# Housing investment and house prices

Dag Henning Jacobsen, senior economist, Financial Markets Department, Kristin Solberg-Johansen, economist, Economics Department, and Kjersti Haugland, economist, Monetary Policy Department.[1]

**In this article, we analyse developments in housing investment and the interaction between demand and supply in the housing market. The analysis indicates that the pronounced increase in housing investment since 2004 is related to low interest rates and high house prices. In the past 3½ years, house prices have increased by close to 50 per cent. The sharp rise in housing demand has pushed up house prices, since supply is determined by the existing housing stock in the short term. Capacity constraints in the building sector are preventing a rapid adjustment of the total housing supply to increased demand. When the housing stock over time adapts to demand, this will in isolation push down house prices. House prices may therefore have become higher in the short term than they will be in the somewhat longer term. However, a model-based analysis illustrates that there may be a soft landing for house price inflation despite monetary policy tightening and an increased supply of dwellings.**



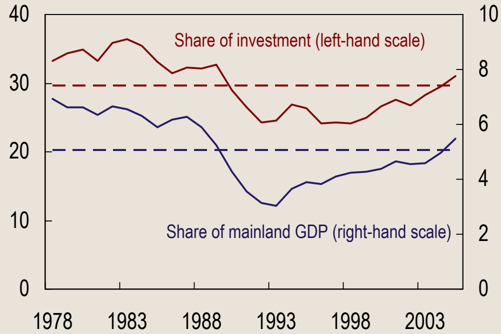
## 1 Introduction

A substantial portion of household demand comprises housing purchases, renovation and rehabilitation. Since 1978, fixed housing investment has averaged about one third of total fixed investment and 5 per cent of gross mainland GDP (see Chart 1).

Fluctuations in housing investment influence cyclical developments in the Norwegian economy. At the same time, developments in the housing market may affect financial stability. About three quarters of Norwegian households own their own dwelling. Housing wealth accounts for close to 60 per cent of households' total wealth, and a substantial portion of banks' lending to households is secured on dwellings. Housing investment may also influence total gross household debt, as household borrowing normally increases with sales of new dwellings.[2] A higher level of housing investment than that necessary to maintain the housing stock results in an increase in housing capital. Over time, an increase in housing stock will in isolation push house prices down. If house prices decline, collateral values may fall below the value of many of the associated housing loans. This increases the risk of loan losses for banks. A fall in house prices will also reduce household wealth and the possibility of raising a mortgage-secured loan. This may dampen private consumption and the general level of economic activity.

Since housing investment has a bearing on business cycles, banks' collateral and household debt, we aim to identify the most important macroeconomic forces driving investment in dwellings. We also seek to elucidate how rapidly and strongly housing investment reacts to changes in the explanatory factors. In addition, we analyse the interaction between demand and supply in the housing market.

**Chart 1** Gross fixed investment in dwellings as a share of mainland fixed investment and mainland GDP. Per cent. Annual figures. 1978 – 2005




Source: Statistics Norway

The next section considers which macroeconomic factors may influence housing investment. Section 3 presents the empirical model and Section 4 analyses the interaction between housing investment and house prices.

## 2 Which factors influence housing investment?

This section discusses possible explanatory factors behind housing investment based on economic theory. It forms the basis for the empirical analysis in the next section.

Analyses of the housing market often employ models in which house prices are determined by demand for housing services and the supply of housing capital, while housing investment is determined by investment profitability.[3] Investment profitability depends positively on house prices. Higher house prices result in higher

1 We would like to thank Tor Oddvar Berge, Eivind Bernhardsen, Solveig Erlandsen, Snorre Evjen, Gunnvald Grønvik, Kåre Hagelund, Kjersti-Gro Lindquist, Bjørn Naug, Kjetil Olsen og Knut Sandal for useful contributions and comments. The analysis was carried out using PcGive 10.1 (Hendry and Doornik 2001).

2 See Jacobsen and Naug (2004)

3 See for example Mankiw and Weil (1989), Meen (2001, Chapter 3.6) and Poterba (1984).

housing investment and thereby higher housing capital. An increase in housing capital contributes in turn to curbing the rise in house prices. Norges Bank has previously estimated house price models using demand factors and housing stock as explanatory variables.[4] An empirical model for housing investment, simulated in conjunction with a house price model, can be used for a more long-term analysis of the housing market. The focus in this section is on developments in the supply of housing capital.

## *Property developers' housing capital investment*

The presentation below broadly follows Obstfeld and Rogoff (1996) and Hubbard (1998). The point of departure is the investment decision of a typical enterprise that earns income from selling completed housing capital. This means that income is earned by selling new dwellings and services such as rehabilitation and renovation.[5] In order to accumulate housing capital, the enterprise has to invest. The enterprise chooses the investment level that maximises its value. The real value of the enterprise at a time t, $V_t$, is given by the value of the sum of the current and discounted future profit:

$$(1) \qquad V_t = \max \sum_{s=t}^{\infty} \left( \frac{1}{1+R} \right)^{s-t} \left[ \Pi(K_s) - CJ_s - C\frac{\Phi}{2} \cdot \frac{(J_s - \delta K_s)^2}{K_s} \right]$$

under the condition $K_{s+1} = (1-\delta)K_s + J_s$

The present value of future profit is calculated by means of a discount factor which depends on the real interest rate, *R*. The discount factor is shown in the first set of brackets in equation (1), and the real interest rate is here assumed to be constant. The first expression in the square brackets, the function $\Pi(K_s)$, expresses the real income the enterprise earns in each period through selling housing capital, $K_s$. The enterprise's costs are expressed in the next two expressions in the square brackets. The first expression represents the direct costs, where *C* is the real factor price of housing investment, $J_s$. *C* is an index composed of prices for factor inputs such as materials, labour, land etc. Simplifying, in this section we assume below that the real factor price, *C*, is equal to 1. In addition to the direct costs, the enterprise incurs extra costs associated with changes in its capital assets, expressed as $C \cdot \Phi \cdot (J_s - \delta K_s)^2 / 2K_s$, where $\Phi$ is a constant and positive parameter. If, for example, the enterprise wishes to increase the scope of building projects in a given period, there are extra costs associated with the procuring of factor inputs. The extra costs reflect the fact that it is more expensive for the enterprise to invest a large amount in a single period than to distribute its investment over several periods. The larger the enterprise – in terms of the size of its fixed capital – the lower the extra costs.

The condition under equation (1) describes the relationship between capital and gross investment, and $\delta$ is the depreciation rate. If investment is higher than what is required to maintain the existing capital, net investment is positive and the capital stock will increase.

