Measuring and predicting household housing wealth

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1.   Introduction

In its work on financial stability, the Central Bank of Norway evaluates developments in the housing market and household wealth and debt. Households' housing wealth is a significant part of their total wealth and an important macroeconomic variable. Economic theory and empirical analyses show that household wealth affects the level of activity through a wealth effect on household consumption. Furthermore, banks' losses on mortgage-secured loans will, in general, depend on housing values.

Housing wealth is not easily observable, however, and needs to be calculated using information on prices and stocks. Different methods and data can be used, and the size of housing wealth varies significantly across information sets and methods. Depending on the method and the information set, Norwegian household housing wealth relative to Mainland GDP[2] varies from 189 to 230 percent in the 4th quarter of 2005. Our preferred measure is based on the number of dwellings, average dwelling size, average house price (NOK 1000/sq.m.) and households' share of the housing stock.

In addition to constructing a sound and reliable measure of housing wealth, we also want to understand developments in this variable, and the relationships between these developments and the business cycle and economic policy. By definition, growth in housing wealth reflects growth in house prices and housing stock. Hence, we need to understand the developments in these two variables. Furthermore, growth in housing stock is determined by depreciation and housing investment, and we therefore want to understand which macroeconomic factors are important for housing investment.

Analysing house prices and investment in housing is challenging, due to the complexity of the housing market and the structural changes that have affected it. First, the housing market in Norway has gone through important changes as a result of the abolishment of price regulation in the 1980s. Second, since households to a large degree debt-finance their investment in the housing market, the deregulation of credit markets and increased competition from foreign financial institutions may well have affected the housing market. And third, since buying a house or a flat is an investment decision, developments in risk and expected return on alternative investment opportunities may also have affected the housing market. In this paper we do not explicitly focus on structural changes, but rather on regular macroeconomic driving forces behind the observed developments in supply and demand in the housing market, which have a major impact on household wealth and debt.

At the Central Bank of Norway, a small, simultaneous model has been developed, which includes estimated equations for the two variables that ultimately determine developments in household housing wealth, namely house prices and housing investment. In addition, the

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model includes definitional equations for housing stock and household housing wealth. We use the model to analyse the driving forces behind observed developments in house prices and housing stock. Even though our model is a representation of a limited part of the economy, by simulating the model, we can gain insight into the relationship between house prices, investments and housing wealth when shocks hit the economy.

Interest rates affect the housing market through several channels, and by simulating the model assuming a shock to interest rates, we can learn more about the direct and indirect effects. Simulations of our small, simultaneous model show that an increase in interest rates affects housing wealth through a negative direct effect on both house prices and investments. The fall in house prices reduces housing investment further. This curbs growth in housing stock and dampens the negative effect of the interest rate shock on house prices. The direct effect on house prices of the increase in interest rates clearly dominates, however. Our model also includes an estimated equation for household debt. A higher interest rate, coupled with a fall in house prices, reduces household debt growth for a long time.

The rest of this paper is organised as follows: Section 2 outlines alternative measures of household housing wealth; in Section 3 we present our small simultaneous model and the simulations, while Section 4 provides a conclusion.

2.   Measuring household housing wealth

In this section, we calculate household housing wealth. Alternative data and methods are available, and the results of different calculations are compared and evaluated.

Data sources

Since household housing wealth is not directly observable, it must be calculated using available information on house prices and housing stock. There is, however, more than one empirical variable available for both prices and stock, and one has to choose which variables to apply in the calculations. In general, the choice of information set may affect the results. We therefore calculate household housing wealth using different measures and evaluate the consequences.

Our first method is based on information on the total housing stock measured in square metres. Statistics Norway publishes data on the number of dwellings in Norway about every tenth year. They also produce figures for completed dwellings each year. In order to establish a consistent time series of the number of dwellings, we make use of information on the number of dwellings in 1970, 1980, 1990 and 2001. Combining this information with completed dwellings each year, we obtain a time series of annual data. A survey of living conditions is published annually, which provides information on developments in average floor area per dwelling.[3] Total floor area is calculated by multiplying the number of dwellings and average floor area. In order to calculate the value of total housing stock measured in square metres, we use an average price per square metre. The associations of Norwegian real estate agents (hereafter denoted NEF/EFF) publish price indices for detached houses, multi-dwelling houses and flats based on sold units. This is the only price index available that shows the average price per square metre. An average price per square metre, which is representative for the entire housing stock, is obtained by weighting the sub-indices together. As weights we use each house type's share of total housing stock.[4] Housing wealth is

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[3]   For analyses of Statistics Norway's surveys of living conditions, see for example Nordvik (2006).

