



**CENTRAL BANK OF ICELAND**

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**WORKING PAPERS No. 29**

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Analysing the effects of the recent mortgage  
market restructuring**

by

**Lúdvík Eliasson and Thórarinn G. Pétursson**

**February 2006**

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**Economics Department**

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ISSN: 1028-9445

# The residential housing market in Iceland: Analysing the effects of the recent mortgage market restructuring

Lúdvík Elíasson and Thórarinn G. Pétursson\*

February 2006

## Abstract

In June 2004 the government-backed Housing Financing Fund eased its loan regulations in an attempt to consolidate its position in the domestic credit market. This led to a strong response from the domestic commercial banks which actively entered the mortgage market for the first time. These changes led to a substantial decline in long-term real mortgage rates, increased the access to credit, and allowed homeowners to withdraw equity from their homes without actual transactions. This paper sets up a simple model of housing demand and supply to analyse these effects. The results suggest that the structural change has led to a substantial rise in housing demand, with house prices rising by just under 20% one year after the change. This triggered a similar rise in housing investment roughly two years after the reform. The model predicts that the effects on house prices gradually die out as house prices return to the level that is consistent with normal profit margins in the construction sector. The housing stock, however, remains about 5% larger than in the baseline scenario. The effects are even larger when taking account of the second-round effects on the housing market through the effects of increased wealth and easier access to credit on general consumption and overall demand in the economy.

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\**Address:* Elíasson: Landsbanki Research. Pétursson: Central Bank of Iceland and Reykjavík University. Much of this work was done while the first author was at the Central Bank of Iceland. This paper is partly based on a project on the Icelandic mortgage market from 2004 from the Economics Department of the Central Bank of Iceland. We are grateful to the other contributors to that project, Gudmundur Gudmundsson, Magnús Gudmundsson, Már Gudmundsson, Kristjón Kolbeins, Markús Möller, Gudmundur Sigfinnsson, and Arnór Sighvatsson, and to Thorvardur T. Ólafsson for reading the manuscript. None of them are, however, responsible for any errors or omissions in this study. The views expressed in this paper do not necessarily reflect those of the Central Bank of Iceland.

## 1. Introduction

In the summer of 2004 the housing market in Iceland went through dramatic changes when the government-backed Housing Financing Fund eased its loan regulations in an attempt to consolidate its already strong position in the domestic credit market. This led to a strong response from the domestic commercial banks which actively entered the mortgage market for the first time, thus greatly enhancing competition in the market.<sup>1</sup> These changes made mortgage financing more accessible, the real cost of mortgage finance declined significantly, and the opportunity for homeowners to withdraw equity from their housing without actual transaction became available for the first time. The effects on the mortgage market, the demand for housing, house prices and domestic demand in general have been dramatic and are still working their way through the system. Since these changes occurred, nominal house prices have risen by just under 46% (by roughly 40% in real terms) and by 35% between 2004 and 2005 (by just over 30% in real terms). At the same time private consumption has been booming, with consumers taking on more debt as liquidity constraints have eased and the real price of debt has fallen. The soaring house prices also make households feel wealthier, as their housing wealth increases, fuelling demand and pushing house prices even further. Private consumption rose by over 12% in the third quarter of 2005 from the same period the year before, and the economy has been showing symptoms of serious overheating.

Although there are also other factors behind the booming economy, such as favourable terms of trade, declining taxes and an investment boom in the aluminium industry, it is clear that this restructuring of the domestic mortgage market has had a major impact on the economy, and the housing market in particular. This paper tries to address and analyse some of the economic effects, by estimating a simple model of the domestic housing market. This model identifies the demand and supply schedules for housing, allowing for a direct estimate of the effect of the structural changes on house prices and housing investment through easier access to credit and lower real mortgage rates. The estimates suggest that house prices peak at just under 20% above the baseline scenario one year after the change, with housing investment rising by a similar amount from baseline about two years after the change. The effects on house prices gradually die out as they return to a level that is consistent with normal profit margins in the construction sector. The housing stock, however, remains about 5% larger than in the baseline scenario. There are also potentially important second-round effects stemming from the effects of increased housing wealth and easier access to credit on general consumption and overall demand in the economy, including second-round effects on the housing market. The paper therefore also uses the macroeconomic model of the Central Bank of Iceland to analyse the general macroeconomic effects (allowing for monetary policy responses). Taking account of these second-round effects suggests that house prices could rise well above 20% over

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<sup>1</sup>Previously the housing financing loans offered by banks were generally used only after other means of funding were exhausted. The loans offered by banks were on less favourable terms, i.e. they carried considerably higher interest rates and had much shorter maturities. This issue is addressed in more detail in Chapter 4.

a period of 5 years after the shock. This accounts for something like half of the rise in house prices actually observed, with the remainder attributed to the effects of the other shocks hitting the economy at the same time, and a possible house price bubble.

This paper is organised as follows. Chapter 2 describes the basic economic structure of the housing market. The data is described in Chapter 3 and the changes to the housing market are discussed in Chapter 4. This is followed by an empirical estimation of the housing market model in Chapter 5. Chapter 6 reports the simulation results and Chapter 7 concludes.

## 2. The economics of the housing market

As in other durable goods markets, equilibrium in the residential housing market is obtained by the matching of the demand and supply of housing, determining the price of the outstanding stock of housing and the flow of new housing into the market (see Meen, 2001 for a literature survey). In this stock-flow analysis, the demand for new housing can be formulated in a standard life-cycle model of utility maximising households (cf. Meen, 1990). From such an analysis, one can derive a demand function specifying housing demand as determined by factors such as relative prices, the cost of financing housing purchases, household income and net wealth<sup>2</sup>

$$H^d = f \left( \frac{P_h}{P}, R, Y, W_f, D \right) \quad (2.1)$$

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where  $H^d$  is the demand for housing services (the housing stock),  $P_h$  is the price of housing,  $P$  is the general price level,  $R$  is the real cost of financing housing purchases (the real interest rate),  $Y$  is household disposable income,  $W_f$  is household financial wealth (reflecting expected future income) and  $D$  is household debt.