## *The investment decision*

The enterprise maximises its value, shown through equation (1), with respect to investment and desired future capital stock. See annex for a mathematical derivation. The first order condition describing the enterprise's investment decision is given by:

$$(2) \qquad \frac{J_s}{K_s} = \frac{Q_s - 1}{\Phi} + \delta$$

The investment decision depends negatively on the size of the parameter $\Phi$, which is part of the expression of extra costs, and positively on the depreciation rate $\delta$. The investment decision also depends positively on the present value of the future return on housing investment, $Q_s$. The variable $Q_s$ can be expressed as follows:

$$(3) \qquad Q_s = \sum_{i=1}^{\infty} \frac{(1-\delta)^{i-1}}{(1+R)^i} \left[ \Pi_K(K_{s+i}) + \frac{\Phi}{2} \left\{ \frac{J_{s+i}^2}{K_{s+i}} - \delta^2 \right\} \right]$$

The first element in the square bracket denotes the rise in income following a marginal increase in the housing stock. The second element, which also contributes positively to return, shows that increased investment today reduces *future* extra costs. The present value of the sum of the two elements is *Q*, which expresses the market value of one extra unit of capital relative to investment costs.[6] Equation (2) shows that net investment is positive if the value of a marginal increase in capital is greater than the investment costs ($Q > 1$).

In the derivation above, the variable $Q_s$ contains all information relevant to the investment decision. However, this variable cannot be observed empirically. An alternative is therefore to use an *average Q*, expressed as the ratio of average house prices to costs of increasing the housing capital. This average *Q* will not necessarily capture all information relevant to the investment decision.[7] The real interest rate is a particularly important variable for estimating the profitability of investments. Since we only observe average *Q*, we investigate whether the real interest rate is a determinant of housing investment as well as the ratio of house prices to construction and land costs.[8] The real interest rate measures

4 See Eitrheim (1993) and Jacobsen and Naug (2005).

5 For simplicity we ignore the fact that some households build their own houses and perform their own renovation.

6 The name of variable Q is associated with the Q theory of investment behaviour (see Tobin (1969).

7 In the case where the enterprise has constant returns to scale in both the production function and the adjustment cost function, and in addition faces given prices in the product market, marginal Q will be equal to average Q (see Hayashi, 1982). The derivation in this section requires no explicit assumption about the production function or whether the enterprise is a price-taker or not.

8 A number of empirical analyses of housing investment/housing starts include the interest rate as an explanatory factor in addition to house prices and construction costs (see for example Barot and Yang (2002), Berger-Thomson and Ellis (2004), Egebo, Richardson and Lienert (1990), Meen (2001), Topel and Rosen (1988) and Tsoukis and Westaway (1994).

both the real interest expenses associated with loan-financing building projects and the real return lost by financing the construction of dwellings with equity.

## *Different information for property developers and lenders*

A number of studies have pointed out that the costs of financing investment projects may be lower if the enterprise uses its own capital rather than loans.[9] This is because lenders do not have full information regarding the risk associated with the investment. They may therefore require a risk premium for loans that are not secured on the enterprise's assets.[10] The risk premium will in general increase with the size of the unsecured loan and push financing costs up and investment down. Enterprises that increase their earnings can finance a larger share of their investment with equity. An improved capacity for internal funding may therefore lead to increased investment. In the empirical analysis in the next section we investigate whether retained earnings by property developers is an important explanatory factor for housing investment.

## *Land prices*

Available land is a necessary factor input for house building. Land prices are therefore a factor price for property developers who sell new dwellings. There are no time series for representative trends in average land prices in Norway. One alternative is to use one or more other variables that can capture changes in land prices. We therefore discuss briefly which macroeconomic factors may affect developments in land prices.

When housing demand in a particular area increases, it results in higher prices for land and dwellings in the area. Developing new plots of land in reasonable proximity can take a long time, as this requires municipal zoning and often infrastructure development. In the short and medium term, the factors that drive housing demand will therefore also to a large extent determine developments in land prices.[11] An empirical analysis of house prices carried out in Norges Bank indicates that interest rates, income, unemployment and households' expectations regarding their own financial position and the Norwegian economy are important factors behind housing demand.[12] Household income growth, in particular, is a central, long-term force driving developments in housing demand and house prices, and thereby probably land prices as well.

In low-density areas, there will over time be ample supply of land available for residential construction. In the long term, land prices in these areas will therefore be determined by the alternative value of the land. The alternative value is mainly given by the return on agriculture and forestry.[13] As a result of a shortage of available land in urban and high-density areas, land prices in central areas will over time be determined by factors other than those applying to low-density areas. For many households who work in urban areas, there is a value associated with living centrally, because it will save travel costs. Travel costs consist of both direct transport costs and time costs. The desire to live centrally and close to services and one's place of work pushes land prices up in and near urban areas (see Alonso (1964) and Wheaton (1974)). Households therefore have to weigh up a higher price for a centrally located dwelling against increased travel costs if they choose a (cheaper) dwelling farther away. In simplified terms, prices for both dwellings and land will therefore rise from the edges of urban areas in towards the city centres, where they will be highest. If real income increases over time, the value placed on leisure time by employees and the self-employed will also rise. The value of the saved travel costs will thus rise as well. This leads to higher land prices in central areas. As three quarters of the Norwegian population lives in urban and high-density areas, and migration to urban areas has increased markedly since the mid-1980s, income growth may have had a general impact on the average price of land.[14] We therefore set up the following equation for the price of land, *PL*:

$$(4) \qquad PL/P = h(Y/P, Z) \qquad\qquad h_1 > 0$$

*P* is the general price level, *Y* is household disposable income and *Z* is a vector of other factors that may influence land costs. The equation expresses that there is a positive relationship between real household income and real land prices. Examples of variables that can be incorporated in vector *Z* are the real interest rate, unemployment, household expectations and local government regulations.

## *The framework for the empirical model*

From the discussion above we would expect that factors such as the real interest rate, house prices and construction and land costs have a bearing on the relationship between housing investment and housing stock. In addi-

9 See Myers and Majluf (1984) and Hubbard (1998) for a theoretical discussion. See for example Fazzari, Hubbard and Peterson (1988) and Gilchrist and Himmelberg (1995) for empirical analyses.

10 This risk premium does not reflect ordinary credit risk. A positive probability of loan losses (and administrative costs) will result in a supplementary premium on the interest rate also in the case where both borrower and lender have full information regarding the probability of default and loan losses.

11 A similar assumption is made in Statistics Norway's MODAG model (see Boug et al., 2002 Chapter 5.5).

12 See Jacobsen and Naug (2005).

13 The alternative value of the area is relevant to the price of the undeveloped land. The costs of developing infrastructure may be higher for land in rural areas than in central areas.