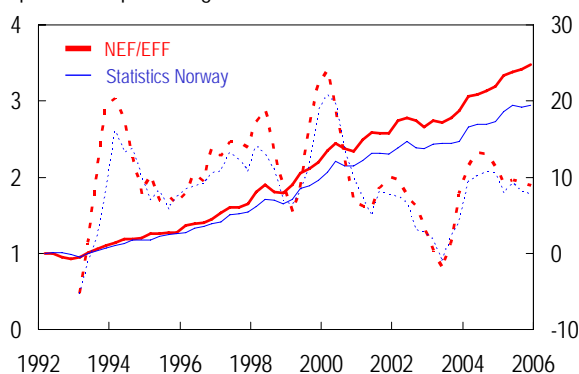[4]   For more information on housing types' share of the housing stock, see Gulbrandsen (2003).

calculated by multiplying the housing stock in square meters by the average price per square metre.

The second method is based on the value of housing capital in fixed prices, as calculated in the national accounts on the basis of cumulated gross investment in housing. Housing wealth is calculated at current prices by multiplying housing capital at fixed prices by a house price index. However, the result of this method depends on the housing investment deflator that we use at the starting point of the time series.

When calculating household housing wealth on the basis of the value of housing capital at fixed prices, we can choose between two different house price indices. Statistics Norway publishes a quarterly house price index starting from the first quarter of 1992.[5] This index measures price developments in the total stock of dwellings. NEF/EFF publish monthly figures on house prices.[6] This index measures the average price per square metre representative for monthly turnover. On a monthly basis the index extends back to 1997, on a quarterly basis back to 1990, and on a yearly basis back to 1985.

Both price indices are constructed using a hedonic method. The price indices are adjusted for house size, type of dwelling and location. The developments in the indices are similar, but not identical (see Figure 1).

Figure 1 House prices. Level (solid lines, left hand scale) and change (dotted lines, right hand scale) over the last four quarters as percentages. Indices, 1992Q1 = 1

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

The differences in the two indices can largely be explained by the following: first, the weights used when aggregating across different segments of the housing stock are not the same. Second, although both indices are calculated using a hedonic method which adjusts for size, type of dwelling and location, the two calculations differ. Third, the basic data for the two indices are slightly different. The first factor is probably most crucial for explaining the differences, since Statistics Norway calculates a price index for the total stock of dwellings and NEF/EFF calculate a price index for housing turnover.

To calculate developments in house prices further back in time, we use a price index calculated as part of a project at the Central Bank of Norway on historical monetary statistics

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[5]   See Christensen (2003).

[6]   See www.nef.no.

for Norway.[7] This price index has been measured annually since 1819, using a repeated sales method. The transaction prices are collected from the real estate register in four major cities in Norway. Since 1986, the index has been spliced with the house price index calculated by NEF/EFF.

Our two measures of the housing stock call for different methods when calculating household housing wealth. In the second case, we can use two different price indices, and in total we therefore have three different alternatives for calculating housing wealth (see Table 1).

Table 1

**Different information sets available for
calculating household housing wealth**

Method/alternative	Information on volume	Price index
1	Housing stock in square metres (Statistics Norway)	Sub-indices from NEF/EFF weighted together using each housing type's share of total housing stock
2a	Value of the housing capital in fixed prices (national accounts)	NEF/EFF
2b	Value of the housing capital in fixed prices (national accounts)	Statistics Norway

Sources: Statistics Norway; ECON; FINN.no; Association of Norwegian Real Estate Agents (NEF); Association of Real Estate Agency (EFF).

Since we want to calculate *household* housing wealth, we also need to estimate the share of the housing stock that is owned by households. On the basis of information on the share of households that own their own homes and an estimate of the share of households that own more than one dwelling, we estimate that households own 83% of the total housing stock.

