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2013/5

## The Swedish housing market: Trends and risks

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## Preface

In December 2011 the Swedish Fiscal Policy Council invited me to prepare a report on recent trends and risks in the Swedish housing market. My background for accepting the invitation was my long-standing interest in the Swedish economy and Swedish economic policy and my research on the Danish housing market while I was serving as Chief Economist of the Danish central bank. Most of the work on the report was carried out during the summer and fall of 2012.

Section 5 of this report draws on joint research with my Copenhagen University colleague Michael Bergman who is also a former member of the Fiscal Policy Council. I am grateful to Michael for inspiring collaboration; his econometric skills were indispensable for the work reported in section 5. Thanks are also due to Georg Marthin and Johanna Modigsson for assistance in gathering some of the data used in the report. Finally, I want to thank John Hassler, Steinar Holden and Irma Rosenberg for constructive comments on earlier drafts of the report. I am solely responsible for any remaining errors or shortcomings.

Copenhagen, March 2013.

Peter Birch Sørensen

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# 1 Introduction and outline of the report

Since the mid-1990s real house prices in Sweden have more than doubled and they are now at a historically high level. This has raised concerns that the market for owner-occupied housing may be overvalued and that Sweden may be headed for a significant drop in house prices.

Against this background, Sveriges Riksbank (2011) recently published an extensive report analysing trends in the Swedish housing market and discussing the resulting risks to economic and financial stability. The present report supplements the Riksbank report by offering some further perspectives on the Swedish housing market. The basic issue is whether Swedish house prices are currently seriously overvalued. If that is the case, what are the future implications for the Swedish economy? In addressing these difficult questions, the report draws on the international literature on the economics of housing markets and presents some new estimates of long-run equilibrium house prices in Sweden.

The report is structured as follows: *Section 2* reviews the long-term and recent trends in Swedish house prices and compares them to house price developments in other countries. The section also discusses whether real house prices can be expected to remain constant or to trend upwards in the long run. *Section 3* discusses how we can measure whether house prices are in some sense overvalued so that we may speak of a “housing bubble”. The section reviews alternative theories of how housing bubbles may arise, and it offers an illustrative case study by describing the recent bubble and subsequent downturn in the Danish housing market. The last part of the section considers whether there are signs of a genuine housing bubble in Sweden. *Section 4* explains the concept of the user cost of owner-occupied housing and illustrates how estimates of the user cost may be used to evaluate whether house prices are out of line with the cost of rental housing and with disposable incomes. The section offers new estimates of the evolution of the ratio of user costs to rents and disposable incomes in Sweden. *Section 5* turns to the difficult question of how to identify the so-called fundamental house price, that is, the equilibrium house price implied by rational economic behaviour. The section describes two alternative ways of calculating the fundamental house price and presents some new estimates of the evolution of fundamental house prices in Sweden. It also analyses the empirical link between actual and fundamental house prices. *Section 6* offers some further perspectives on Swedish house prices, discussing how various factors such as financial innovation, demographics, property taxes and housing supply constraints may have affected equilibrium house prices in recent years. The section also considers how a possible downturn in the housing market might affect economic and financial stability in Sweden. The conclusions of the report are summarized in *Section 7*, and the technical appendix lays out the theoretical foundation for the concept of user cost of owner-occupied housing.

## 2 Swedish house prices in international perspective

### 2.1 The evolution of real house prices in Sweden

Figure 2.1 shows the evolution of house prices in Sweden since 1952. From the early 1950s to the mid-1990s real house prices seemed to fluctuate around a roughly flat long-term trend.<sup>1</sup> This was followed by an unusually long and strong boom in house prices. The boom was interrupted by the international economic crisis of 2008–09 which caused a temporary downturn in the Swedish housing market. However, the market quickly recovered and although house prices have recently showed some signs of weakening, they remain at a very high level from a long-term historical perspective.

Figure 2.2 illustrates the development of real house prices in the various regions of Sweden. The price increases since the mid-1990s have been particularly strong in areas with large cities. This is a phenomenon also observed in other countries where real house prices have gone up.

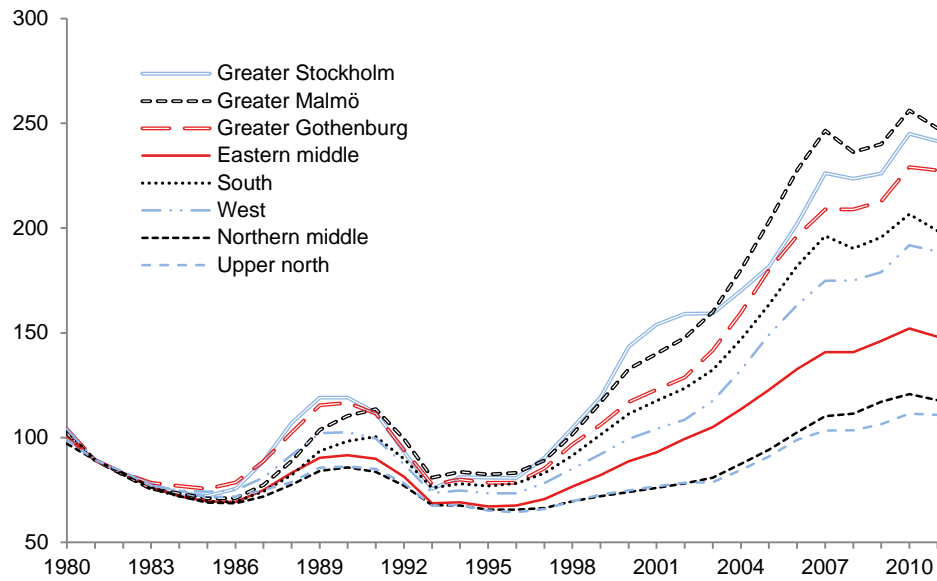
**Figure 2.1 Real house prices in Sweden 1952–2011**



Source: Statistics Sweden and own calculations.

<sup>1</sup> The real house price is the nominal price of single-family homes (“småhus”) deflated by the consumer price index.

**Figure 2.2 Real house prices in the various regions of Sweden 1980–2011**



Source: Statistics Sweden and own calculations.

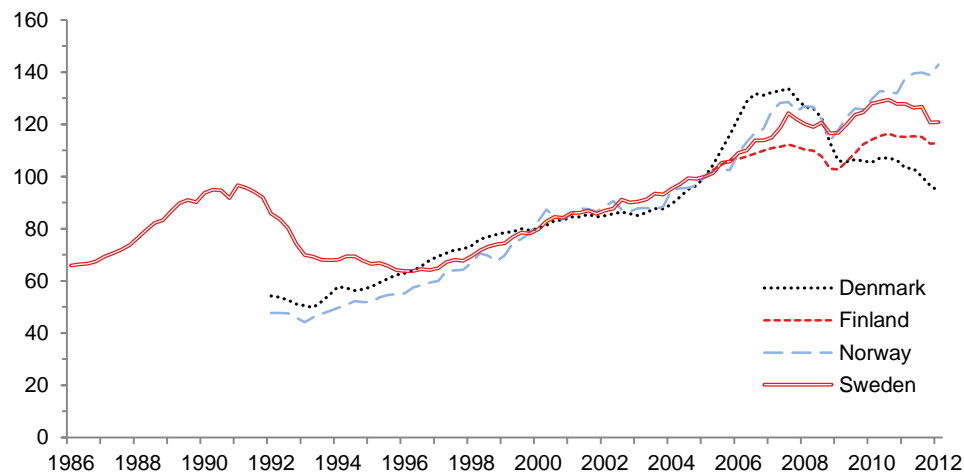
## 2.2 A comparison with other countries

Figures 2.3a, 2.3b and 2.3c show that Sweden was certainly not the only OECD country to experience a significant run-up in real housing prices prior to the international financial crisis in 2008–09. Indeed, countries like Ireland, UK, Norway and Spain experienced even stronger house price booms.