14 See the 2001 population and housing census for information on how large a share of the population lives in densely or sparsely populated areas, respectively.

tion, we investigate whether retained earnings of property developers influence housing investment. These relationships can be expressed through the following general function:

(5) $J/K = g(R, PH/P, PJ/P, PL/P, E/P)$

$g_1 < 0,\ g_2 > 0,\ g_3 < 0,\ g_4 < 0,\ g_5 > 0$

where

$J$ = gross fixed housing investment
$K$ = housing capital at constant prices
$R$ = real interest rate
$PH$ = house price index
$P$ = index of the general price level in the economy
$PJ$ = construction costs
$PL$ = land prices
$E$ = retained earnings of property developers
$g_i$ = the derivative of g(•) with respect to argument $i$

A rise in the real interest rate will result in higher financing costs and hence lower housing investment. Conversely, higher real house prices will increase the profitability of building new dwellings, and thus increase housing investment. Higher real construction and land costs have a negative effect on profitability and contribute to pushing down housing investment. An increase in retained earnings may make a positive contribution to profitability by curbing the financing costs associated with housing investment.

By inserting (4) in (5) we get:

(6) $J/K = g(R, PH/P, PJ/P, h(Y/P, Z), E/P)$
$= f(R, PH/P, PJ/P, Y/P, E/P, Z)$

$f_1 < 0,\ f_2 > 0,\ f_3 < 0,\ f_4 < 0$ og $f_5 > 0$

An increase in the real interest rate has a direct negative effect on housing investment, shown as the first argument in equation (6). However, a higher real interest rate, expressed through vector $Z$, may have a positive effect on housing investment, as an increase in real interest rates probably pushes down land prices. The first effect is expected to dominate, so that higher real interest rates result in lower housing investment.

Equation (6) shows a negative relationship between housing investment and household income, since the income variable represents developments in land prices. Higher income may, as mentioned, increase land prices, and thereby decrease housing investment. We expect to find a negative relationship between building activity and real disposable income if house prices carry sufficient information about housing demand.[15]

By using a semi-logarithmic functional form for equation (6), we set up the following equation for fixed housing investment:

(7) $\ln J = c + \beta_1 R + \beta_2 \ln PH/P + \beta_3 \ln PJ/P + \beta_4 \ln Y/P + \beta_5 \ln K + \beta_6 \ln E/P + \beta_7 \phi(Z)$

where $c$ is a constant and the $\beta i$'s are coefficients we wish to estimate. Equation (7) is the basis for the specification of the empirical model.

## 3 An empirical model of housing investment

The modelled time series for housing investment is part of the quarterly national accounts. These quarterly investment figures are mainly based on figures for housing starts. Although investment in residential construction constitutes the largest single component of housing investment, rehabilitation and renovation are also significant components.[16]

In long-term analyses of the housing market, the reciprocal effects of house prices and housing stock/investment must be taken into account. These reciprocal effects may be an argument for estimating the equations for house prices and housing investment simultaneously.[17] When estimating an equation system where house prices and housing investment are determined simultaneously, we carried out tests which confirmed that housing investment can be modelled as a single equation.[18]

We tested for effects of the following variables (see Section 2):

[15] When the estimated housing investment model is simulated in conjunction with an equation for house prices, higher income will increase housing investment. This is because the increase in income works through both house prices and land prices, and the net effect on housing investment is positive.

[16] Rehabilitation of dwellings involves some demolition and building, while renovation is defined as less extensive maintenance and necessary repairs. Housing investment also includes transaction costs (mainly estate agents' fees) in connection with the sale of existing dwellings and land. Investment in leisure homes is also added, but constitutes only a small share of total housing investment.

[17] House prices are normally an explanatory factor in models of housing investment. However, the supply side in house price models is normally represented by the entire housing stock (see for example Meen (2001), Chap. 6.3).

[18] We estimated a vector-autoregressive model of order 4 which contained the relationship between housing investment and housing stock, house prices, interest rates, construction costs and a proxy variable for land prices. All variables were measured as real variables, as defined in Box 1. With 64 quarterly observations, we had to impose two restrictions in order to estimate the VAR(4) model. One restriction was that the relationship between housing investment and housing capital is constant. The other restriction was that the coefficients of the variables that capture developments in construction and land costs are identical in size and sign. These restrictions were tested in the estimation of the single-equation model shown in Box 1, and they were not rejected by data. The cointegration analysis was carried out using a VAR (2) model, which is a valid reduction of the VAR (4) model. We identified two long-term relationships: one between housing investment, housing stock, house prices, construction and land costs and interest rates, and one between construction and land costs, interest rates and a trend variable. Only the first cointegrating vector was significant in the (reduced form) housing investment equation. In the long-term relationship for housing investment, all other variables were found to be weakly exogenous to the parameters in the vector. A Wu-Hausman test showed that the variables were also weakly exogenous with respect to the short-term dynamics in the housing investment equation. With weak exogeneity of the other variables in the housing investment relationship, inference can be made in the conditional single-equation model without loss of efficiency. We therefore estimated a single-equation model of housing investment in which we included both current and lagged values of the variables, in order to take account of possible lags in investment behaviour. We then imposed valid restrictions which simplified the interpretation of the dynamics.

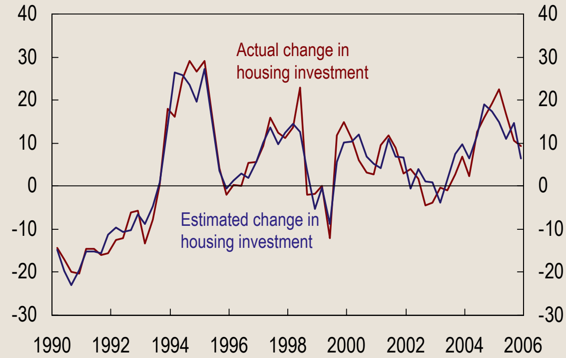
- Household real disposable income[19]
- Unemployment
- An indicator of household expectations concerning their own financial situation and the Norwegian economy
- The real value of retained earnings of property developers (defined as the building industry and the relevant segment of the property management industry)
- Housing capital at constant prices
- Real house prices
- Real construction costs
- Banks' real lending rate[20]

It may, as mentioned, be reasonable to assume that house prices and land prices are influenced by the same factors. In an attempt to capture developments in (unobservable) land prices, we test for effects of income, unemployment and expectations in the investment equation. As housing investment also includes renovation and rehabilitation, which are assumed to increase with income growth and greater optimism, we could have found direct effects of these factors that were not channelled through land prices. However, coefficients and t-values for unemployment and the consumer confidence indicator were close to zero. Household real disposable income, on the other hand, was found to be statistically significant, and the coefficient of the variable had a negative sign. This is interpreted to mean that income growth captures developments in land prices, which is consistent with the discussion in Section 2.