Methods of calculation - formulas

Method 1: Housing stock in square metres[8]

The first method we present is based on figures for the total housing stock measured in square metres and the average price per square metre. As mentioned above, Statistics Norway publishes figures on the number of dwellings. Since the last available observation for the number of dwellings is January 2005, we add the number of dwellings completed last year when calculating an annual figure for 2005. We do not have the figures on dwellings that have been demolished or on commercial premises converted to dwellings. However, these two variables have opposite effects on the housing stock, and the net impact is probably small compared with the construction of new dwellings.

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[7] See Eitrheim and Erlandsen (2004).

[8] The National Bank of Denmark uses a similar method when calculating the housing wealth in Denmark, see Olesen, Overgaard and Pedersen (2006).

On the basis of the number of dwellings, average floor space, price per square metre and percentage of household ownership, we can calculate household housing wealth using the following equation:

$$\text{Housing wealth}_t = (\text{average price per square metre})_t$$

$$\cdot (\text{housing stock}_{t-1} + \text{the number of completed dwellings}_t) \tag{1}$$

$$\cdot (\text{average floor space \{in square metres\}})_t \cdot 0.83$$

The ratio 0.83 is an estimate of the share of the housing stock owned by households.

Method 2: Housing stock in fixed prices

The second method is based on housing capital in fixed prices from the national accounts. Statistics Norway publishes quarterly national accounts data back to 1978, which is the starting point for our calculations, using the following equation:

$$\text{Housing wealth}_{1978} = (\text{housing capital in fixed prices})_{1978} \cdot$$

$$\tag{2}$$

$$(\text{price deflator for gross fixed investment in housing capital})_{1978} \cdot 0.83$$

The ratio 0.83 is an estimate of the share of the housing stock owned by households. Equation (2) gives an estimate of how much it would cost to rebuild the entire existing housing stock in 1978 at fixed factor prices the same year.

With the equation above as basis, housing wealth in later periods is calculated using the following equation:

$$\text{Housing wealth}_t = \text{housing wealth}_{t-1}\left(\frac{\text{house price}_t}{\text{house price}_{t-1}}\right) \cdot \left(\frac{\text{housing capital in fixed prices}_t}{\text{housing capital in fixed prices}_{t-1}}\right) \tag{3}$$

Results from the calculation of household housing wealth

Using method 1, we estimate household housing wealth at NOK 3 245bn, or 230 per cent of GDP Mainland Norway (GDP excluding oil, gas and international shipping) in 2005, see Table 2. The results from the second method, where housing wealth is calculated on the basis of housing capital in fixed prices, are NOK 2 672bn or NOK 3 229bn, depending on which house price index we use.

Table 2

Calculated household housing wealth in billions of NOK and as a percentage of mainland GDP. 2005[1]
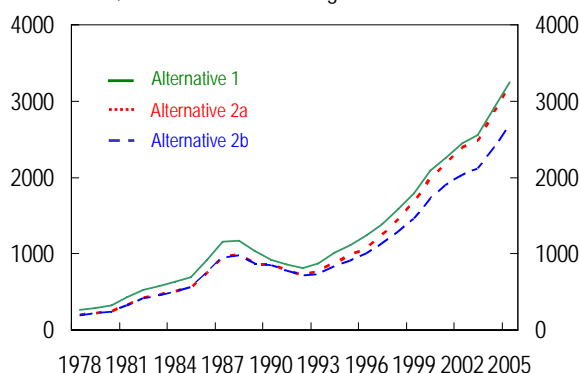
Method/alternative	Billions of NOK	Per cent of mainland GDP
1	3 245	230
2a	3 229	229
2b	2 672	189

[1] Housing stock in fixed prices 2005Q4 is based on estimates in Inflation Report 1/06.

Source: Central Bank of Norway.

