R^2 = 0.80, \sigma = 0.049, DW = 2.03.$$

Estimation period: 1992 Q4 – 2004 Q1.

Estimation method: Least squares method

Absolute *t*-values are given in brackets under the estimates.

Variables and test statistics are defined in Table 1.