In general, one can expect that a rise in the relative price of houses should decrease housing demand. The same applies to a rise in the real interest rate. A rise in disposable income and financial wealth should, however, increase housing demand other things being equal. It is more difficult to determine the effects of household debt on housing demand. In the case where housing finances are restricted by credit rationing, an easing of such restraints, which is reflected in a rise in household debt, might lead to a temporary increase in the demand for housing. This would also hold if increased debt indicates increased consumer optimism, which would lead to stronger demand and rising house prices (see Barot and Yang, 2002). Increased debt would, however, also imply an increase in the repayment burden and a fall in

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<sup>2</sup>This abstracts from other potentially important factors affecting housing demand, such as demographic factors, housing benefits, taxes, expectations of future house price movements (as housing also has an important investment element), and the ratio of house prices to rental prices. Note, however, that in a perfect capital market, the rental price of house services should be identical to the real user cost in equilibrium (e.g. Pain and Westaway, 1996). With capital market imperfections, one would however expect the price elasticity of demand to be higher than the rental elasticity (see e.g. Riddel, 2004).

household net worth, which could lead to increased financial distress and therefore offset the credit access effects in the long run. Hence, it is not theoretically clear what the effect of household debt on housing demand is, and the short-run and long-run relationship can be different. One might, however, expect that the positive effect of increased debt on expenditure will decline as credit becomes more freely available to households.<sup>3</sup>

It is common to assume a unit income elasticity of housing demand which implies that the demand function can be re-written as

$$\frac{H^d}{Y} = f\left(\frac{P_h}{P}, R, \frac{W_f}{Y}, \frac{D}{Y}\right) \quad (2.2)$$

This gives an inverse demand function as

$$\frac{P_h}{P} = \phi\left(\frac{H}{Y}, R, \frac{W_f}{Y}, \frac{D}{Y}\right) \quad (2.3)$$

Hence, equation (2.3) gives a constant relative price of houses if the stock-to-income, wealth-to-income, and debt-to-income ratios, together with the real interest rate are constant over time.<sup>4</sup>

In the stock-flow analysis, the supply of housing starts is determined by the internal return of housing investment, which reflects the ratio between the market price of housing and the cost of new construction

$$Q = \frac{P_h}{C} \quad (2.4)$$

where  $C$  is the cost of new construction. This framework suggests that as house prices rise above construction costs ( $Q$  rises above 1), profits above normal levels can be obtained by increasing the supply of new constructions by firms in the construction industry. Investment in housing therefore rises relative to the existing housing stock. This gives the following Tobin's  $Q$  type of relation between housing investment and  $Q$ , see Poterba (1984)

$$\frac{I_h}{H} = h\left(Q\right) \quad (2.5)$$

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<sup>3</sup>Credit market imperfections can also complicate the relationship between housing demand and the other underlying demand factors, leading to potentially perverse effects on the housing stock (see Muellbauer and Murphy, 1997, and Kenny, 1999). Stein (1995) also shows how credit market imperfections can generate self-reinforcing multipliers and multiple equilibria in the housing market, with dramatic responses in house prices to minor changes in the explanatory variables.

<sup>4</sup>Poterba (1984) and Meen (1990, 2000) show how such a demand relation can be derived from a standard arbitrage condition for the real price of owner-occupier services. The arbitrage condition gives real house prices as a function of the real imputed rental price of housing services, tax variables, the depreciation rate on housing, inflation, and real house price capital gains. With the imputed rental price determined by disposable income, wealth, and the housing stock, a house price equation similar to (2.3) can be obtained.

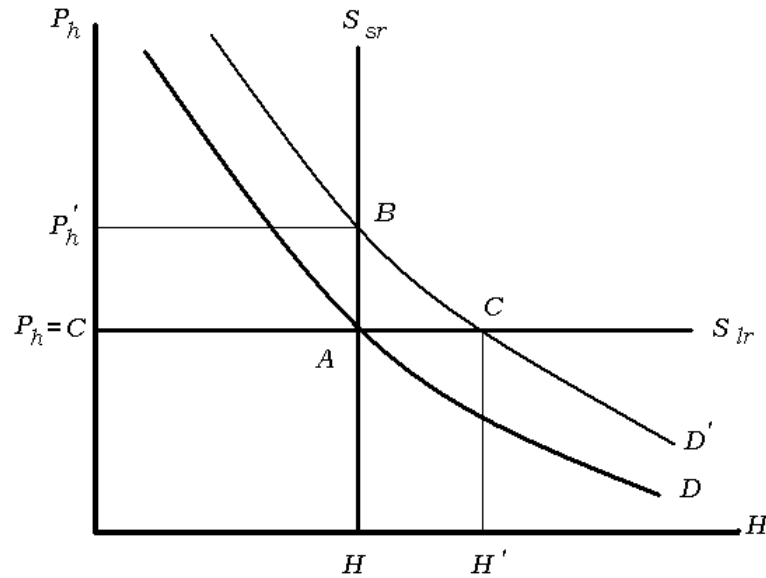
where  $I_h$  is housing investment.<sup>5</sup>

The model is closed with a perpetual investment stock-flow relation

$$H^s = I_h + (1 - \delta_h)H_{-1} \quad (2.6)$$

where  $H^s$  is the supply of housing and  $\delta_h$  is the depreciation rate of the housing stock.

Equilibrium in the housing market is obtained where  $H^d = H^s = H$ . Figure 1 shows how supply and demand interact in the short and long run to determine the price and stock of housing. In the short run the supply of housing can be expected to be (almost) perfectly inelastic as the ratio of new houses to the total housing stock is very low. Hence, the housing stock is basically predetermined over the very short run and the short-run supply curve thus vertical. House prices in the long run are, however, determined by the Q-ratio, i.e.  $P_h = C$ . Hence, the supply curve is perfectly (or almost perfectly) elastic in the long run.



**Figure 1.** Equilibrium in the housing market

This implies that housing demand determines house prices in the short run, but the housing stock in the long run. In the light of large transaction and search costs on the demand side, and long investment horizons and a very low ratio of new housing to the outstanding stock on the supply side, one can expect that the adjustment towards the long-run equilibrium will be slow and that house prices can deviate

<sup>5</sup>Tsoukis and Westaway (1994) use an intertemporal optimisation framework to derive a similar relation. Additional variables, such as the real cost of borrowing, output growth and tax effects, are sometimes added. Note also that this modelling approach assumes that new and existing housing are perfect substitutes.

from building costs for a prolonged period.<sup>6</sup> This can be seen from the figure for a positive shift in the demand curve (e.g. reflecting a positive income shock). The demand curve shifts rightwards and prices rise from A to B with the housing stock unchanged. At that point market prices are above housing costs, i.e. the Q-ratio is above 1. Hence there are incentives for building companies to respond by increasing housing investment. The supply of housing gradually increases, pushing prices back towards the long-run equilibrium at  $Q = 1$  at point C, with the housing stock now at  $H$ .<sup>7</sup> This suggests that housing prices can fluctuate over time and deviate from building costs. The induced price volatility will be more pronounced the steeper the demand curve.<sup>8</sup>

### 3. The data

To estimate the demand and supply schedules described above, this paper uses annual data from 1961 to 2003 (43 yearly observations). Data on housing investment, the housing stock and real disposable income is obtained from national accounts data from Statistics Iceland. The consumer price index is used to approximate the general price level. The building cost index is also obtained from Statistics Iceland.  $R_t$  is given as the interest rate on indexed government bonds with an average maturity of 5 years, obtained from the Central Bank of Iceland. This interest rate roughly reflects the mortgage interest rate that households pay. Finally,  $D_t$  is measured as the total household real debt obtained from the Central Bank of Iceland.