Figure 2 shows developments in household housing wealth according to the three alternative calculations. The major difference between the two methods is how to measure the housing stock. The first method uses directly measured volume figures for housing stock, i.e. the housing stock in square metres. The second method uses a variable that is derived from housing investment and a depreciation rate for housing capital. Although the depreciation rate is based on information from Statistics Norway, this parameter is unobservable and may suffer from measurement error. Our assessment is that there is less uncertainty connected with the first method. Our preferred method for measuring household housing wealth is therefore method 1, where housing wealth is based on the housing stock in square metres.

Figure 2 Household housing wealth in billions of NOK. Three alternatives, see Table 1. Annual figures. 1978-2005

Sources: Statistics Norway, NEF, EFF, FINN.no, ECON, Gulbrandsen (2003), Nordvik (2006) and Norges Bank

3.   Understanding developments in household housing wealth

In Section 3.1 we present a small, simultaneous model developed at the Central Bank of Norway. The model includes estimated equations for the two variables that ultimately determine developments in household housing wealth, namely house prices and housing investment. In addition, the model includes estimated equations for household debt and the bankruptcy rate of domestic firms, as well as definitional equations for housing stock, household housing wealth and interest rates. The model is part of a forecasting and policy analysis system that is used in monetary policy, and is regularly used to evaluate financial stability in different macroeconomic scenarios for the Norwegian economy.

In Section 3.2 we use this model to analyse the driving forces behind developments in house prices and housing investment. By simulating the model, we evaluate possible consequences of an interest rate shock for housing wealth.

3.1   The model

Our small model includes, among other equations, estimated equations for house prices and housing investments. All estimated equations are in the equilibrium correction form, and we use quarterly data. Lower case letters denote natural logs of the variables, and Δ defines the first difference operator, i.e. $\Delta(x_t) = \ln(X_t) - \ln(X_{t-1})$, and $\Delta_4(x_t) = \ln(X_t) - \ln(X_{t-4})$, etc.

House prices

The estimated house price equation is given below in (4). It contains effects of disposable income, housing stock, the unemployment rate, banks' after-tax lending rate and a consumer

confidence indicator. The estimation period is 1990Q2 – 2005Q4, R^2 = 0.82 (standard deviation of the equation = 0.015). Absolute *t*-values are given in brackets below the coefficients.

$$\Delta ph_t = -\underset{(7.0)}{3.16} \, \Delta(I_{m,t} \cdot (1 - \tau_t)) - \underset{(3.3)}{1.47} \, \Delta(I_{m,t-1} \cdot (1 - \tau_{t-1})) + \underset{(1.9)}{0.12} \, \Delta income_t + \underset{(3.1)}{0.04} \, E_t$$

(4)

$$-\underset{(5.7)}{0.12} \left[ph_{t-1} + \underset{(2.5)}{4.47} \, (I_{m,t-1} \cdot (1 - \tau_{t-1})) + \underset{(3.5)}{0.45} \, u_t - \underset{(8.6)}{1.66} \, (income_t - hstock_{t-1}) \right]$$

where *PH* = house prices; I_m = interest rate (average interest rate on banks' mortgage-secured loans); τ = deduction in taxable income for interest expenses (equals 0.28 from 1992); *INCOME* = household disposable income (adjusted for reinvested dividends from 2000); *E* = a function of a consumer confidence indicator, which represents households' expectations about their own financial situation and the domestic economy; *U* = registered unemployment rate; *HSTOCK* = housing stock. The model also contains seasonal dummies and a constant. See Jacobsen and Naug (2005) for a detailed discussion of (a previous version of) this equation.

Housing investment

The estimated equation for gross investment in housing is given below in (5). It contains effects of house prices, construction costs, a proxy for land prices, housing stock (due to investment for maintenance) and the interest rate. The variables are measured in real terms. The estimation period is 1990Q1 – 2005Q4, R^2 = 0.72 (standard deviation of the equation = 0.038). Absolute *t*-values are given in brackets below the estimates.

$$\Delta jh_t = \underset{(6.7)}{0.57} \, (\Delta_3 pht - \Delta_3 pc_t) - \underset{(2.6)}{0.17} \, \Delta_2 jh_{t-2} - \underset{(6.5)}{2.6} \, (\Delta_4 I_t - 1/3 \cdot \Sigma_{j=-1,..,1} \, \Delta_4 pcjae_{t-j})$$

$$-\underset{(8.0)}{0.75} \, [(jh_{t-1} - hstock_{t-10}) - (ph_{t-4} - pc_{t-4}) + (lp_{t-1} - pc_{t-1}) + (pj_{t-4} - pc_{t-4})$$