However, Belgium, Norway and Sweden stand out as the countries with the mildest and the shortest housing market downturns during the crisis, whereas most of the other countries have seen deeper and more prolonged drops in real house prices.

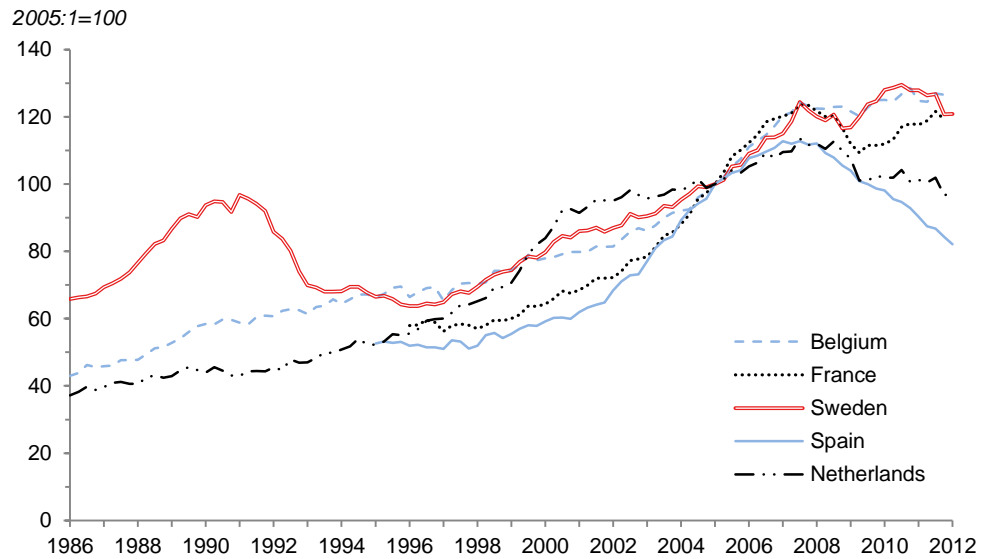
**Figure 2.3a Quarterly real house prices in Denmark, Finland, Norway and Sweden**

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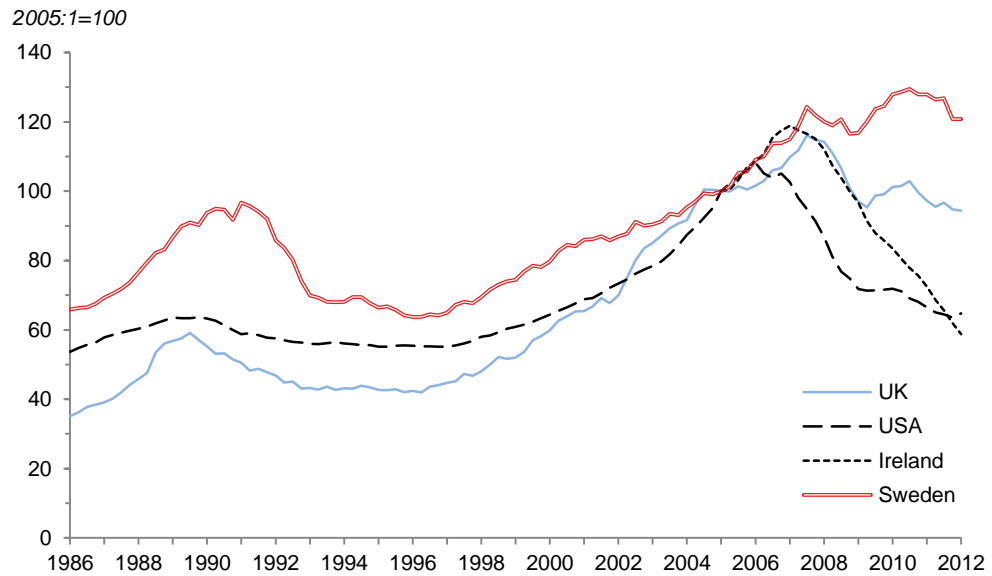
Source: OECD and own calculations.

**Figure 2.3b Quarterly real house prices in Belgium, France, Netherlands, Spain, and Sweden**



Source: OECD and own calculations.

**Figure 2.3c Quarterly real house prices in Ireland, Netherlands, UK, USA and Sweden**



Source: OECD and own calculations.

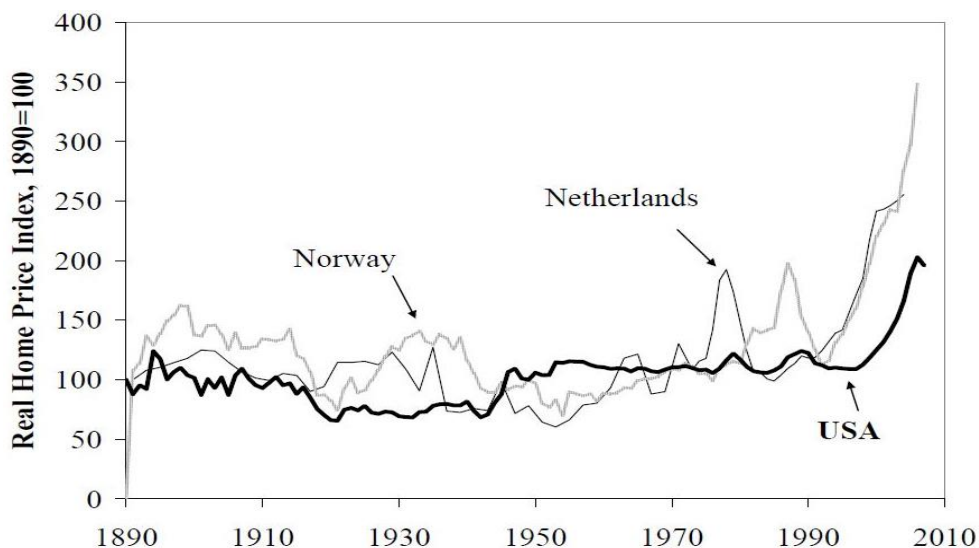
## 2.3 Do real house prices trend upwards?