Official data on house prices from the Land Registry of Iceland is only available from 1981. For the period prior to that this paper uses information on the real housing wealth from Baldursson (1993). As the real housing wealth is defined as

$$W_{ht} = \frac{P_{ht}H_t}{P_t} \quad (3.1)$$

data on house prices can be obtained using existing data on  $H_t$  and  $P_t$  (with  $P_{ht} = P_t W_{ht} / H_t$ ). This data is linked to the official house price data from 1981 (the data for

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<sup>6</sup>For empirical evidence see, for example, Meen (1996) and Riddel (2004). The slow price adjustment (together with credit market frictions) is also reflected in a short-run positive correlation between real house prices and turnover in the housing market (see Berkovec and Goodman, 1996, for empirical evidence for the US, and Meen (2000) and Andrew and Meen, 2003, for the UK). This also seems to be a feature of the recent housing boom in Iceland.

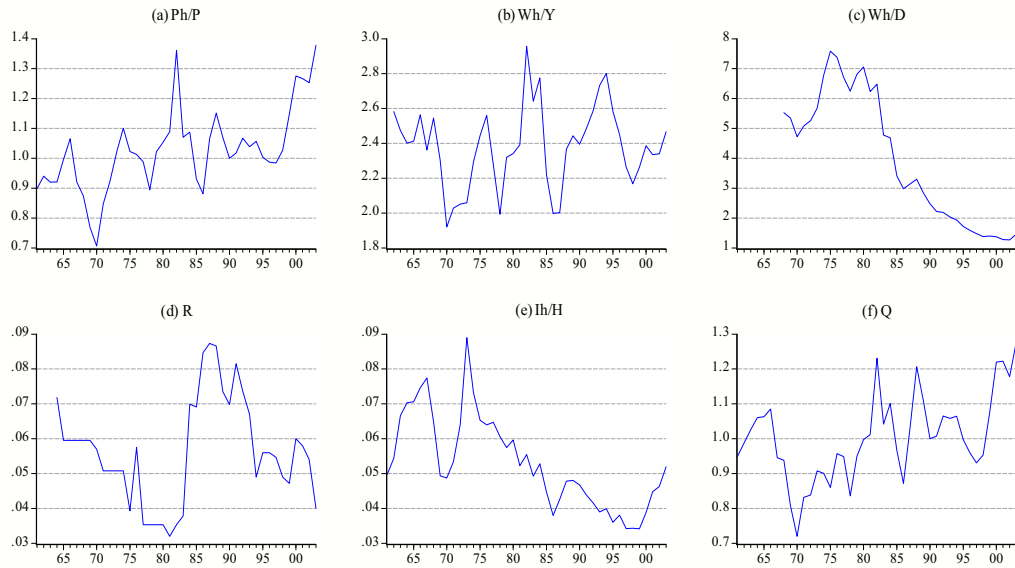
<sup>7</sup>This analysis assumes that the supply of building land is not a binding constraint. If that is not the case, the supply curve might shift upwards reflecting a rise in building costs as the price of land rises. Hence part of the stock adjustment can take place through a rise in construction costs. In that case a new long-run equilibrium could be reached at some point between points B and C in Figure 1. It would still hold that  $Q = 1$  in equilibrium as construction firms will pass the increased costs completely through to homebuyers (reflecting the extreme non-traded character of housing), but unlike the case where land is in abundance, now an increase in housing demand (e.g. through a rise in income) would lead to a permanent rise in housing prices. See Kenny (1999) for a discussion.

<sup>8</sup>One important factor affecting the slope of the demand curve is the tax treatment on owner-occupied housing (see van Noord, 2003). A tax treatment that encourages owner-occupation can lead to a higher and more volatile equilibrium housing price.



which the two series overlap is very similar). All constant price series are measured at 1990 prices. Figure 2 reports few interesting data transformation.

Figure 2a gives the real housing price,  $P_{ht}/P_t$ . This series has been trending upwards, with some significant fluctuations, especially in the high inflation regime until the late 1980s. Real house prices have also risen sharply in the last few years in the sample, for example, by 20% since 1999. Large falls in real house prices are also apparent, usually coinciding with, or slightly lagging, periods of business cycle downturns (the periods 1967-69, 1974-75, 1982-85, 1988-95 and a short recession in 2002).<sup>9</sup>



**Figure 2.** The data

Purchasing a house constitutes a significant outlay for the average family and is probably in most cases the largest investment individuals undertake over their lifetime. Therefore, one would expect a close relationship between the market value of housing (or real housing wealth,  $W_{ht}$ , from equation 3.1) and disposable income. This is confirmed in Figure 2b, which shows the ratio of real housing wealth and disposable income,  $W_{ht}/Y_t$ . Despite some fluctuations, the ratio is quite stable over the whole period, with the average house currently worth about 2.5 times annual disposable income, which is slightly above the period average of 2.4. This ratio peaked in 1982 when the average house was worth just under 3 times the annual disposable income. The apparent stationarity of the ratio (confirmed by formal unit root testing) suggests an important role as a long-run property of the empirical house price equation in Chapter 5.<sup>10</sup>

<sup>9</sup>These business cycle dates (except the last one) are obtained from Pétursson (2000a).

<sup>10</sup>A Dickey-Fuller unit root test rejects stationarity of all the level series. This also applies to the real interest rate, although a more proper interpretation of the apparent non-stationarity of

Figure 2c shows that the ratio of the market value of housing to total household debt,  $W_{ht}/D_t$ . This ratio has fallen sharply in the last two decades, reflecting the increased development of domestic financial markets and easing of credit constraints. This ratio is now about 1.5, implying an average equity ratio of one-third (down from 85% in 1980). This rise in indebtedness suggests that the fast growth of disposable income in the last few years has not been reflected in a similar rise in the demand for housing due to a rising debt burden.

Figure 2d reports the real interest rate used in this study. This rate has been falling gradually over the last decade after a sharp increase in the late 1980s following the liberalisation of market interest rates.<sup>11</sup>

In Figures 2e-2f we turn to the supply side of the housing market. Figure 2e shows the development of the investment rate (the ratio of investment to the housing stock,  $I_{ht}/H_t$ ). The rate fell gradually from the early 1970s to the late 1990s, reflecting the high investment intensity in the early part of the period when a large part of the current housing stock was under construction. This investment boom came to an end in the early 1980s, as interest rates became market determined. This probably also reflects the introduction of financial indexation in 1979. Prior to that, with high inflation, negative real interest rates on credit and underdeveloped financial markets, investment in housing was a primary vehicle for domestic savings.