(5)

$$-\underset{}{5.19} \, (I_{t-4} - 1/3 \cdot \Sigma_{j=-1,..,1} \Delta_4 pcjae_{t-j-4})]$$

where *JH* = gross investment in housing; *I* = banks' average lending rate; *PCJAE* = consumer prices adjusted for taxes and energy prices; *HSTOCK* = housing stock; *PH* = house prices; *PC* = consumer prices; *LP* = (a proxy for) land prices. The model also contains seasonal dummies and a constant. See Jacobsen et al. (2007) for a detailed discussion of this equation.

Housing stock

Housing stock is calculated as the level of housing stock in the previous period plus net investment, i.e. plus gross investment minus depreciation.

$$HSTOCK_t = (1 - \delta) \cdot HSTOCK_{t-1} + JH_{t-1}$$

(6)

where *HSTOCK* = housing stock (housing capital in fixed prices); *JH* = gross investment in housing; δ = 0.0063, a quarterly depreciation rate. The parameter is consistent with annual figures published by Statistics Norway.

Household housing wealth

$$HHW_t = \alpha \cdot PH_t \cdot HSTOCK_t \tag{7}$$

where *HHW* = household housing wealth; *PH* = house prices; α = 0.83, households' share of total housing wealth.

Household debt

The equation for household debt is given in (8). It contains effects of house prices, housing stock, the interest rate, turnover in the housing market, the share of students in the population, households' income and unemployment. The estimation period is 1994Q1 – 2004Q1, R^2 = 0.97 (standard deviation of the equation = 0.0019). Absolute *t*-values are given in brackets below the estimates.

$$\Delta debt_t = \Delta hstock_t - \underset{(2.6)}{0.29} \Delta(debt_{t-1} - hstock_{t-1}) - \underset{(5.2)}{0.29} \Delta I_t + \underset{(3.0)}{0.02} \Delta turnover_{t-2}$$

$$+ \underset{(1.5)}{0.01} (\Delta_4 wincome_t + \Delta pht_t) - \underset{(3.9)}{0.03} \Delta u_t \tag{8}$$

$$- \underset{(7.4)}{0.07} \left[debt_{t-1} - ph_{t-1} - hstock_{t-1} + \underset{(3.2)}{1.70} I_{t-1} - \underset{(1.4)}{0.17} turnover_{t-1} - \underset{(5.0)}{0.64} studentshare_{t-1}) \right]$$

where *DEBT* = household gross debt; *HSTOCK* = housing stock; *I* = banks' average lending rate; *TURNOVER* = number of house sales; *WINCOME* = total wage income in the economy; *PH* = house prices; *U* = registered unemployment rate; *STUDSHARE* = no. of students aged 20–24 years as a share of the population, five quarter average. The model also contains seasonal dummies and a constant. See Jacobsen and Naug (2004) for a detailed discussion of this equation.
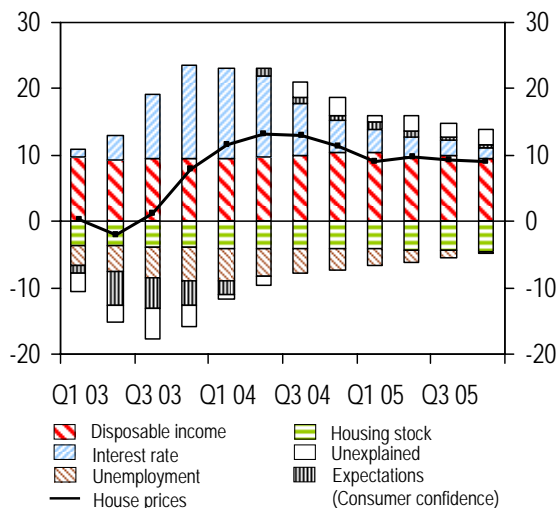
3.2   Model simulations

The model outlined in Section 3.1 can be used to evaluate developments in house prices and housing investment, i.e. the two variables that ultimately determine developments in household housing wealth. We are particularly interested in understanding the contribution of the different explanatory variables to developments in prices and investment. That will help us reach a conclusion with respect to the driving forces behind developments in housing wealth in the past. The model can also be used to evaluate the consequences for household housing wealth of different macroeconomic scenarios. We illustrate this below by raising the interest rate above the interest rate path in our baseline scenario.