There may be a positive relationship between internal funding capacity and housing investment (see discussion in Section 2). However, we found no statistically significant effect of retained earnings of property developers. This may indicate that the magnitude of asymmetric information between borrowers and lenders is limited, so that the costs of using internal or external finance are approximately the same. However, if asymmetric information is prominent, and residential construction is normally debt-financed, the absence of any effect may be because the risk premium required by lenders is (partly) captured by the average lending rate in the model.

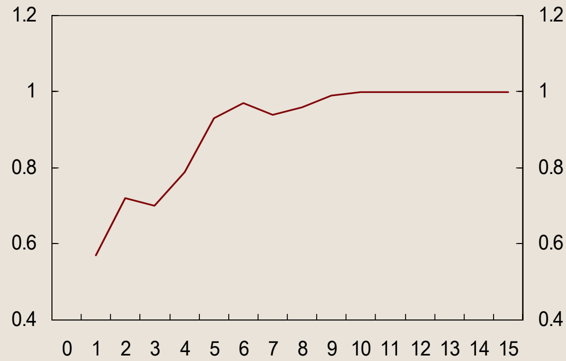
The preferred model, shown in Box 1, is estimated on data from 1990 Q1 to 2005 Q4. The model is an equilibrium correction model of the logarithm of gross fixed housing investment. It contains the effects of the real lending rate, real house prices, real construction costs, housing stock and household real income as a proxy variable for real land prices. Chart 2 shows that the model fits data well over the estimation period.

**Chart 2** Actual and fitted housing investment. Percentage change over 4 quarters. 1990 Q1 – 2005 Q4




Sources: Statistics Norway and Norges Bank

**Chart 3** Model-based change in housing investment due to a permanent one per cent increase in real house prices. Percentage change over time. Quarterly figures




Source: Norges Bank

## *How is housing investment affected by changes in the explanatory factors?*

According to the model, the level of housing investment will increase by one per cent over time if real house prices increase permanently by one per cent and all other factors remain constant.[21] The effect is fairly rapid: in the course of the first year following a house price rise, almost three quarters of the effect occurs, and it feeds fully through after about two years (see Chart 3). Similarly, but with the opposite effect, an increase in real construction costs of one per cent will result in a one per cent fall in housing investment. Here, too, three quarters of the effect occurs after one year, and after almost two years the long-term effect feeds fully through. An increase of one per cent in household real disposable income, which is assumed to capture

[19] Tax-motivated fluctuations in share dividends have had a considerable effect on measured developments in household disposable income in recent years. The variable has therefore been adjusted so that it does not contain reinvested share dividends in the years 2000 – 2005.

[20] We used the rise in the consumer price index adjusted for tax changes and excluding energy products as a measure of inflation expectations in the variable for real lending rate. This gave a better fit than using the rise in the (unadjusted) consumer price index. This may indicate that expected inflation at the time of the investment decision is less correlated with price fluctuations due to tax changes or fluctuations in energy prices.

[21] DiPasquale and Wheaton (1994) find an elasticity of construction with respect to house prices of 1.0–1.2 per cent. The empirical analysis was carried out on US annual data over the period 1963–1990. Topell and Rosen (1988), using US quarterly data from 1963 to 1983, find an elasticity of 2¾ per cent for the same variable. Tsoukis and Westaway (1994) used UK quarterly data from 1970 to 1990 and found the corresponding elasticity to be 0.97 per cent.

## Box 1. A model of housing investment

$$\Delta j_t = \underset{(8.0)}{4.04} - \underset{(2.6)}{0.17}\,\Delta_2 j_{t-2} + \underset{(6.7)}{0.57}\,\Delta_3(ph-p)_{t-1} - \underset{(6.5)}{2.62}\,\Delta_4\Big(I - 1/3 \cdot \sum_{j=-1}^{1}\Delta_4 pate_{t-j}\Big)_t$$

$$-\underset{(8.0)}{0.75}\Big[j_{t-1} - k_{t-10} - (ph-p)_{t-4} + (pj-p)_{t-4} + (y-p)_{t-1} + 5.19\Big(I - 1/3 \cdot \sum_{j=-1}^{1}\Delta_4 pate_{t-j}\Big)_{t-4}\Big]$$

$$-\underset{(3.3)}{0.05}\,S1 - \underset{(5.1)}{0.08}\,S2 - \underset{(4.4)}{0.06}\,S3 + \varepsilon_t$$

$$R^2 = 0.71,\quad \sigma = 0.038,\quad AR_{1\text{-}4}: F(4, 52) = 1.06,\quad ARCH_{1\text{-}4}: F(4, 48) = 0.19,$$

$$NORM: \chi^2(2) = 0.45,\quad HET: F(11, 44) = 0.91,\quad RESET: F(1, 55) = 0.04.$$

Estimation period: 1990 Q1 – 2005 Q4. Estimation method: Ordinary least squares. Absolute $t$ values are shown in brackets under the estimates. Lower-case letters indicate that variables are measured on a logarithmic scale. $\Delta$ is a difference operator:

$$\Delta X_t = (X_t - X_{t-1}),\ \Delta_2 X_t = (X_t - X_{t-2}),\ \Delta_3 X_t = (X_t - X_{t-3}),\ \Delta_4 X_t = (X_t - X_{t-4}).$$

The variables are defined as follows:

| | | |
|---|---|---|
| $J$ | = | Gross fixed housing investment. Source: Statistics Norway |
| $PH$ | = | House price index. Sources: Norwegian Association of Real Estate Agents (NEF), Association of Real Estate Agency Firms (EFF), FINN.no and ECON |
| $P$ | = | Consumer price index. Source: Statistics Norway |
| $I$ | = | Banks' average lending rate for private non-financial enterprises. Source: Statistics Norway |
| $PATE$ | = | Consumer price index adjusted for tax changes and excluding energy products. Source: Statistics Norway |
| $K$ | = | Housing capital at constant prices. Source: Statistics Norway |
| $PJ$ | = | Deflator for gross investment in housing services. Source: Statistics Norway |
| $Y$ | = | Household disposable income adjusted for reinvested dividends. Sources: Statistics Norway and Norges Bank |
| $Si$ | = | Variable which is equal to 1 in quarter $i$, otherwise zero. |
| $\varepsilon$ | = | Regression residuals (unexplained variation in left-side variable) |

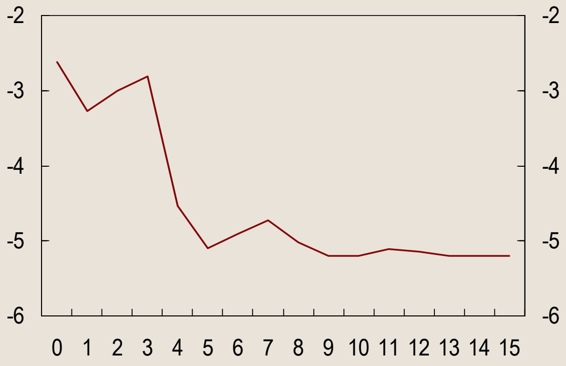
$R^2$ is the share of the variation in the left-side variable that is explained by the model, $\varepsilon$ is the standard deviation of the regression residuals, $AR_{1\text{-}4}$ is a test for 4th order autocorrelation in the residuals, $ARCH_{1\text{-}4}$ is a test for 4th order ARCH residuals, $NORM$ is a test of whether the residuals are normally distributed, $HET$ is a test for heteroskedacity and $RESET$ is a test of the model's functional form.

developments in land prices, will also push down housing investment one per cent. Here the full effect occurs after a year and a half.