Finally, Figure 2f shows the development of the Q-ratio. The ratio fluctuates around unity, although a slight upward trend can be detected.<sup>12</sup> As can be seen, the Q-ratio declined sharply in the recession in the late 1960s but gradually increased and rose above unity in 1981. The Q-ratio has also been above one from 1995, with house prices peaking at almost 30% above costs in 2003. That implies a substantial incentive for building companies to increase housing investment, as reflected in the rise in the investment rate in Figure 2e. The fluctuations in the Q-ratio is quite similar to other OECD countries (see Girouard and Blöndal, 2001), although a substantial variation is also apparent.<sup>13</sup>

## 4. Recent changes in the Icelandic mortgage market

For decades the government backed Housing Financing Fund (HFF) dominated the market for financing house purchases in Iceland. A simplified description of the system is that the HFF provided the best option and thus buyers went there first.

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that series is a structural break in the data generating process rather than an inherent unit root property.

<sup>11</sup>A discussion of this liberalisation and its interactions with the real economy and inflation can be found in Pétursson (2002).

<sup>12</sup>This could reflect measurement errors in  $P_{ht}$  related to quality improvements for a given size of housing. A decreasing supply of available land might also cause a trend in  $Q_t$  as that would be reflected in  $P_{ht}$  but not  $C_t$ , which does not include the price of land. For most of the period, however, the price of land is not a sizeable part of  $P_{ht}$  as land in Iceland was in abundance. Hence, this is probably not a serious problem during the period analysed here.

<sup>13</sup>In the period 1970-1999 the standard deviation of the Q-ratio was highest in the Netherlands (24.5%) but lowest in the United States (2%). In Iceland the standard deviation was 12.5% in the same period.

There was a maximum amount on HFF loans and there was also a cut off depending on a loan-to-value (LTV) ratio. The value estimate was not based on the market price but on the Land Registry's valuation, which commonly was somewhat lower than the actual transaction value. In August 2004 the commercial banks started to offer realistic alternative sources of funding. Until then their role had been much smaller, serving only to fill the need for loans after credit from the HFF and the pension funds had been exhausted.

At the same time the commercial banks also introduced the option of refinancing without an actual transaction. This had not been an option with HFF loans, which were only given to those buying a home. Refinancing gave homeowners the possibility to withdraw some of the equity they had in their homes, as well as lowering their repayments by taking newer loans with lower rates of interest, with longer repayment profile, and substituting all their debt with long term annuity loans.

Equity withdrawal lowers the cost of choosing to redistribute the asset portfolio by lowering the share of houses in favour of other assets. It also enables homeowners to withdraw some of their savings, which had accumulated in the form of dwellings, and thus have more available for current spending. This change therefore increased the households' demand for housing and other goods, as well as alternative forms of savings.

Giving homeowners the opportunity, not previously available, to shift some of their accumulated assets for consumption, will affect the behaviour of those who do take that option in the same way as if they were handed a windfall gain. This is similar to a case studied by the Bank of England (1999) following the demutualization of building societies and other mutual institutions, where a sizable sum was paid out to the personal sector. Although this was merely a restructuring of the building societies' balance sheets, this wealth had previously not been available for consumer spending. The same is true for the restructuring of the Icelandic mortgage market, by allowing households to withdraw equity from their housing wealth more easily.

One way of simulating the effects of the shock would be to isolate the effect on consumption in the way the Bank of England (1999) did. To the extent that the new loans enabled people to increase the debt on their houses this may have been seen as a lifting of a constraint on credit. In most cases it seems, however, relevant to assume that those already owning houses were perhaps least constrained. The windfall gain that is felt because of this would then be assumed to be spent over the lifetime of those who receive it.

The main impact of the change is due to lower re-payments. The monthly payments of mortgages fell significantly for a number of reasons: mortgage rates fell significantly, the average length of a mortgage increased, the LTV-ratio increased, the share of annuities as compared to fixed payments increased, and to some extent indexation of loans increased (although this was almost the only choice anyway before). The effects of each of these changes will now be discussed in turn.

Before the change in the mortgage market in 2004 there was a variety of choices for financing the purchase of houses. The HFF loans were a first choice. They had the lowest interest rates and were available for either 25 or 40 years. There was a limit on both the amount and the LTV-ratio (as a fraction of the Land Registry's

valuation). These loans therefore covered the need for financing in only a small number of cases. The next option was typically a loan from the buyer's pension fund. Most pension fund loans had an interest rate premium over the HFF loans, were for a limited amount, and also with strict cut off with respect to the LTV-ratio, again most commonly as a percentage of the Land Registry's valuation. Pension fund loans had shorter maturities than the HFF loans, typically with a maximum length of 30 years. Finally the financing was completed by commercial bank loans. They had a much higher real interest rate than the other loan options (often above 8%), and commonly were given for 10 years, with fixed (indexed) re-payments. The payment profile for a typical house purchase was therefore usually steep to begin with, i.e. for the first 5-10 years, and falling after that. In a recent study of the housing market, Landsbanki (2005) estimates that before the changes the average financing was split between the HFF (70%), the pension funds (25%), and the commercial banks (5%). These assumptions imply an average real interest rate of 6.5% in 1990, but this had fallen to 5.45% in early 2004 (Central Bank of Iceland, 2004). In the fall of 2004 the real interest on housing financing fell to about 4.15%, or by 130 basis points in total.

At the same time the average maturity of loans has increased. This has happened for two reasons: a higher debt ratio for loans with the longest maturity, due to shifting from the Land Registry's valuation to market price as a benchmark for the house value (as well as higher ratios), and refinancing, which also increased the average maturity of the loan. In addition it had been common to acquire the outstanding HFF loans along with the house, thus purchasing the house with financing. This is no longer practiced except in unusual circumstances, and thus the average length of outstanding loans has increased. The combined effect of these changes is that the maximum length of loans has increased from about 34 years to 40 years according to the estimates from Landsbanki (2005).

As already mentioned the average LTV-ratio has risen. It is higher because the maximum LTV-ratio has increased from 80% to 100% (although the most common ratio is somewhat lower), and the maximum at best available terms has gone from 65% to 100% for most apartments, and to at least 80% for more expensive (above 25 m.kr.) single family housing. In addition, the value of which the ratio is taken has changed. Previously there was a complicated mixture of loans used for financing, with a variety of benchmarks. The main value used for reference was the Land Registry's valuation, but after the change the market price has been used. This has increased the LTV-ratio, as a percentage of the market price, but it is difficult to estimate by how much.<sup>14</sup>

Smaller changes may also have further increased the purchasing capacity of the typical household. One is that although almost all loans for housing in Iceland are annuities, the main exception was the high interest bank loans that were used as a final form of financing. After the change in the mortgage market in 2004 the common

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<sup>14</sup>Some of these effects have just recently been partially reversed. Mortgage rates have risen slightly again, although this probably reflects cyclical factors, with the Central Bank continuing to tighten policy. At the same time the commercial banks have again started to use the Land Registry's valuation as a benchmark for at least part of the largest loans, and they have become reluctant to go above a 80-90% LTV-ratio.

practice is to acquire all the financing needed from one source. In addition many of the older loans bearing the highest rates of interest were refinanced with new annuity loans.