When evaluating the likely future development of house prices in Sweden and elsewhere, a crucial question is whether there is an underlying tendency for real house prices to increase or not? There is no consensus on this issue in the international academic literature. In several papers Robert Shiller has argued



that there is no evidence of a positive long-run trend in real house prices. Figure 2.4, taken from Shiller (2007), shows the evolution of real house prices in three countries for which very long time series have been constructed.<sup>2</sup>

**Figure 2.4 The long run evolution of real house prices in the Netherlands, Norway and the United States**



Note: The index for the Netherlands shows the evolution of house prices in Amsterdam. The index for Norway shows the average price development in the four largest cities.

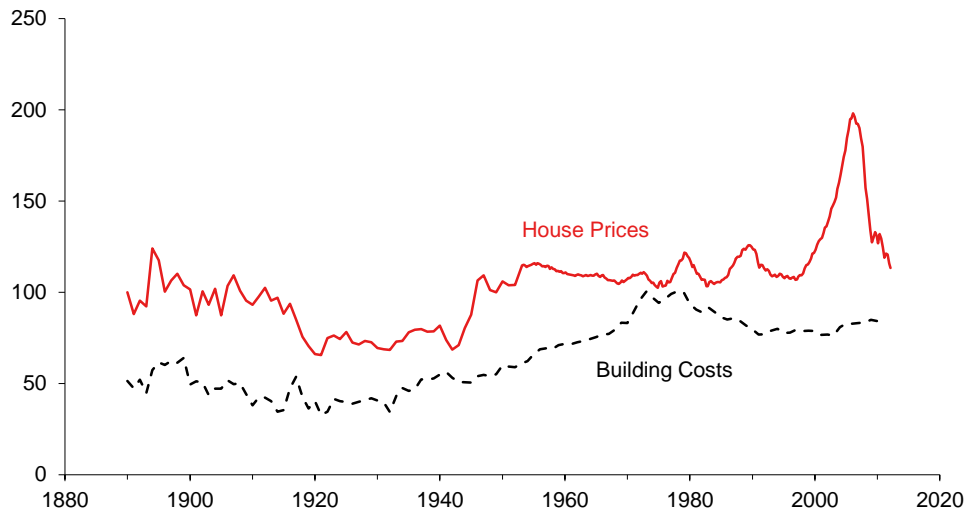
Source: Shiller (2007, Figure 4).

According to Figure 2.4 real house prices went through several prolonged cycles during the century from around 1890 to the early 1990s, but without displaying any clear upward or downward trend. The boom in house prices since that time and up until the recent financial crisis was quite extraordinary in a long run historical perspective.

Figure 2.5 takes Shiller's long run real house price index for the USA up to the present and also includes his index for real construction costs in America. In the second quarter of 2012 the real house price index stood at 113,2 as compared to a value of 100 in 1890, indicating a very modest increase over this period of more than 120 years. In the 60-year period from around 1920 to about 1980 real building costs did in fact increase significantly after having trended downwards for a long time, but today construction costs are considerably below the peak reached in the late 1970s.

<sup>2</sup> The indices in Figure 2.4 attempt to adjust for changes in the quality of housing in various ways, but obviously it is very difficult to estimate the quality-adjusted change in house prices over such a long period. Englund (2011, p. 62) provides a useful discussion of the measurement problems involved in constructing a house price index.

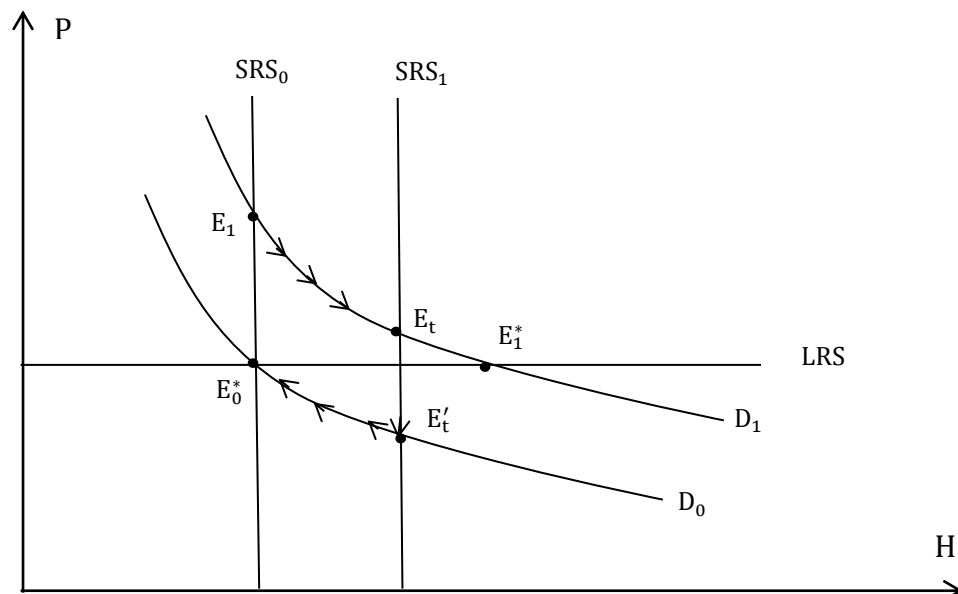
**Figure 2.5 Real house prices and real building costs in the United States**



Source: [www.econ.yale.edu/~shiller/data.htm](http://www.econ.yale.edu/~shiller/data.htm).

Shiller's view that real house prices are likely to remain relatively constant over the long run is shared by many other economists. The theory behind this view can be illustrated by Figure 2.6 where the stock of owner-occupied housing ( $H$ ) is measured along the horizontal axis and the real house price ( $P$ ) is measured on the vertical axis. The horizontal curve labelled  $LRS$  is the long run supply curve in the housing market. It shows the real marginal cost of producing a new housing unit, and we see that this cost is assumed to be constant. As long as the price of existing houses exceeds the marginal cost of building a new house of similar size and quality, profit-maximizing construction firms will add to the housing stock by building new houses. In contrast, if the price of existing houses falls short of the cost of constructing a new house, the building industry will face a profit squeeze which will drive construction activity below the level needed to compensate for the depreciation of existing houses. As a consequence, the housing stock will shrink.

**Figure 2.6 Dynamics of the housing market**



The vertical curves  $SRS_0$  and  $SRS_1$  are short run supply curves indicating the housing stock existing at a given point in time. The downward-sloping curves labelled  $D_0$  and  $D_1$  are demand curves showing how the demand for housing varies with the house price. What consumers really demand is a *flow* of housing services, but we can reasonably assume that the consumption of housing services is proportional to the *stock* of housing measured along the horizontal axis. The annual cost of the housing service provided by a house with a market price  $P$  is  $cP$ , where  $c$  is the user cost of housing, defined as the housing cost per krona of housing wealth. The user cost depends on the mortgage interest rate, property taxes, maintenance costs etc., as explained in detail in Section 4. For a given value of  $c$ , the cost of housing services will be proportional to the house price  $P$ . A fall in  $P$  will then induce a greater demand for housing, as indicated by the negative slope of the demand curves in Figure 2.6. The demand for housing also depends on other factors such as disposable incomes. If incomes go up, or if the interest rate (and thereby the user cost) goes down, the demand for housing will increase at any given level of house prices, and the demand curve for housing will therefore shift to the right.