Housing investment reacts both rapidly and strongly to changes in banks' real lending rates. The model indicates that housing investment will fall by almost 5¼ per cent in the long term if the real interest rate increases permanently by one percentage point and the other explanatory factors remain unchanged. Most of the effect is exhausted after one year (see Chart 4).

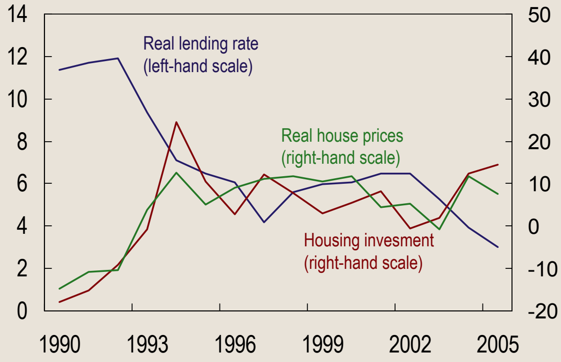
Over time, an increase in housing stock will result in higher housing investment because of increased maintenance requirements. In the long term, an increase in housing stock of one per cent will push up housing investment by one per cent. Thus the ratio of housing investment to housing stock over time will be constant

**Chart 4** Model-based change in housing investment due to a permanent one percentage point increase in the real lending rate. Percentage change over time. Quarterly figures




Source: Norges Bank

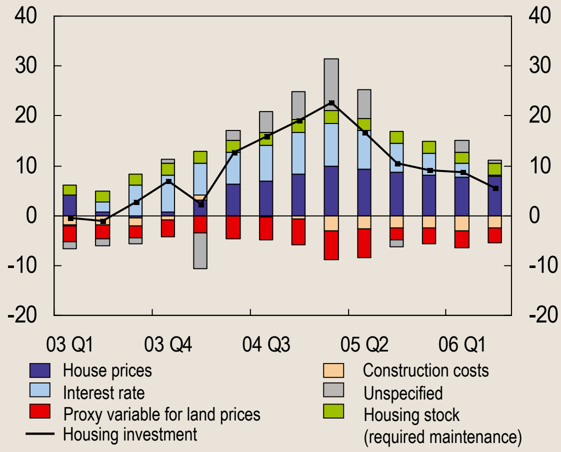
**Chart 5** Real lending rate and growth in real house prices and fixed investment in dwellings. Per cent. Annual figures. 1990-2005




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



**Chart 6** 4-quarter growth in housing investment and calculated contributions from explanatory variables in percentage points. 2003 Q1 – 2006 Q2. Real variables




Sources: Statistics Norway and Norges Bank

for given values of the other explanatory factors. The effect of higher housing stock is slow, however, because residential construction and upgrading today result in increased maintenance requirements only after the dwellings have been exposed to wear and tear over a period. In the model, increased housing stock will result in higher maintenance investment after 2½ years, and the full effect will come into evidence after about 4 years.

## *What has driven housing investment in recent years?*

Falling house prices and higher interest rates eroded profitability in the building industry in the early 1990s. Housing investment fell markedly during this period. Interest rates fell from 1993 to 1998, and house prices rose steadily from 1993 and up to the first half of 2003. Housing investment increased from 1994 until the turnaround in the Norwegian economy in 2002. Since the pick-up in the Norwegian economy in the second half of 2003, both house prices and residential construction have increased markedly. Chart 5 indicates that developments in house prices and interest rates are key forces driving housing investment.

Chart 6 shows the direct, estimated contributions from the model's explanatory factors to four-quarter growth in housing investment from 2003 Q1 to 2006 Q2. The decomposed contributions are based on the estimated model and developments in the explanatory variables. In addition to higher maintenance investment as a result of increased housing stock, the marked increase in housing investment since 2004 is particularly influenced by developments in the real interest rate and real house prices. According to the model, the decline in interest rates from December 2002 to March 2004 pushed up housing investment by over 6 percentage points in the period from the second half of 2003 up to and including the first half of 2005. Moreover, higher house prices have pushed up housing investment by between 6 and 10 percentage points since 2004 Q2. From the same time, and up to and including 2005 Q2, some of the growth in housing investment is explained by factors outside the model.

Higher land prices (measured by the proxy variable) have had the most pronounced dampening impact on housing investment in recent years. Construction costs pushed down housing investment relatively less in this period. This may reflect a particularly ample supply of labour in the building industry: inward labour migration from among others new EU member states may have had a dampening effect on the rise in costs in the building industry. In addition, higher capacity, as a result of inward labour migration, may have increased the industry's adaptability to improved profitability. Such an effect is not directly captured in the model, and may help to explain the unspecified contribution in Chart 6 in 2004 and into 2005.

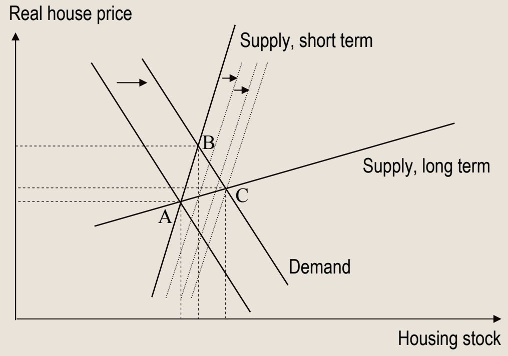
# 4 Can house prices fall as a result of high residential construction?

In this section, we analyse the interaction between the demand and supply side of the housing market. House prices have increased by close to 50 per cent since summer 2003. This has contributed to growth in housing investment. Higher housing investment increases the housing stock, and over time this curbs house price inflation. Since capacity in the building industry is limited, residential construction will at all times be low compared with the total housing stock. It therefore takes time before the overall supply of dwellings is adapted to increased demand. House prices may thus have increased more in the short term than they will in the somewhat longer term, when the housing stock is once again adapted to demand.