Another factor that contributes, albeit marginally, to increased purchasing capacity is increased indexation. Before the change almost all mortgages in Iceland were indexed with inflation as measured by the consumer price index. The only case in which this did not hold was when a part of a house purchase was financed by overdraft loans on bank deposit accounts, or with bank loans shorter than 5 years. The cases where this applies are, however, few and have little significance on the analysis. It is probably more likely that indexation has increased, but the effect of this change will be ignored since it is small in comparison with other effects under consideration.

The changes outlined above affect the economy in various ways. Effects on households are of primary importance when economic responses to these changes are estimated. The effects on the housing market are found by using estimates of the demand and supply schedules discussed in the previous chapter. The change is modelled as a shock to two key variables. As the average mortgage rates fell from 5.45% in 2004 to 4.15% as discussed earlier the annual average of the real rate on mortgages is assumed to fall by 55 basis points during the year when the market restructuring begins and by additional 75 basis points the year after. There is also a shock to the availability of credit to households as discussed above. Given the Central Bank's (2004) estimates of the average mortgage profile and assuming that home buyers are on average willing to make equal monthly mortgage payments as before the change the average loan will increase by roughly 26% due to these changes to financing. As discussed above, rising house values and higher LTV-ratios will further boost access to credit. The upper limit on mortgages, covering any type of normal financing, was previously 80% of the houses value, but after the restructuring this had increased to 100% for most apartments, while larger single-family house mortgages were still limited at 80% LTV-ratio. The simple assumption used in the simulation is that this raised the average mortgage by 12.5%. This increase is assumed to be fully realised about three years after the shock, although two-thirds are felt within the first half year. This is obtained by assuming that buyers will only care about the re-payment profile when buying a house and it will thus not matter how fast, if at all, they are increasing their equity in the house. This implies that the average mortgage rose in total from 12.9 m.kr. to 18.4 m.kr., or by 43% in total.<sup>15</sup>

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<sup>15</sup>This is obtained by assuming that the loans are annuities and that the average loan was 12.9 m.kr. before the shock, with a 5.45% interest rate, repaid over 34 years. This results in monthly payments at around 70 thousand kronur. With a 4.15% interest and 40 years repayment, the same payment profile is obtained with a loan amount of 16.3 m.kr. Given that most re-payment schedules before were steeper to begin with, as the funding was combined from a variety of sources, assuming an increase from 12.9 to 16.3 m.kr. is an underestimation of the total effect on the average loan amount. The increase in LTV-ratios works in the same direction. Accounting for the additional effect of changing re-payment profile and rising LTV-ratios boosts the average mortgage further up to 18.4 m.kr.

## 5. Empirical results

This chapter presents the empirical estimates of the housing demand and supply schedules in Iceland in equations (2.3) and (2.5) using the data described in Chapter 3. Several issues need to be kept in mind when estimating the demand and supply schedules over such a long period for Iceland. A number of important structural changes have taken place over the period, both in the economy and the housing market and mortgage market specifically. Inflation was much higher in the 1970s and 1980s than has been observed since the early 1990s. Interest rates became market determined only in the late 1980s and the current system of housing loans from the government backed HFF was introduced in 1989. This suggests that the empirically estimated relations need to be interpreted with some care.

### 5.1. The demand for housing

Equation (5.1) shows the final estimate of the demand schedule estimated for the period 1970 to 2003, where lower-case letters denote logarithms and  $\Delta$  denotes first differences (with standard errors shown in brackets and  $p$ -values for the diagnostic tests)

$$\Delta p_{ht} = 0.775 + 0.844\Delta p_{ht-1} - 0.435\Delta(w_h - d)_{t-1} - 0.713(w_h - y)_{t-1} - 2.742R_t \quad (5.1)$$

(0.10)            (0.07)            (0.12)            (0.10)            (0.74)

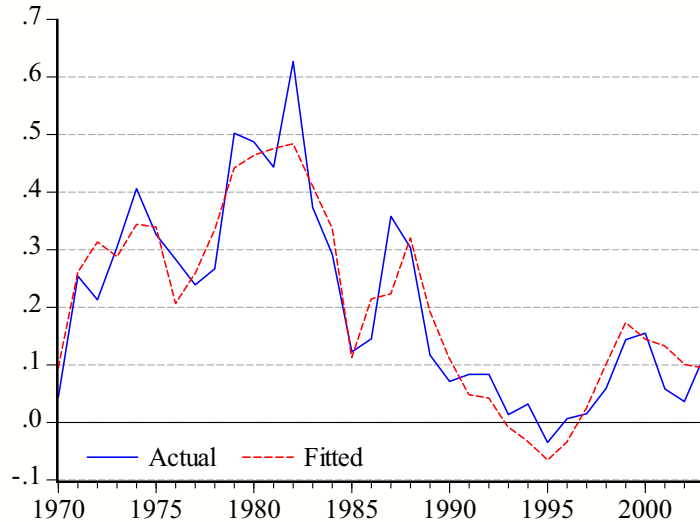
$$T = 34, R^2 = 0.864, \sigma = 6.18\%, JB(2) = 0.41, BG(1, 28) = 0.47, W(8, 25) = 0.57$$

where  $\sigma$  is the residual standard error,  $JB(2)$  denotes the Jarque-Bera test for residual normality (distributed as  $\chi^2(2)$  under the null),  $BG(1, 28)$  denotes the Breusch-Godfrey LM test for first-order residual autocorrelation (distributed as  $F(1, 28)$  under the null), and  $W(8, 25)$  is the White LM test for residual heteroscedasticity (distributed as  $F(8, 25)$  under the null).

The final model is similar in structure to the typical house-price equations estimated in the literature. Some of these include in addition the effects of changing demographics on house prices. We tested for this demographic effect using the ratio of Greater Reykjavik City population against total population. This variable was found to be statistically insignificant. We also tested for the existence of ‘frenzy’ effects, i.e. periods of large price changes driven by speculative motives, using cubic terms of the explanatory variables, found to be important for UK house prices by Hendry (1984) and Muellbauer and Murphy (1997), but without any success. Finally, there are theoretical arguments that suggest that real house prices may be positively affected by changes in the rate of inflation, which is generally attributed to the interaction of tax benefits to owner-occupied housing and inflation (cf. Meen, 1990). We find no evidence of a separate effect of inflation in the above house-price equation. As Meen (1990) shows, an explanation for this could be the existence of credit rationing which can offset this positive effect of inflation on real house prices. Another offsetting factor could be the front-end-loading of debt, i.e. an increase in

the real burden of debt payments as inflation (and therefore nominal interest rates) rise, even though the real interest rate remains unchanged (see the discussion in Meen, 1996).