We can now illustrate the market forces that tend to keep house prices in line with real construction costs in the long run. Suppose the initial situation in the housing market is given by point  $E_0^*$  in Figure 2.6. This is a long-run equilibrium where housing demand equals housing supply *and* where the cost of building a new house is just equal to the cost of acquiring an existing house of the same size and quality. In such a long-run equilibrium the construction of new homes is just sufficient to make up for the depreciation of the existing housing stock, thus ensuring that the aggregate housing stock remains constant over time.

Now suppose that, at time 1, disposable income goes up so that the housing demand curve shifts outwards from  $D_0$  to  $D_1$ . In the short run the housing stock is fixed because it takes time for building activity to add to the existing stock. On impact, house prices must therefore increase from  $E_0^*$  to  $E_1$  to clear the housing market. In this new short-run equilibrium, the price of existing houses exceeds the cost of building new houses. This drives construction activity above the level necessary to compensate for depreciation of the existing housing stock. As additional housing units are added to the current stock, the short run supply curve  $SRS$  gradually shifts to the right so that house prices are gradually forced back towards their original level. If no further disturbances occur, this adjustment process will continue until the housing market reaches a new long run equilibrium at point  $E_1^*$  in Figure 2.6. At this point the housing stock has increased, but prices are back in line with construction costs. Alternatively, suppose that at time  $t$ , where the housing market is in short-run equilibrium at point  $E_t$ , disposable income falls back to its original level so that the demand curve also shifts back to  $D_0$ . In the short run house prices must then fall from point  $E_t$  to  $E_t'$  where existing houses are now cheaper than new houses. Hence construction activity will fall below the level needed to maintain the housing stock, so the short-run supply curve will

gradually shift to the left. This process will continue until the housing market is back in the original long-run equilibrium  $E_0^*$  where house prices are again equal to construction costs.<sup>3</sup>

The view illustrated in Figure 2.6 that real house prices tend to be constant in the long run is shared by many economists, but it has also been challenged by many others. To understand the controversy, note that two key components of the cost of supplying a new house are the price of the land on which the building is erected and the cost of the labour needed to build the house. The horizontal long-run supply curve in Figure 2.6 implicitly assumes that land prices do not increase more than other prices and that labour productivity in the construction sector increases in line with productivity in other sectors.<sup>4</sup>

Consider first the likely evolution of land prices. Since the total supply of land is fixed, it may be hard to increase the supply of land used for housing purposes without driving up the relative (real) price of land. If land is scarce, we would therefore expect the long-run supply curve in the housing market to have a positive slope, as depicted in Figure 2.7: when construction firms expand the supply of new housing, the total demand for land is likely to increase, and with total land supply being fixed, the real price of land must go up to clear the land market. Construction firms may react to this by economizing on the use of land, e.g. by erecting taller apartment buildings, but there is probably a limit to the possibilities of substituting buildings for land in the housing sector. As economic growth raises the level of income, shifting the housing demand curve to the right, we would therefore expect the housing market to move up along a rising long-run housing supply curve due to an increase in the real price of land, as illustrated by the move from point  $E_0^*$  to point  $E_1^*$  in Figure 2.7.

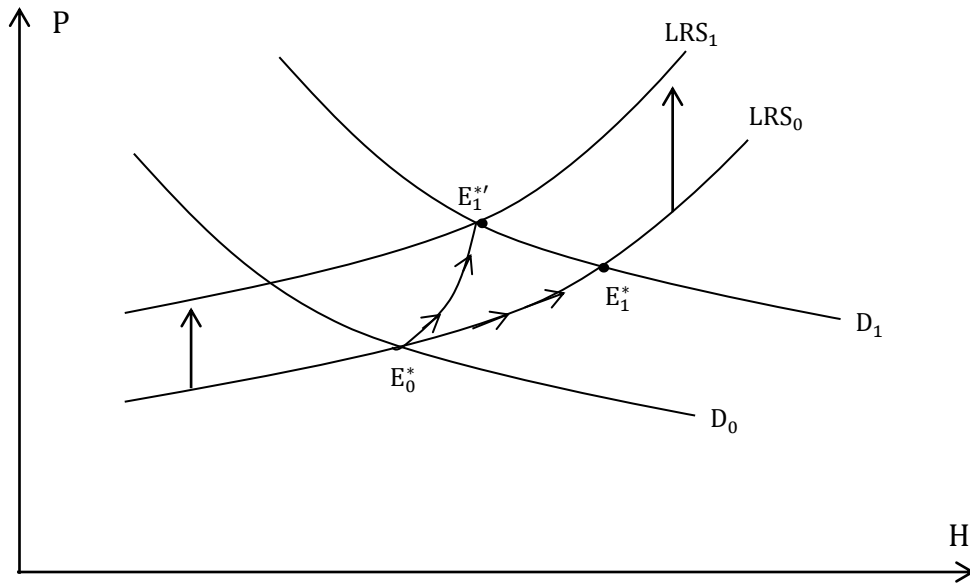
Moreover, the long-run output growth in other sectors is also likely to raise the total demand for land, thereby driving up its relative price. In that case the real cost of supplying a new housing unit will go up even if the demand for land used for housing has not increased. In terms of Figure 2.7, the long-run housing supply curve will shift upwards from, say,  $LRS_0$  to  $LRS_1$ . The long-run growth process may thus take the economy from the equilibrium  $E_0^*$  to an equilibrium like  $E_1^{*'}$  rather than  $E_1^*$ .

---

<sup>3</sup> Figure 2.6 assumes that house prices adjust instantaneously to clear the market. Empirical work indicates that house prices only gradually adjust to equilibrate housing demand and housing supply (see section 3). Moreover, the analysis in Figure 2.6 does not account for the shifts in the housing demand curve which may occur if changes in actual house prices generate changes in the expected capital gains on houses. Hence the figure does not give a fully adequate picture of the short-run dynamics of house prices. Nevertheless, the figure does capture the long-run mechanism whereby house prices are driven back towards construction costs through adjustments in housing supply.

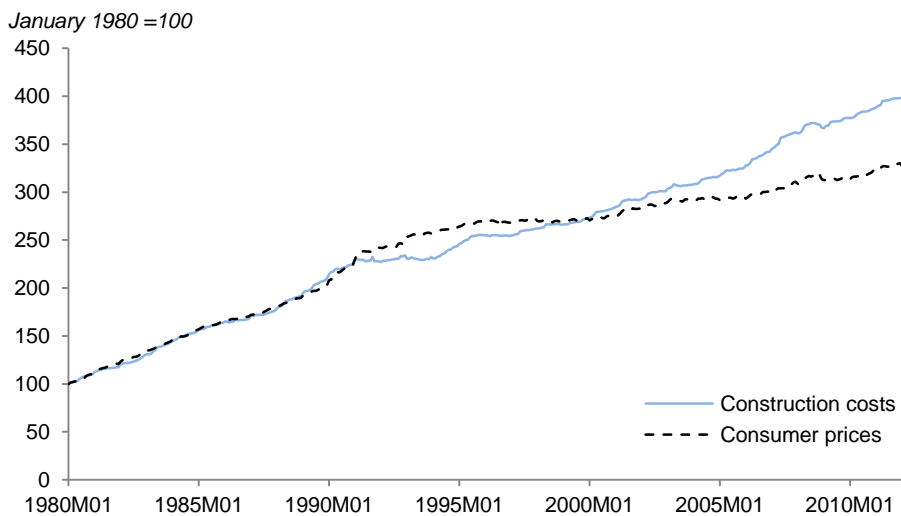
<sup>4</sup> In the long run the wages of construction workers must increase at the same rate as wages in other sectors. Labour productivity in the construction sector must therefore grow in line with average labour productivity elsewhere in the economy to ensure the same growth rate of unit labour costs.