The estimated contributions to developments in house prices and housing investment of the explanatory variables

In Figures 3 and 4 we use the estimated equations to identify the contribution of each explanatory variable to developments in house prices and housing investment respectively. The solid line shows the 4-quarter growth in per cent for housing prices and investment, while the bars shows the estimated isolated contribution to 4-quarter growth of each
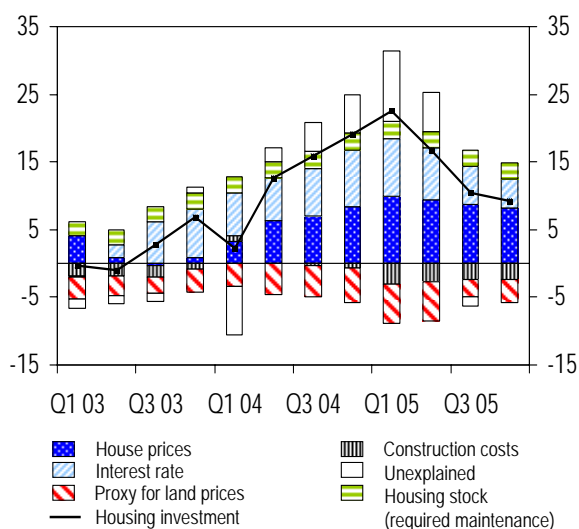
explanatory variable measured in percentage points. The bars include both immediate and lagged effects as predicted by the model.

Figure 3 House prices and calculated contributions of explanatory variables. 4-quarter growth in per cent and contribution in percentage points

Sources: Norwegian Association of Real Estate Agents, Association of Real Estate Agency Firms, FINN.no, ECON and Norges Bank

Figure 4 Housing investment and calculated contributions of explanatory variables. 4-quarter growth in per cent and contribution in percentage points. All variables measured in real terms

Sources: Statistics Norway and Norges Bank

Figure 3 shows that after a transitory decline in house prices in 2003, the 4-quarter growth in house prices has been around 10-15 per cent in later years. Disposable income has permanently contributed around 10 percentage points of the 4-quarter growth in house prices, while the growth in housing stock has contributed negatively by around 3-4 percentage points. The variation in house price inflation in recent years is largely due to developments in the interest rate, unemployment and household expectations. For example, in the first quarter of 2004, the interest rate contributed to a 4-quarter growth in house prices of 14 percentage points. A relatively high unemployment rate and low consumer confidence contributed to weak developments in house prices in 2003, while the accelerated house price inflation in 2004 is very much due to a decline in the interest rate.

With respect to developments in housing investment, Figure 4 shows that house prices and the interest rate explain much of the variation in 4-quarter growth. Hence, housing investment follows a relatively similar pattern to house prices. In general, investment is difficult to model econometrically due to high volatility in these data. This is reflected in Figure 4 by the bar for "unexplained". The unexplained part, i.e. the residual, is relatively large in the first quarter of both 2004 and 2005.

From Figure 3 and 4 we can conclude that the strong growth in household housing wealth of recent years is largely driven by developments in interest rates and disposable income. Interest rates affect house prices and housing investment directly, but also indirectly, since the explanatory variables are also influenced by interest rates.

Simulating the model assuming higher interest rates

By simulating the model, we can learn more about the direct and indirect effects of changes in explanatory variables. Interest rates work through several channels in our small model, and we simulate the model assuming a shock to interest rates. As our baseline scenario, we use the baseline scenario for 2006-2009 in the Inflation Report 2/2006 of the Central Bank of Norway. Our model is largely linear, and conclusions are therefore largely robust with respect to the

choice of baseline scenario. Over the last 2-3 years, the interest rate level in Norway has been low. Since 2005, however, interest rates have been increasing. According to the baseline scenario, the key interest rate will gradually increase towards a more normal level. This will affect other interest rates positively. We extend the baseline scenario to 2015 assuming that banks' lending rate moves toward 6 per cent.