The explanatory power of the model is quite high and all the parameters are well specified. Furthermore, there is no evidence of residual mis-specification. The empirical demand function therefore seems to capture the main features of the price data, as shown in Figure 3.



**Figure 3.** Actual and fitted house price inflation,  $\Delta p_{ht}$

The structure and coefficient signs in equation (5.1) offer a clear economic interpretation of the equation as an inverted demand for housing equation. There is clear evidence of price inertia that can reflect economic factors such as down payment constraints (cf. Stein, 1995), housing market search costs, expectations and construction delays. Noting that  $w_{ht} = p_{ht} + h_t - p_t$ , Table 1 shows the effects on house prices of shocks to the explanatory variables.

**Table 1.** Responses of  $p_{ht}$  to a 1% increase in RHS variables

	$p_t$	$h_t$	$d_t$	$y_t$	$R_t$
Simultaneous effect	0.00	0.00	0.00	0.00	-2.74
After 1 year	1.15	-1.15	0.44	0.71	-4.65
After 2 years	1.51	-1.51	0.30	1.21	-4.85
After 5 years	0.88	-0.88	-0.08	0.96	-3.59
After 10 years	1.00	-1.00	0.00	1.01	-3.84
Long run	1.00	-1.00	0.00	1.00	-3.85

Looking at the individual impulse responses in Table 1, shows that a rise in general prices will lead to an initial fall in real house prices, thus increasing housing

demand and eventually pushing house prices up again. Increased household income will also increase demand and push up house prices. The opposite happens when real interest rates rise. Finally, a rise in household debt increases housing demand and temporarily pushes up house prices, reflecting easier access to credit for financing housing consumption. No significant long-run effects of household debt are, however, found, implying that the positive short-run effects of easier access to credit are offset by negative affects of increased debt burden and increased risk of financial distress in the long run.

The responses in Table 1 show clear evidence of housing prices overshooting their long-run equilibrium following a shock to the underlying demand factors. Such overshooting behaviour is not surprising considering that housing is also an asset, and has been found in other studies such as Kenny (1999).

The long-run solution to (5.1) implies the following demand schedule for housing (with  $K^d$  denoting a constant)

$$\frac{H^d}{Y} = K^d \left( \frac{P_h}{P} \right)^{-1} \exp(-3.846R) \quad (5.2)$$

The long-run income elasticity is unity, consistent with other studies such as Barot and Yang (2002), Hendry (1984) and Kenny (1999). Somewhat larger income elasticity has been found in other studies, such as Meen (1990, 2000), Pain and Westaway (1996) and Muellbauer and Murphy (1997), although an elasticity above unity can be problematic in macroeconomic models where consumption is related to housing wealth, and hence house prices (see Barot and Yang, 2002). The long-run price elasticity is also found to be unity, which might be surprising considering that housing is usually thought of as a ‘necessary’ good with few long-run substitutes. Unit long-run price elasticity is also found in Kenny (1999) and Barot and Yang (2002) find a long-run price elasticity very close to unity for the United Kingdom. Lower price elasticities are, however, found by Hendry (1984), Meen (1990, 1996, 2000), Pain and Westaway (1996) and Muellbauer and Murphy (1997). Finally, the long-run semi-elasticity of the real interest rate is about -3.8, i.e. a permanent one percentage point increase in real interest rates will decrease house prices by just under 4% in the long-run (this gives an elasticity of -0.15 at a 4% representative interest rate). This is somewhat larger than found in most of the other studies referred to above, but similar to the results in Muellbauer and Murphy (1997) and Meen (1990, 2000).

## 5.2. The supply of housing

When estimating the supply schedule (2.5) one has to account for the declining investment rate from the early 1970s to the late 1990s. As discussed in Chapter 3, this reflects the high investment intensity when a large part of the current housing stock was under construction.

To account for this decline in investment intensity (denoted as  $\kappa(t)^s$ ) a simple logistic function is used (see Pétursson, 2000b, for a similar application for the measurement of the opportunity cost of holding money)



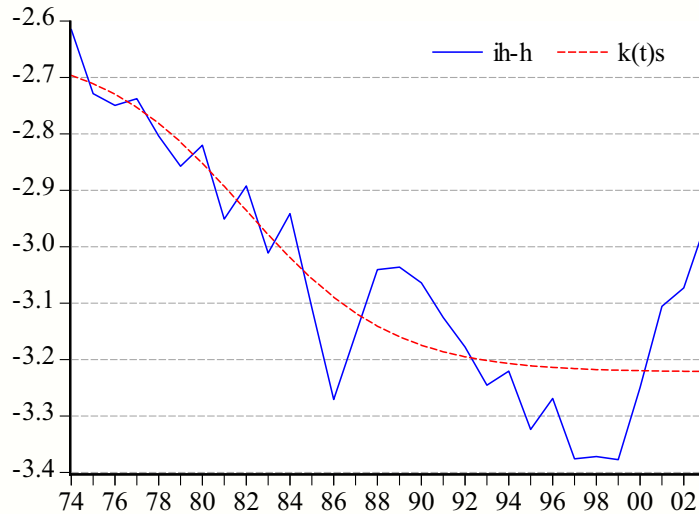
$$(i_h - h)_t \equiv \kappa(t)^s = h_1 + [1 + \exp(\alpha - \beta t_T)]^{-1}(h_2 - h_1) \quad (5.3)$$

where  $t_T$  is a linear trend equal to one from period  $T$  but zero up to that,  $\alpha$  determines the start of the adjustment period,  $\beta$  the speed of adjustment and  $h_1$  is the steady state investment rate in the earlier period and  $h_2$  in the latter period after the adjustment phase is completed. Different starting values and speed of adjustment were tried and  $\alpha = \beta = 0.3$  finally chosen, with the start of the adjustment process in 1981. Estimating (5.3) for the period 1974 to 2003 gives (with Newey-West standard errors in brackets)<sup>16</sup>

$$\kappa(t)^s = \underset{(0.03)}{-2.649} - [1 + \exp(0.3 - 0.3t_{81})]^{-1} \underset{(0.04)}{3.222} - \underset{(0.03)}{2.649} \quad (5.4)$$

$$T = 30, R^2 = 0.774, \sigma = 10.34\%$$

Equation (5.4) suggests that the investment rate fell gradually from roughly 7% ( $\exp(-2.649)$ ) in the early 1970s to 4% ( $\exp(-3.222)$ ) in the late 1990s. Figure 4 shows the actual and estimated rate. The figure shows that the investment rate tends to fall below its trend,  $\kappa(t)^s$ , in, or quickly following, recessions (except in the short recession of 2002), using the business cycle dates referred to earlier.