These adjustments are illustrated in Chart 7. The housing market is initially in equilibrium, as shown by adjustment at point A. A sharp increase in demand then results in a new, short-term adjustment at point B, where house prices have increased markedly. As a result of limited capacity in the building industry, the short-term supply curve will have a steeper slope than the long-term supply curve. The price rise makes more housing projects profitable, with an attendant increase in residential construction. This is illustrated in the chart by the rightward shift of the short-term supply curve in each period, for example in each year. The housing stock increases as long as house prices are higher than the level shown by the long-term supply curve. Over time, adjustment is reached at point C, where the housing market is again in long-term equilibrium. House prices have then been pushed down compared with the short-term equilibrium, as shown by the vertical distance between points B and C.

The sharp increase in both house prices and building activity prompts an analysis of the negative price effect of increased housing stock and factors that may counteract the effect of an increased supply of dwellings. To illuminate this, we simulate models of house prices and housing investment. Housing stock measured as housing capital at constant prices is incorporated in the house price model, while house prices are an explanatory factor in the model for housing investment. In order to capture the effect of housing investment on house prices, the simulations must also include the definitional relationship between housing investment and housing capital. The equation for housing investment is shown in Box 1, and the equations for house prices and housing stock are reported in Annex 2. The other explanatory factors in the house price model are the interest rate, unemployment, disposable income and an indicator of household expectations regarding their own financial situation and the Norwegian economy.[22] In such a housing market model, house prices are determined by demand factors and total housing stock, and

**Chart 7** Illustration of adaptation between demand and supply in the housing market in the short and long term




carry all necessary information about the demand side for the housing investment decision. See Jacobsen and Naug (2005) for further discussion of (an earlier version of) the house price model and the forces driving housing demand.

## *Projected developments in explanatory factors*

In simulating developments in house prices, housing investment and housing stock, assumptions must be made about developments in the exogenous explanatory factors during the simulation period. The exogenous variables are consumer prices, interest rates, unemployment, total income, the housing investment deflator (which measures construction costs) and an indicator of household expectations regarding their own financial situation and the Norwegian economy. The household expectations indicator is assumed to be neutral, and it is measured in such a way that the assumption is realised by setting it equal to zero over the simulation period. Up to end-2009, developments in the other explanatory factors are based on projections in *Inflation Report* 3/06. Thereafter, they approach a projected long-term trend, and from 2011 they follow the long-term path. The assumptions about long-term developments in the explanatory variables are based partly on historical experience. The simulations must not be interpreted as Norges Bank's projections. The purpose is only to illustrate how a particular path for economic developments may influence housing market adjustment. It is assumed that in the long-term the explanatory factors change as follows each year:

- Consumer prices increase in line with the inflation target of 2½ per cent.
- The real money market rate is close to 2¾ per cent. The average lending margin on loans to households is one percentage point, and for enterprises the figure is 1¾ percentage points.

[22] Jacobsen and Naug (2005) did not find direct effects of either the total population or the share of the population aged 20–24 and/or 25–39. In this model, demographic changes influence house prices indirectly by influencing aggregate household income.

- Registered unemployment is 3¼ per cent of the labour force, i.e. the average for the past 25 years.

- Total household real income increases by 2½ per cent. This reflects: *(i)* real income growth per person-hour of 2 per cent, equivalent to assumed productivity growth; and *(ii)* assumed growth in person-hours of ½ per cent. To simplify, it is assumed that the growth in person-hours over time reflects population growth. An assumed annual population growth of ½ per cent will result in an estimated population close to the middle alternative of Statistics Norway's projections.[23]

- The housing investment deflator is based on the total weighted costs of various factor inputs associated with residential construction. In calculating the deflator, the cost indices are adjusted by a factor (based on a price index for new detached dwellings) which captures changes in profit margins and productivity. Since 1978 the average annual rise in both the housing investment deflator and the consumer price index has been about 4½ per cent. In the simulations, the housing investment deflator therefore rises in pace with consumer prices.

- Real land prices (measured by the proxy variable) increase by 2½ per cent. The assumption that the average real land price increases over time is discussed briefly below.

## *Does the real marginal cost of residential construction increase in the long term?*

Over time the ratio of the average house price to the representative cost of building one extra dwelling must be constant. For the past fifty years, the annual average rise in real house prices has been 2½ per cent.[24] This does not support the proposition that the real marginal cost of residential construction is constant over time.

We assumed on the basis of the historical data above that the real housing investment deflator is constant in the long term. The investment deflator measures actual construction costs and is adjusted by a factor that captures productivity changes. However, the deflator does not include land prices, and available land is a necessary factor input for residential construction. If a substantial portion of housing demand is concentrated on central areas in the long term, the shortage of available land in such areas may result in rising, long-term real marginal costs for residential construction for the country as a whole. In the simulations we let (the proxy variable for) real land prices increase by 2½ per cent annually in the long term.[25]

## *The house price level at the start of the simulations*

Since the second half of 2005, house prices have increased somewhat more than the empirical house price model implies. This may indicate that the rise in house prices is high compared with a fundamental value determined by the interest rate, income, unemployment and housing stock. However, the strong rise in prices may reflect structural changes in recent years that are not (fully) captured by the model. Globalisation has resulted in a low rise in prices for imported goods and higher prices for oil and some other Norwegian export goods. This improvement in the terms of trade may have raised household income expectations. Structural changes may also have contributed to the fall in long-term interest rates. This may have generated expectations of a permanently lower real interest rate level. At the same time, new loan products have given households greater scope for choosing the repayment profile for their loans. These factors may have contributed to the rise in house prices in recent years.

Since there is uncertainty as to whether house prices deviate from or are close to an equilibrium value, we carry out two alternative simulations. At the start of simulation A, house prices are somewhat higher than implied by the model. Assuming that the strong rise in prices may reflect structural driving forces, we make an alternative, simplified assumption that house prices are now equal to an estimated equilibrium value. At the start of simulation B the model's constant term is therefore adjusted so that house prices are in line with the model's prediction.

## *Developments in house prices, housing investment and housing stock*

Charts 8 and 9 show the result of the simulations of the three equations from 2007 to 2050. The real interest rate will increase through a gradual rise in interest rates and inflation as projected in *Inflation Report* 3/06. Increased real interest rates and high growth in the housing stock curb the rise in real house prices at the start of both simulations, whereas strong developments in the labour market make a positive contribution. In simulation A in Chart 8, the rise in house prices is also pushed down because house prices are initially higher than the model's prediction. The rise in prices in the initial years of the simulation period is therefore lower in simulation A than in simulation B shown in Chart 9. The result is that growth in housing investment and housing stock is also lower in simulation A. This explains why real house prices in the next phase decline less in simulation A than in simulation B.