**Figure 2.7 Dynamics of the housing market when land is scarce**



The other implicit assumption behind the horizontal long-run housing supply curve in Figure 2.6 is that labour productivity in the construction sector evolves in line with productivity in the rest of the economy. If productivity growth in the building industry is slower, we would expect that industry’s unit labour costs to rise at a faster rate than elsewhere in the economy, assuming that the wages of construction workers must increase at the same rate as the average wage level (since construction firms could not otherwise attract labour). Construction costs would then tend to rise at a faster pace than the general price level. Figure 2.8 shows that construction costs in Sweden have in fact risen faster than consumer prices during the last decade. This could reflect a relatively weak rate of productivity growth in construction. Such a trend provides a further reason why the long-run supply curve in Figure 2.7 may shift upwards over time.

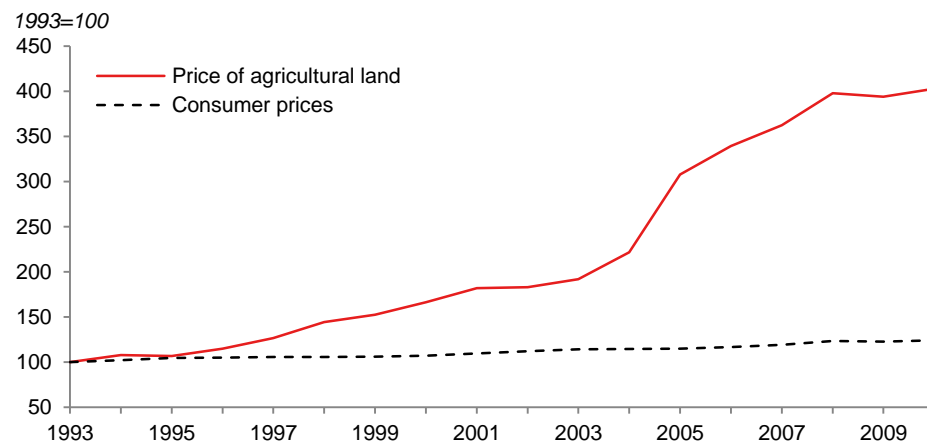
**Figure 2.8 Construction costs and consumer prices in Sweden**



Note: Construction costs are measured by the “Total faktorprisindex för gruppbyggda småhus”.  
 Source: Statistics Sweden.

The measure of construction costs in Figure 2.8 does not include the price of land, but only the prices of labour, materials and overhead costs (including profit margins). As mentioned, the total cost of supplying a new house to the market also includes the price of the building site. The opportunity cost of land used for housing may be approximated by the price of agricultural land. In the long run one would therefore expect a link between the price of residential land and the price of land used for agriculture. In Sweden the latter price has risen much faster than consumer prices since the mid-1990s, as shown in Figure 2.9.

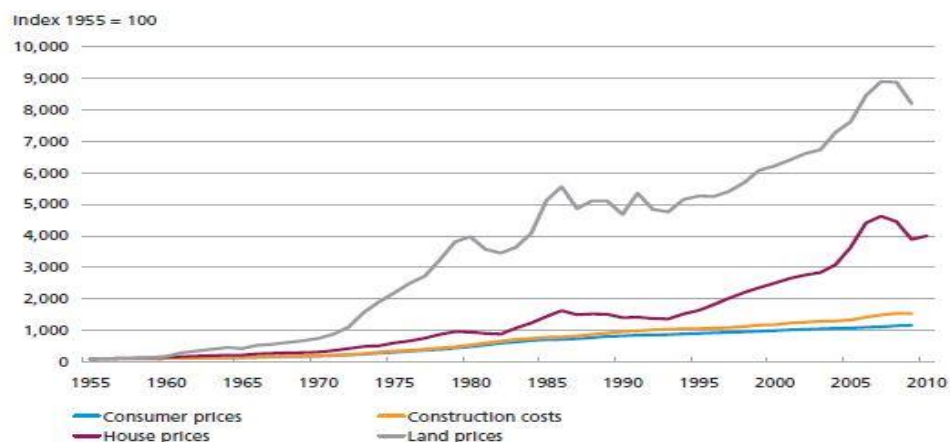
**Figure 2.9 Agricultural land prices and consumer prices in Sweden**



Source: Statistics Sweden.

Figure 2.10 shows that construction costs (excluding the price of land) have also increased at a faster rate than consumer prices in Denmark. Moreover, we see that Danish land prices have risen much faster than consumer prices since around 1960, although at an uneven pace. This is consistent with the view that the total real cost of supplying a new housing unit will tend to increase over time due to rising real land prices. According to Figure 2.10 there has indeed been a clear upward trend in real house prices in Denmark since 1960.

**Figure 2.10 Consumer prices, house prices, land prices and construction costs in Denmark**



Note: All prices and costs are measured in nominal terms. The land price is the price of building sites.  
Source: Figure 5.5 in Dam et al. (2011), based on data from Statistics Denmark.

The secular trend in the price of housing land depends on the overall scarcity of land in the country and on factors such as zoning laws and urban planning practices influencing the elasticity of the supply of sites for house-building. A country like the USA may still have large areas of vacant land that could be used for housing. Moreover, whereas countries like Denmark, Sweden and some other European countries have experienced relatively poor productivity growth in the construction sector, productivity in the American building industry seems to have evolved more favourably. The costs of construction in the USA have also been kept in check by the stagnating real wages of common labour in America in recent decades (Shiller, 2007, p. 5). Since all these determinants of the cost of new housing may evolve in different ways in different countries, it would be surprising if real house prices displayed identical long-run trends across countries. In particular, the relative abundance of land in the USA may make sustained increases in real house prices less likely in that country.

To assess whether permanent increases in real house prices could really be sustainable, we may also consider the following simple model of the housing market, where  $c$ ,  $P$  and  $H$  still denote the user cost, the real house price and the real housing stock, respectively,  $Y$  is real disposable income, and  $B$  is the share of expenditure on (owner-occupied) housing in household budgets:

$$\text{Housing supply} \quad H = H(P) \quad (2.1)$$

$$\text{Housing demand} \quad D = D(cP, Y) \quad (2.2)$$

$$\text{Equilibrium} \quad H = D \quad (2.3)$$

$$\text{Budget share of housing} \quad B = \frac{cPH}{Y} \quad (2.4)$$

Equation (2.1) assumes that housing supply  $H(P)$  is an increasing function of the real house price. The demand for housing is given by the function  $D(cP, Y)$  in (2.2), indicating that housing demand depends (negatively) on the cost of housing services,  $cP$ , and (positively) on disposable income. Equation (2.3) is the condition for equilibrium between housing demand and housing supply, and (2.4) defines the budget share of housing expenses.