We shock the model by assuming that the interest rates will increase at a faster pace than in the baseline scenario during the first few years. Banks' lending rate reaches 9 per cent around 2009. From then onwards, this interest rate is assumed to stay unchanged until 2015 (see Figure 5).[9]

Figure 5 Three-month nominal money market interest rate. Solid line: baseline scenario. Dotted line: high interest rate path
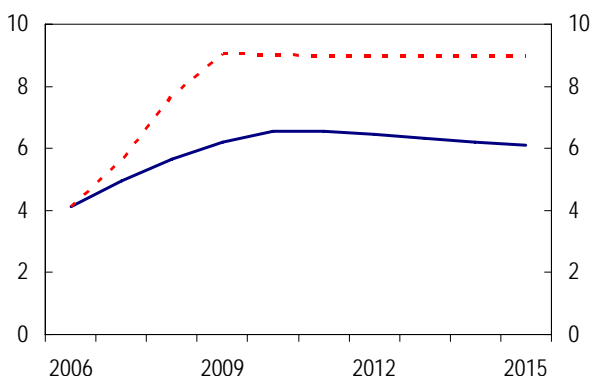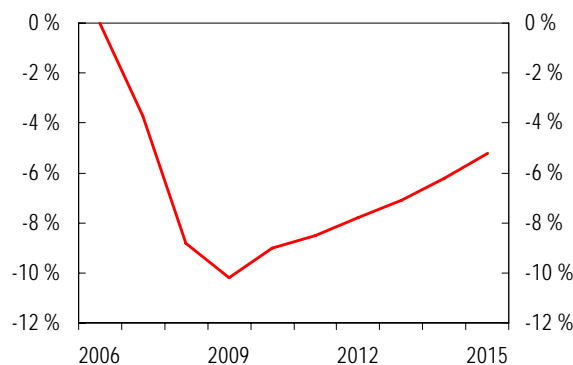

Figure 6 The effect on household housing wealth of the high interest rate path. Deviation from baseline scenario

Source: Central Bank of Norway.

Our model shows that the higher interest rate scenario will reduce household housing wealth by approximately 5 per cent in 2015 relative to the projection path (see Figure 6). This is largely due to a negative direct effect on both house prices (see Figure 7) and investment (see Figure 8).

Figure 7 The effect on house prices of the high interest rate path. Deviation from baseline scenario
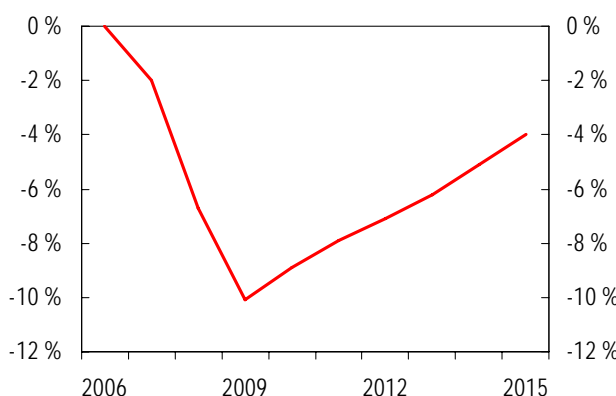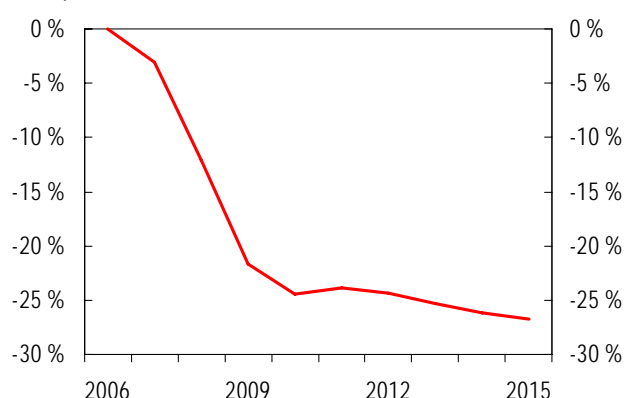

Figure 8 The effect on housing investment of the high interest rate path. Deviation from baseline scenario

Source: Central Bank of Norway.