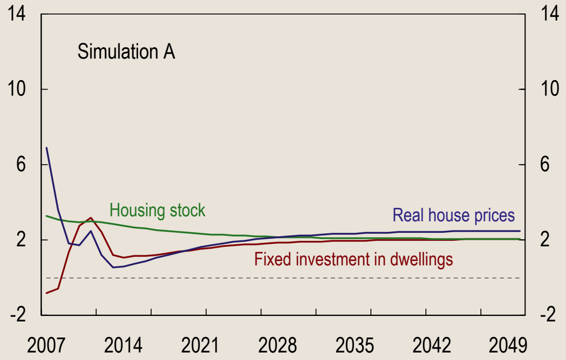
In both alternatives, income growth is assumed to

23 In this model, housing demand will therefore be driven in the long term by population growth and average growth in real income. See DiPasquale and Wheaton (1994), Mankiw and Weil (1989) and Poterba (1984) for a discussion of housing demand in the long term.

24 See Eitrheim and Erlandsen (2004) for a more detailed description of the time series for house prices. The index for the period 1819 to 1986 is based on data from the cities Oslo, Bergen, Trondheim and Kristiansand. From 1986 it is based on data for house sales throughout Norway.

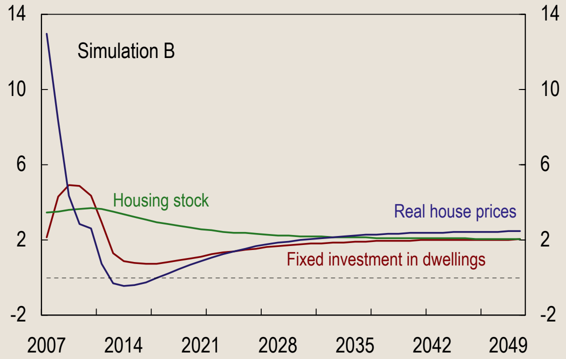
25 Other studies also emphasise the importance of the fact that a limited supply of a necessary factor input in residential construction results in a rising long-term supply curve (see for example DiPasquale and Wheaton (1994) and Kenny (1999)).

**Chart 8** Real house prices, fixed investment in dwellings and housing stock. Annual growth. Per cent. 2007-2050




Source: Norges Bank

**Chart 9** Real house prices, fixed investment in dwellings and housing stock. Annual growth. Per cent. 2007-2050

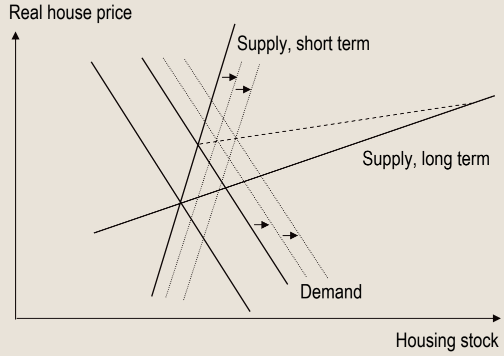



Source: Norges Bank

remain high throughout the period, while growth in the housing stock declines compared with the starting point for the simulations. As a result, the rise in real house prices picks up gradually. Until the long-term equilibrium path is reached, demand growth in both simulations is approximately in line with the increase in supply. In the long term, real house prices increase in pace with the growth in real income, and the ratio of real house prices to real construction costs and real land prices is constant. Moreover, housing investment and housing stock grow at the same pace over time, by 2 per cent annually. This is equivalent to the annual growth in housing stock over the last 20 years. The simulations indicate that the adjustment to a long-term equilibrium may take a long time.

There is substantial uncertainty associated with such calculations. Experience shows that the economy is exposed to disturbances that may cause a fall in house prices, but also to positive shocks that boost house prices. Although real house prices have increased on average every year since 1819 (the starting point for the house price series), history also shows periods of falling prices. High house prices and extensive construction activity increase the possibility of a price fall if a downturn occurs. If demand for dwellings should decline, house prices could fall markedly.

**Chart 10** Illustration of adaptation between demand and supply in the housing market in the short and long term




## *Can structural factors contribute to a soft landing for house prices?*

The simulations shown in Charts 8 and 9 illustrate that house price inflation may have a fairly soft landing, despite high construction activity and a gradual tightening of monetary policy. Chart 7 showed an adjustment from one static, long-term equilibrium to another. Chart 10 shows a simplified illustration of the simulations. The broken line is intended to show a dynamic adjustment, i.e. a path for market clearance in each period, for example each year.

Chart 10 illustrates that the stable house price trend depends on two factors: *(i)* the slow adjustment of the overall housing supply must be accompanied by a certain growth in housing demand, and *(ii)* the real cost of building one extra dwelling must increase over time, i.e. the long-term supply curve must have a positive slope.

The interest rate in Norway has been lower than what is considered as a neutral level over a substantial period. If the interest rate rises in line with the interest rate path in *Inflation Report* 3/06, the interest rate level will be normalised. The normalisation of the interest rate reflects low unemployment and signs that wage growth is picking up, among other things. Strong developments in the labour market generate positive impulses to housing demand at the beginning of the simulation period. We have assumed that housing demand over time is driven by stable population growth and increasing real income per capita. The demand growth that accompanies the slow adjustment of the overall housing supply therefore holds up real house prices in the short and medium term.

Around three quarters of the population of Norway lives in cities and high-density areas. This indicates that a substantial share of households prefers to live centrally. The shortage of available land in central areas may result in rising, long-term marginal costs for residential construction for the country as a whole. If the real cost of building one extra dwelling increases over time, real house prices will also increase in the long term when the housing stock is adjusted to increased demand.

## 5 Conclusion

Housing investment has increased markedly since 2004, and in 2005 the number of housing starts was at its highest since the early 1980s. We have analysed factors determining developments in housing investment using an empirical model. The model's explanatory factors are interest rates, house prices, construction costs, housing stock and household income as a proxy variable for land prices. The analysis indicates that the recent upswing in housing investment is related to low interest rates and strong rise in house prices. In the same period, land prices have contributed most – viewed in isolation – to pushing housing investment down. Developments in construction costs have contributed to a lesser extent. This may be partly attributable to the increased supply of foreign labour, which has curbed the rise in costs in the building industry.

In order to shed light on the interaction between demand and supply in the housing market, we have simulated models for housing investment and house prices up to 2050. Developments in the models' explanatory factors are based on projections in *Inflation Report* 3/06 up to end-2009, and thereafter estimates of long-term developments based partly on historical experience. The simulations show stable developments in house prices despite higher interest rates and high building activity. This is because the overall housing stock adapts slowly to an increase in demand for housing, and growth in the supply of dwellings is still accompanied by some rise in demand. The simulations do not provide evidence that we must assume further strong growth in demand in order to hold up house prices in the first years of the simulation period.