Since the user cost  $c$  depends on interest rates and tax rates, it may be expected to be stationary in the long run, so in a long-run perspective we may assume  $dc=0$ . From equations (2.1) through (2.4) one can then show that

$$\frac{dP}{P} = \left( \frac{\varepsilon_Y}{\varepsilon_H + \varepsilon_R} \right) \frac{dY}{Y}, \quad (2.5)$$

$$\frac{dB}{B} = \left[ \frac{\varepsilon_H(\varepsilon_Y - 1) + \varepsilon_Y - \varepsilon_R}{\varepsilon_H + \varepsilon_R} \right] \frac{dY}{Y}, \quad (2.6)$$

$$\varepsilon_R \equiv -\frac{\partial D}{\partial cP} \frac{cP}{D}, \quad \varepsilon_Y \equiv \frac{\partial D}{\partial Y} \frac{Y}{D}, \quad \varepsilon_H \equiv \frac{\partial H}{\partial P} \frac{P}{H} \quad (2.7)$$

where  $dX$  indicates the absolute change in variable  $X$ ,  $\epsilon_R$  is the numerical elasticity of housing demand with respect to the cost of housing services,  $\epsilon_Y$  is the elasticity of housing demand with respect to real disposable income, and  $\epsilon_H$  is the price elasticity of housing supply.<sup>5</sup>

On average over the long run, the growth rate of real income,  $dY/Y$ , is positive. The income elasticity of housing demand is also positive, and the numerical price elasticity of housing demand ( $\epsilon_R$ ) is generally a finite number. According to equation (2.5) the long run growth rate of real house prices will then be positive unless the supply of housing is infinitely elastic in the long run (that is, unless  $\epsilon_H \rightarrow \infty$ ). The case of an infinitely elastic housing supply corresponds to the textbook case of a horizontal long-run housing supply curve depicted in Figure 2.6.

However, if economic growth creates a growing scarcity of building sites, the elasticity of housing supply is likely to be finite, corresponding to the upward-sloping long-run housing supply curve shown in Figure 2.7. In that case equation (2.5) predicts a secular increase in real house prices. But wouldn't secularly increasing real house prices imply that housing expenses would absorb an ever-increasing share of household budgets (and hence be unsustainable?). According to equation (2.6) the answer is: not necessarily. For example, if the numerical income and price elasticities of housing demand are both equal to 1 – as they could well be according to the Swedish study by Brusewitz (1998) – it follows from (2.6) that the budget share of housing expenses will be constant over the long run even if the elasticity of housing supply is finite.

As mentioned, equations (2.5) and (2.6) assume that the real user cost of housing is stationary over the long run. In Figure 2.11 the real user cost of owner-occupied housing in Sweden is proxied by the real after-tax interest rate on 5-year mortgage loans plus a constant risk premium. We see that the user cost rose sharply in the early 1990s. This was due to a special combination of an increase in the nominal interest rate triggered by a foreign exchange crisis, a sharp drop in the expected inflation rate and a significant cut in the capital income tax rate. However, since the early 1990s the user cost has tended to move back towards the level prevailing in the 1980s. This is consistent with the theoretically well-founded idea that the user cost is stationary in the long run.

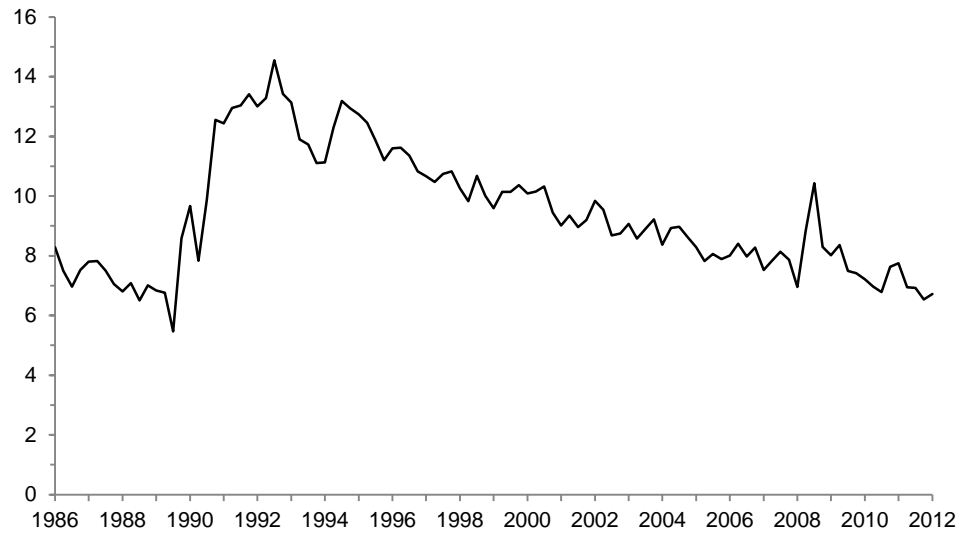
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<sup>5</sup> In other words,  $\epsilon_R$  measures the percentage decrease in housing demand in case of a 1 per cent increase in the real housing cost,  $\epsilon_Y$  is the percentage increase in housing demand generated by a 1 per cent increase in real income, and  $\epsilon_H$  is the percentage increase in housing supply induced by a 1 per cent increase in the real house price.



**Figure 2.11 The real user cost of owner-occupied housing in Sweden**

Percentage points



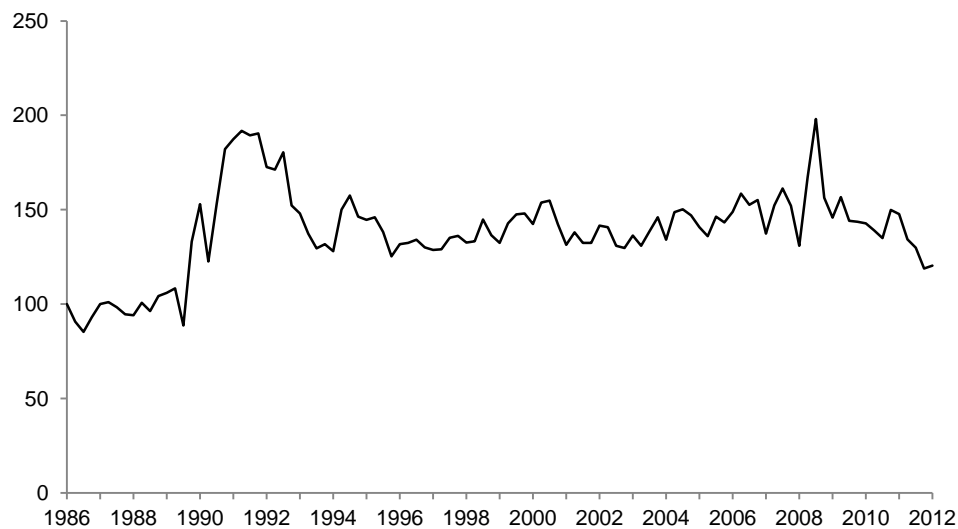
Note: The user cost is approximated by the real after-tax interest rate on 5-year mortgage loans plus a risk premium of 7 per cent.