The fall in house prices decreases housing investment, and hence curbs growth in the housing stock even further (see Figure 9). To some degree, the reduction in housing stock dampens the negative effect of the interest rate shock on house prices. The direct effect on

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9   This interest rate paths are developed for illustrative purposes only and should not be interpreted as realistic alternative interest rate paths for Norway.

house prices of the change in the interest rate clearly dominates. Our model also includes an estimated equation for household debt. A higher interest rate, as well as the fall in house prices, reduces household debt growth for a long time (see Figure 10).

Figure 9 The effect on housing stock of the high interest rate path. Deviation from baseline scenario
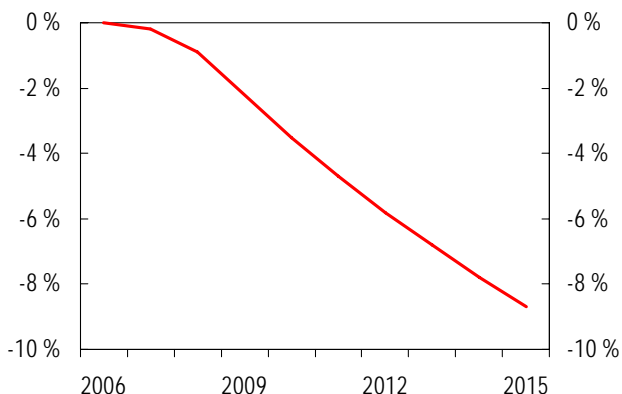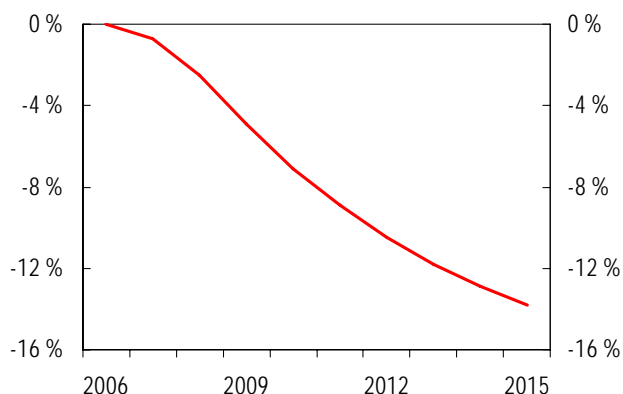

Figure 10 The effect on households debt of the high interest rate path. Deviation from baseline scenario

Source: Central Bank of Norway.

4.   Conclusion

In this paper we develop alternative measures of household housing wealth using information on house prices and housing stock. Different methods and data can be used, and the size of housing wealth varies significantly across information sets and methods. Norwegian household housing wealth relative to GDP Mainland Norway varies from 189 to 230 percent in 4th quarter 2005, depending on the method and information set. There is no clear and objective selection criterion available for choosing among the different measures of household housing wealth. Our preferred measure is based on the number of dwellings, average dwelling size, average house price (NOK 1000/sq.m.) and households' share of the housing stock. We evaluate potential measurement error problems to be smaller in this alternative.

By simulating a small model that includes estimated equations for house prices and housing investment, we show how household housing wealth is related to the business cycle and monetary policy. Over the past years, the development in house prices and investment, and hence the development in housing wealth, is very much driven by changes in interest rates and growth in disposable income. The latter variable affects house prices directly and housing investment indirectly through a house price effect on investment.

Monetary policy affects household housing wealth both directly and indirectly through several channels. Simulations on our model show that an increase in interest rates affects household housing wealth through a negative direct effect on both house prices and investment. The fall in house prices decreases housing investment, and hence curbs growth in the housing stock. The reduction in housing stock dampens the negative effect of the interest rate shock on house prices. The direct effect on house prices of the change in the interest rate clearly dominates, however. Our model also includes an estimated equation for household debt, and a higher interest rate, as well as the fall in house prices, reduces household debt growth for a long time.

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