Real house prices in the simulations increase over time. This is because we have assumed that the real cost of building one extra dwelling will increase in the long term. Rising long-term marginal costs may be related to a preference by a considerable share of the population for residing in central areas, where there is a shortage of available land. There is substantial uncertainty associated with the estimates, and the simulations must not be interpreted as Norges Bank's projections. Experience shows that the economy is exposed to disturbances that result in periods of low house price inflation. Conversely, positive shocks have resulted in unexpected price rises. A time series from 1819 to 2005 shows that Norwegian house prices over time have increased more than the general price level in the economy.

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## Annex 1

We consider a profit-maximising enterprise (see Section 2 for a definition of the variables).

(1) $$V_t = \max \sum_{s=t}^{\infty} \left( \frac{1}{1+R} \right)^{s-t} \left[ \Pi(K_s) - I_s - \frac{\Phi}{2} \frac{(I_s - \delta K_s)^2}{K_s} \right]$$

under the condition $K_{s+1} = (1-\delta)K_s + I_s$

The factor price is set equal to 1. During each period, the enterprise maximises value with respect to investments and future capital stock. We use the Lagrange method:

(1') $$L_t = \sum_{s=t}^{\infty} \left( \frac{1}{1+R} \right)^{s-t} \left\{ \Pi(K_s) - I_s - \frac{\Phi}{2} \frac{(I_s - \delta K_s)^2}{K_s} - Q_s (K_{s+1} - (1-\delta)K_s - I_s) \right\}$$

where the Lagrange multiplier, $Q_s$ , represents the shadow price of capital. By deriving with respect to $I_s$, a first-order condition is obtained:

(2) $$\frac{\partial L_t}{\partial I_s} = 0 \Rightarrow -1 - \Phi \frac{I_s - \delta K_s}{K_s} + Q_s = 0 \Leftrightarrow 1 + \Phi \frac{I_s - \delta K_s}{K_s} = Q_s \Leftrightarrow \frac{I_s}{K_s} = \frac{Q_s - 1}{\Phi} + \delta$$

We then derive with respect to $K_{s+1}$, which yields the first order condition:

(3) $$\frac{\partial L_t}{\partial K_{s+1}} = 0 \Rightarrow -Q_s + \frac{1}{1+R} \left\{ \Pi_K(K_{s+1}) - \left( -\frac{\Phi}{2} \left[ \frac{I_{s+1}^2}{K_{s+1}^2} - \delta^2 \right] \right) + (1-\delta) Q_{s+1} \right\} = 0$$
$$\Leftrightarrow Q_s = \left( \frac{1}{1+R} \right) \left\{ \Pi_K(K_{s+1}) + \frac{\Phi}{2} \left[ \frac{I_{s+1}^2}{K_{s+1}^2} - \delta^2 \right] \right\} + \left( \frac{1-\delta}{1+R} \right) Q_{s+1}$$

In order to simplify the notation, we define:

$$\Pi_K(K_{s+1}) + \frac{\Phi}{2} \left[ \frac{I_{s+1}^2}{K_{s+1}^2} - \delta^2 \right] \equiv \Psi_{s+1}$$

By using equation (3), dating all variables one period forward and then substituting for $Q_{s+1}$, we get:

$$Q_s = \frac{1}{1+R} \Psi_{s+1} + \frac{1-\delta}{1+R} \left[ \frac{1}{1+R} \Psi_{s+2} + \frac{1-\delta}{1+R} Q_{s+2} \right]$$

By continuing the substitution we get:

$$Q_s = \frac{1}{1+R} \Psi_{s+1} + \frac{1-\delta}{(1+R)^2} \Psi_{s+2} + \cdots\cdots + \frac{(1-\delta)^{j-1}}{(1+R)^j} \Psi_{s+j} + \left( \frac{1-\delta}{1+R} \right)^j Q_{s+j}$$

$$Q_s = \frac{1}{1+R}\Psi_{s+1} + \frac{1-\delta}{(1+R)^2}\Psi_{s+2} + \cdots\cdots + \frac{(1-\delta)^{j-1}}{(1+R)^j}\Psi_{s+j} + \left(\frac{1-\delta}{1+R}\right)^j Q_{s+j}$$

We assume that the requirements for $[(1-\delta)/(1+R)]^j \rightarrow 0$ when $j \rightarrow \infty$ are fulfilled so that:

$$(4) \qquad Q_s = \sum_{j=1}^{\infty} \frac{(1-\delta)^{j-1}}{(1+R)^j}\Psi_{s+j} = \sum_{j=1}^{\infty} \frac{(1-\delta)^{j-1}}{(1+R)^j}\left\{\Pi_K\left(K_{s+j}\right) + \frac{\Phi}{2}\left[\frac{I_{s+j}^2}{K_{s+j}} - \delta^2\right]\right\}$$

See Section 2 for interpretation of equation (4).



## Annex 2

A model of house prices:

$$\Delta ph_t = -\underset{(7.6)}{0.33} - \underset{(6.7)}{2.92}\,\Delta IM_{t-2} - \underset{(2.9)}{1.27}\,\Delta IM_{t-1} + \underset{(2.8)}{0.31}\,\Delta y + \underset{(2.8)}{0.04}\,EXP_t$$

$$-\underset{(7.2)}{0.12}\left[(ph - pate)_{t-1} + \underset{(4.1)}{0.39}\,u_t + \underset{(10.7)}{2.65}\,(y - pate - 0.75\,k)_{t-1} + \underset{(3.7)}{6.02}\,\left(IM - 1/12 \cdot \sum_{j=0}^{11}\Delta_4 pate_{t-j}\right)_{t-1}\right]$$

$$+\underset{(7.6)}{0.04}\,S1 + \underset{(2.8)}{0.02}\,S2 - \underset{(0.9)}{0.01}\,S3 + \varepsilon_t$$

*$R^2 = 0.85$, $\sigma = 0.015$, $AR_{1-4}: F(4, 47) = 1.35$, $ARCH_{1-4}: F(4, 43) = 0.48$,*
*$NORM: \chi^2(2) = 3.78$, $HET: F(19, 31) = 0.44$, $RESET: F(1, 50) = 0.00$.*

Estimation period: 1990 Q2 – 2005 Q4. Estimation method: Ordinary least squares. Absolute *t* values are shown in brackets under the estimates. Small letters indicate that variables are measured on a logarithmic scale. Δ is a difference operator: $\Delta X_t = X_t - X_{t-1}$.

See Jacobsen and Naug (2005) for further discussion of (an earlier version of) the model.

The equation for housing capital (at constant prices):

$$K_t = (1 - \Phi)\,K_{t-1} + J_t$$

The variables are defined in Box 1, with the following exceptions:

*IM* = Banks' average lending rate on repayment loans secured on dwellings. Source: Statistics Norway

*EXP* = Indicator of household expectations concerning their own financial position and the Norwegian economy, adjusted for the effects of interest rates and unemployment. Sources: TNS Gallup and Norges Bank

Φ = 0.0063, quarterly depreciation rate. Source: Statistics Norway