Source: Own calculations based on the data presented in Bergman and Sørensen (2012).

As we saw, a secular increase in real house price does not necessarily imply a secular rise in the budget share of housing costs. In Figure 2.12 we have calculated the budget share of total owner-occupied housing costs from formula (2.4). We see that the rise in the user cost in the early 1990s forced Swedish households to spend a larger fraction of their income on housing, but overall Figure 2.12 suggests that the budget share of housing costs is in fact fairly stable over the long haul.

**Figure 2.12 The total cost of owner-occupied housing relative to disposable income in Sweden**

1986:1=100



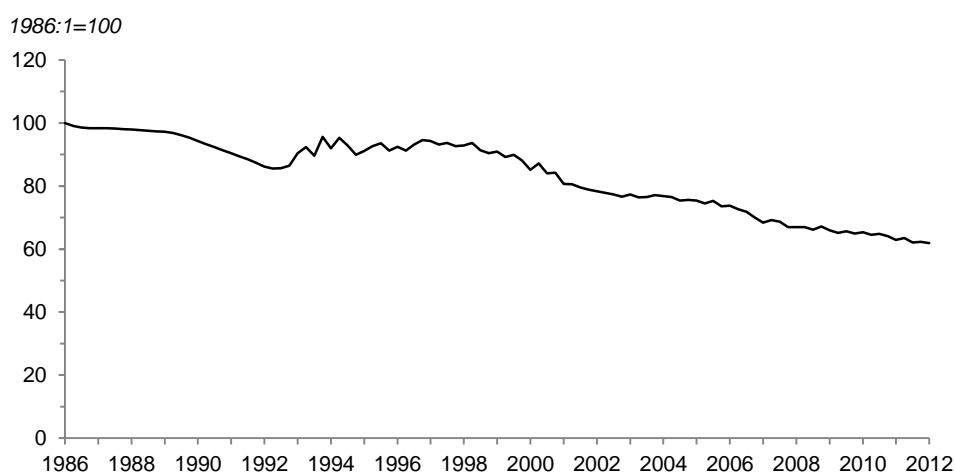
Note: The graph shows the evolution of the budget share defined in equation (2.1).

Source: Own calculations based on the data presented in Bergman and Sørensen (2012).

If user costs and the budget share of housing are both stationary, real house prices can only rise over time if the real housing stock grows at a slower pace than real disposable income. As shown in Figure 2.14, this has in fact been the case in Sweden during the last quarter century.

In summary, there may be an underlying tendency for real house prices to grow over the long run due to growing scarcity of land and possibly also because of relatively weak productivity growth in the building industry. A secular rise in real house prices does not require an ever-increasing share of housing expenses in household budgets, provided the real housing stock grows at a slower pace than real income.

**Figure 2.13 The ratio of the real housing stock to real disposable income in Sweden**



Source: Own calculations based on the data presented in Bergman and Sørensen (2012).

However, between 1995 and 2011 real house prices in Sweden grew at an average annual rate of about 5.7 per cent. When evaluating this number, we should keep in mind that the Swedish housing market reached a trough in 1995, so some recovery of house prices was to be expected. Nevertheless, an annual growth rate of real estate prices close to 6 per cent over such an extended period seems very high, considering the foregoing analysis of the likely secular trend in house prices. For example, suppose we accept that over the long run, the following conditions must hold: 1) The real user cost of housing must be roughly constant. 2) The budget share of housing expenses must be roughly constant. 3) The real housing stock must be non-decreasing (assuming that the population is non-decreasing). Under these conditions, if the long run growth rate of real income is, say, 2 per cent per year, the maximum sustainable long-run annual increase in real house prices is also 2 per cent.

Moreover, before the mid-1990s Swedish real house prices did in fact seem to hover around a roughly constant trend, as we saw in Figure 2.1.

Against this background it is reasonable to ask whether Swedish house prices are currently overvalued. The next main section discusses the concept of “overvaluation” and how overvaluation may come about.

## 3 Housing bubbles: How do they arise? And how do we measure them?

### 3.1 What do we mean by a "housing bubble?"

As noted by Claussen, Jonsson and Lagerwall (2011, p. 81), a statement like "Swedish house prices are overvalued" could be interpreted in various ways such as the following:

- i. House prices are above their long-term trend level
- ii. House prices cannot be explained by "fundamental" factors
- iii. Models of the housing market predict falling real house prices in the future

Figure 2.1 does indeed suggest that Swedish real estate prices are currently above their long-run trend level, indicating that the market is overvalued according to definition (i). The weakness of this definition is that the estimated long-run trend in real house prices depends on the time period considered. If we believe that the structure of the housing market has changed significantly since the early post-war decades, we might not want to include data for these decades in an estimate of the long-term trend in house prices. For example, if we only want to focus on developments after the liberalization of capital markets in the 1980s, a quick look at Figure 2.1 suggests that the underlying trend in real house prices may have become steeper since that time. However, because the position and slope of a fitted trend in house prices is so critically dependent on the time period selected, the use of such a trend line is a rather unsatisfactory way of estimating whether and by how much the housing market may be overvalued.

From a theoretical viewpoint it is better to measure the degree of overvaluation or undervaluation as the distance between actual and fundamental house prices, as suggested by definition (ii) above. The "fundamental" level of house prices is the level that can be explained by "fundamental" economic variables such as interest rates, disposable incomes, household wealth, property taxes etc. In applying this approach it is important to be clear about the time horizon considered. The reason is that it takes time for house prices to adjust to a short-run equilibrium where housing demand equals the existing housing stock, and it takes even longer time for the housing market to adjust to a long-run equilibrium where the prices of existing houses equal the cost of supplying similar new houses *and* where the expected rate of increase of house prices equals the actual rate.

In Figure 2.6 we made the simplifying assumption that house prices adjust instantly to establish a short-run equilibrium where the demand for houses equals the existing stock. In practice several factors prevent such instantaneous adjustment. Individual houses are heterogeneous goods, and it takes time for home buyers to find a house with the characteristics that fit their tastes and needs, just as it may take time for home sellers to find out what a realistic

selling price for their particular house might be in a declining housing market. Moreover, moving from one dwelling to another involves substantial transaction costs. For these reasons we would expect that house prices will only gradually adjust to equilibrate housing demand and housing supply. The empirical evidence supports this view. For example, using data for Swedish regions, Hort (2000) found that the number of houses sold reacts faster than house prices to changes in economic fundamentals (such as interest rate changes). As another example, Genesove and Mayer (2001) presented evidence from the USA indicating that home sellers are reluctant to cut selling prices in a falling housing market. Traditional econometric error-correction models of the housing market also clearly suggest that it takes time for house prices to adjust to the market-clearing level even if (as a simulation experiment) the housing stock is held fixed.