**Figure 4.** Estimated decline in investment intensity

Equation (5.5) shows the final estimate of the supply schedule estimated for the period 1974 to 2003, including the trend rate,  $\kappa(t)^s$ <sup>17</sup>

<sup>16</sup>The model has a very hard time trying to explain the large swing in housing investment in the first years of the 1970s. Thus, the estimation period starts in 1974.

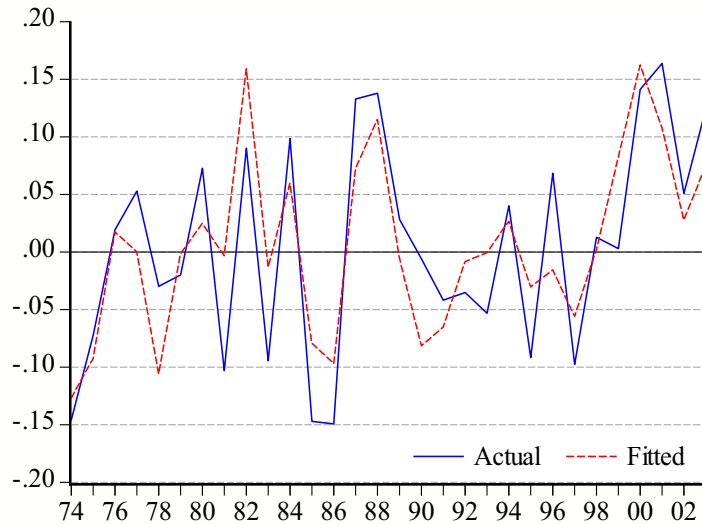
<sup>17</sup>No significant direct interest rate effects on housing investment were found. This could reflect

$$\Delta i_{ht} = \underset{(0.26)}{0.413} + \underset{(0.13)}{0.692}\Delta q_t - \underset{(0.15)}{0.627}q_{t-1} - \underset{(0.14)}{0.374}(i_h - h)_{t-1} + \underset{(0.20)}{0.511}\kappa(t)^s \quad (5.5)$$

$$T = 30, R^2 = 0.668, \sigma = 5.75\%, JB(2) = 0.39, BG(1, 24) = 0.86, W(8, 21) = 0.27$$

The explanatory power of the model is reasonable and all the parameters are well specified. Furthermore, there is no evidence of residual mis-specification. The empirical supply function therefore seems to capture the main features of the investment data, although the fit is poorer than for the demand function, a feature that Barot and Yang (2002) argue is typical of housing investment functions.

Figure 5 shows the actual and fitted data. Fluctuations in housing investment have fallen over time, presumably reflecting smaller overall business cycle fluctuations in Iceland and easier and more continuous access to credit over the period which should lead to a smoother investment profile (see McCarthy and Peach, 2002).



**Figure 5.** Actual and fitted investment growth,  $\Delta i_{ht}$

The structure and coefficient signs of equation (5.5) offers a clear economic interpretation of the equation as a supply for housing of a Tobin's Q type. As the Q-ratio rises, investment gradually increases above its steady state as can be seen from Table 2.

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the long estimation period, which includes a period when interest rates were not market determined. We also tested for short-run effects of output growth and credit but found no significant effects. The same applies to potential effects of changes in the maximum loan amount by the HFF in 1991 and 2001.

**Table 2.** Responses of  $i_{ht}$  to a 1% increase in RHS variables

	$q_t$	$h_t$
Simultaneous effect	0.69	0.00
After 1 year	1.06	0.37
After 2 years	1.29	0.61
After 5 years	1.58	0.90
After 10 years	1.67	0.99
Long run	1.68	1.00

The long-run solution to (5.5) gives the following supply schedule (with  $K(t)^s$  denoting a constant)

$$\frac{I_h}{H} = K(t)^s Q^{1.68} \quad (5.6)$$

Hence, a permanent 1% rise in the Q-ratio will increase the investment rate by 1.7% in the long run. This is similar to the price elasticity found for countries such as Sweden (Barot and Yang, 2002) and the US (Topel and Rosen, 1988) but much higher than what is usually found for the UK (Barot and Yang, 2002, and Meen, 1996, 2000).<sup>18</sup> This probably reflects a more flexible planning system and relatively more abundance of land for construction in these three countries, compared to the UK. This also implies that demand shocks will have a larger stock affect and a smaller price effect over a period of several years in Iceland than, say, in the UK.

Finally, it should be kept in mind that in steady state  $Q_t = 1$ . Hence, any rise in  $Q_t$  will gradually reverse and the investment rate fall back to its initial value (but at a larger stock value). Note, however, that adjustment is slow. Only three-quarters of the adjustment have occurred in three years, with the total shock taking close to a decade to die out. This slow adjustment is in line with results from other countries, as documented in the studies referred to above.<sup>19</sup>

## 6. Estimating the economic effects of changes in the domestic mortgage market

The housing market consists of the demand schedule (equation 5.1), the supply schedule (equation 5.5) and the perpetuity identity (equation 2.6). This model can be used to analyse the dynamic and long-run effects of the structural changes in the domestic mortgage market described in Chapter 4. As previously discussed, the structural change is assumed to have led to an immediate 55 basis points decline in long-term real mortgage rates, followed by a further 75 basis point fall the year after. Furthermore, households' access to credit is assumed to increase by 43% in total due to lower debt service and removal of ceilings on mortgage loans, with two-thirds of the increase occurring in the first year and the remainder in the next two years.

<sup>18</sup>See also Girouard and Blöndal (2001) who estimate similar type of investment function for several OECD countries, with varying degree of success.

<sup>19</sup>Kenny (2003) finds evidence of asymmetric adjustment in Irish data, with investment adjusting more rapidly downwards than upwards. No such evidence is found in the Icelandic data.

As seen from Table 3, the change will affect both the demand and the supply of housing.<sup>20</sup> As the supply of housing is close to being fixed in the short run, larger and more immediate effects appear in house prices which immediately rise by 2%, as demand for housing increases. Most of the effects are however felt in the following three years with prices peaking at 18% above the baseline scenario two years after the shock. As house prices rise, the Q-ratio increases above unity, fuelling housing investment that peaks two years after the initial shock with the investment rate at 18% above the baseline scenario. This increase in the supply of new housing gradually starts to push house prices back towards the initial steady state and housing investment back towards the initial growth path. Referring to Figure 1, describing the equilibrium in the housing market, a new equilibrium is achieved at point C, where the housing stock has increased by 5% in the long run, with housing prices again equal to construction costs. Thus, unlike the findings by Meen (1996) for the UK, the price elasticity of supply is sufficiently large to ensure that a market clearing equilibrium is achieved again within a meaningful time horizon.<sup>21</sup>

**Table 3.** Responses of  $p_{ht}$  and  $i_{ht}$  to changes in the mortgage financing

	$p_{ht}$	$(i_h - h)_t$
Simultaneous effect	0.02	0.01
After 1 year	0.17	0.12
After 2 years	0.18	0.18
After 3 years	0.11	0.17
After 4 years	0.13	0.12
After 5 years	0.00	0.07
After 10 years	0.03	0.05
After 20 years	0.02	0.03
Long run	0.00	0.00

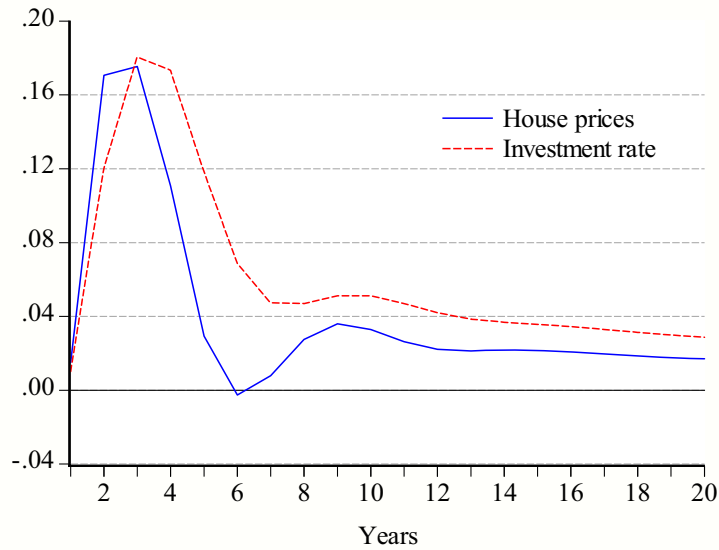
The dynamic responses can further be seen in Figure 6. House prices respond more quickly, peaking one year after the initial shock, with housing investment responding more slowly and dying out more gradually. As previously noted, house prices also overshoot during the adjustment phase, a typical feature of house price behaviour.

It is clear that such a large shock to house prices and housing investment will have important effects on household expenditure decisions and general demand in the economy, with possible second-round effects on the housing market. A rise in house prices and an increase in the outstanding housing stock will have direct effects on household wealth. In addition, this enables households to take on further debt as they have access to larger collateral. Furthermore, a lower real interest rate implies that

<sup>20</sup>These simulations were done assuming that  $\delta_h = 2.5\%$ . The results are not sensitive to this assumption.

<sup>21</sup>Decreasing the price elasticity of supply to 0.5 (a typical finding for the UK) implies that house prices are still 1 percentage point above steady state 120 years after the shock, compared to just over 20 years found here.

the relative price of consumption falls, since saving has become more expensive.<sup>22</sup> All this affects current consumption. A permanently lower real interest rate shifts the consumption path to a higher level. The wealth effect comes in more gradually, boosting demand further over time. Using the macroeconomic model of the Central Bank of Iceland to estimate these second-round effects suggests that the real net housing wealth is about a third larger two to three years after the initial shock, with some counteracting effects of household debt. Increased net wealth, lower interest rate and easier access to credit leads to an immediate 5% rise in consumption above baseline and peaking about four years after the initial shock when consumption is close to 6% above baseline.



**Figure 6.** Responses of  $p_{ht}$  and  $(i_h - h)_t$  to changes in mortgage financing

Consumption and housing investment also increases aggregate demand in the economy, putting pressure on prices, while lowering the rate of unemployment. As the structural change occurs at a time when the economy is going through an upswing, with an already tight labour market, this will put pressure on wages, thus further adding to inflation. Simulations from the macroeconomic model of the Central Bank of Iceland suggest that output growth rises by 0.5% above the baseline scenario at impact and peaks in the second year, when output growth is just under 1% above the baseline scenario. Inflation peaks in the second year after the shock when inflation is about 2.5% above the baseline scenario. Short-term interest rates are, however, about 4% above baseline in the second year after the shock.<sup>23</sup>

<sup>22</sup>Increased debt-financed consumption can also stem from increased household net worth reducing adverse selection and moral hazard problems, see Mishkin (1977).

<sup>23</sup>These simulations assume a simple Taylor rule as the Central Bank response function and that

Increased wealth and income, will lead to a second round effect on house prices, which is partly offset by the monetary policy response included in the exercise. The simulations imply that taking account of these effects could push house prices well over 20% above the benchmark scenario over a period of 5 years after the shock. This accounts for something like half of the rise in house prices actually observed, with the remainder reflecting the affects of the other shocks hitting the economy at the same time and a possible house price bubble.

## 7. Discussion and conclusions

There is a parallel between the case studied here and recent developments in the housing markets in many other countries. House prices have risen as long-term real interest rates have been at historically low levels for quite some time. Mortgage interest rates in Iceland still remain higher than in the neighbouring countries but the recent decline in real rates has coincided with liberalisation of the market for housing financing, and it has happened in an already booming economy. The effects are therefore exaggerated.

The simple model of the Icelandic housing market used for the simulations in this paper modulates the effect of the structural change for two reasons. First, it is an annual model, set forth in annual averages. The responses of particular variables are therefore expected to be more severe at a shorter horizon such as e.g. would be seen in a quarterly model. Second, the model is purely backward looking, i.e. expectations are formed based on past and current realisations of the variables. More realistic forward looking behaviour could induce faster responses to changes such as those studied here, especially given the important asset price property of house prices. Expectations may in fact play a key role in determining the actual dynamics of house prices and housing investment. If, for example, the change is expected to be temporary the initial impact may be stronger than estimated here. The same is true if the state of the economy is believed to be temporarily favourable for investment for other reasons. Given these drawbacks of the model the rise in prices, for instance, would probably happen faster and be stronger. To keep inflation at target, the response of monetary policy would also need to be quicker and the policy rate would probably need to go even higher in the beginning.

It should also be noted that the model uses relationships that are estimated from historical data which spans a period of significant structural changes. It may thus not accurately represent the current structure of the economy, and therefore responses to the shock may be incorrectly specified. This is particularly relevant when studying a shock of this size. The model also describes the behaviour of a typical household, and does not have to be a good representation of the responses of particular household groups.

These changes in financing encourage residential investment. The model accounts

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fiscal policy does not respond specially to the shock. It should also be kept in mind that this model is backward looking. Forward-looking behaviour might alter the dynamic responses to the shock, presumably tilting the responses further forward.

for increased household debt for this sake, but potential effects on the quality and durability of housing are ignored. Issues related to potential financial stress after such a large shock to the housing market are not explored either in the paper, but simulations by Gudmundsson (2005) suggest that a substantial rise in the loan-to-value ratio, as has followed the structural change, can increase the probability of household negative net worth substantially, especially if these changes occur at a time when real house prices are at an historical high.

Despite all the above potential shortcomings of the model, the result stands that the structural change in the domestic mortgage market, which has led to a permanent lowering of real mortgage interest rate, and easier access to credit, has had significant effects on household behaviour and led to a substantial rise in house prices, which has fuelled a domestic spending spree and contributed to an overheating of the economy.

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