At any point in time, the housing market may therefore be expected to be in a state of disequilibrium where house prices are headed towards the level that will bring the demand for housing in line with the existing housing stock (given the expected future capital gain on houses which is one of the determinants of housing demand, as we shall see in section 4). When this price level is reached, the housing market is in short-run equilibrium, since there will be no further downward or upward pressure on real house prices provided the housing stock and the expected capital gains stay constant. A long-run housing market equilibrium is reached when house prices as well as the housing stock have adjusted to the level where the prices of existing homes equal the marginal cost of supplying similar new homes *and* expected capital gains equal actual capital gains.<sup>6</sup>

With these concepts of equilibrium in mind, we might say that the housing market is overvalued (undervalued) from a short-term perspective if the current level of house prices exceeds (is lower than) the estimated short-run equilibrium level. Similarly, we might say that house prices are overvalued (undervalued) from a long-term perspective if current prices are above (below) their estimated long-run equilibrium level. Since it may take a decade or more for the housing market to adjust to a long-term equilibrium following a shock to the market, it is obviously important to specify which of the two concepts of equilibrium one adopts when evaluating the sustainability of current house prices. The analysis in sections 4 and 5 may be seen as alternative attempts to judge whether Swedish house prices are currently above their long-run equilibrium level.

According to the reasoning above there is really no difference between the definitions of “overvaluation” stated in the bullet points (ii) and (iii) in the beginning of this section. House prices could be said to exceed their fundamental values when they are above their (short-run or long-run) equilibrium level. If that is the case, any model of the housing market which is

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<sup>6</sup> If expectations were always rational, the expected capital gains would on average equal the actual gains even in a short-run equilibrium.

correctly specified and estimated will predict that house prices will fall in the future.

However, in some academic studies asset prices are said to be out of line with fundamentals only if they cannot be explained as the outcome of “normal” market dynamics. If this approach is adopted, a house price above the short-run equilibrium level does not necessarily indicate that the housing market is overvalued, provided the current price level can be explained by the normal out-of-equilibrium dynamics of a standard (error-correction) model of the housing market. By definition (iii) above the housing market would still be overvalued, since they are predicted by the relevant model to fall in the future, but by definition (ii) there would be no overvaluation since the current high level of house prices can be explained by the usual market “frictions” that prevent an instantaneous adjustment of house prices to changes in fundamentals.

This distinction between definitions (ii) and (iii) leads us to what seems to be the most reasonable definition of a housing bubble – a term that is often used in a very casual manner: For the purpose of this report we shall define a housing bubble as a situation where house prices deviate significantly from the short-run equilibrium level implied by the current values of the relevant economic fundamentals *and* where this deviation cannot be said to reflect the normal disequilibrium dynamics of the market.

Standard definitions of asset price bubbles typically emphasize that a bubble exists when an asset price deviates from its fundamental value as a result of overoptimistic expectations about future price gains. The point of our definition of a housing bubble is that a deviation of house prices from their fundamental short-run equilibrium level does not necessarily reflect a bubble. Because of high transaction costs and the search costs of matching buyers and sellers in the housing market, we would expect that house prices only gradually adjust towards the equilibrium level implied by current fundamentals. It is only when the deviation of prices from this level becomes abnormally high that we may be confronted with a bubble.

Clearly this definition of a “bubble” is not easy to apply in practice, since there is uncertainty regarding the (short-run) equilibrium price level as well as the “normal” pattern of disequilibrium price dynamics. The uncertainty is particularly large when the housing market undergoes structural change which alters the quantitative link between the fundamentals and the equilibrium price and/or the dynamic adjustment pattern. But regardless of the particular definition of “bubbles” adopted, history shows that asset price bubbles are quite hard to identify *ex ante*, at least until they have grown very large.

The motivation for our interest in bubbles is the well-known fact that asset prices typically fall very quickly and dramatically when a big bubble bursts and prices move back towards their fundamental level. Indeed, markets often appear to overreact in the aftermath of a bubble, driving prices to “unreasonably” low levels below what seems justified by fundamentals. As an example of how a housing bubble may play out, we will now look at the recent Danish housing market experience. We will then consider various ways in

which a housing bubble may arise. In the final part of the section we will briefly discuss whether Sweden currently has a housing bubble.

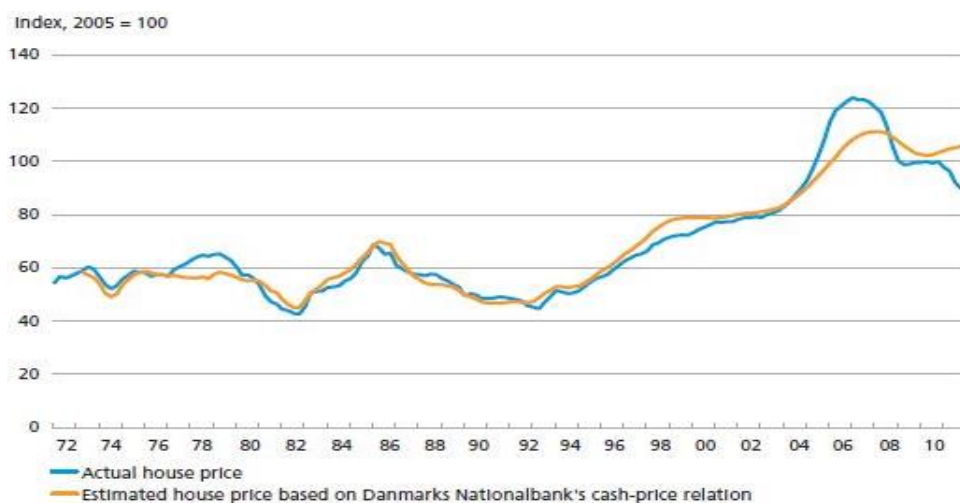
### 3.2 A case study: The Danish housing bubble in the 2000s

As shown in Figure 2.3a, the rise in real house prices in Denmark was extremely steep in 2005–2006. The econometric models of the Danish housing market existing at the time grossly underestimated the rise in house prices even when the actual observed values (and not just the forecasted values) of the explanatory variables were plugged into the models. This remarkable episode motivated a team of researchers in Danmarks Nationalbank to develop a new econometric model of the Danish market for owner-occupied housing. Existing models had assumed that housing demand depends on real disposable income plus a conventional measure of the user cost of housing. The new model developed by Danmarks Nationalbank, presented in Dam et al. (2011), assumed instead that home buyers react to a measure of cost which is a weighted average of the traditional user cost and the minimum necessary first-year cash flow payable by a fully leveraged home buyer. This minimum first-year payment includes after-tax nominal interest payments, property taxes *plus* any amortization required, given the most liberal mortgage loan types available at the time of purchase. There may be two reasons why home buyers may be willing to pay a higher price if the required first-year payment goes down, say, through the offering of interest-only loans. First, some home buyers may be credit-constrained which makes lower cash flow expenses here and now attractive. Second, some home buyers may simply be myopic, not realizing or caring that lower amortization of mortgage debt today will increase total mortgage payments tomorrow.

By including the minimum required first-year payment in the measure of the cost of housing services, it was possible to achieve a better explanation for the evolution of Danish house prices. Nevertheless, although the new housing model tracks the actual development of house prices quite well up until the middle of the previous decade, it still underpredicts the rise in house prices in 2005 and 2006. This is illustrated in Figure 3.1 which shows the actual level of real house prices and the level predicted by a dynamic simulation of the estimated model.<sup>7</sup>

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<sup>7</sup> The model is of the error-correction type, allowing for a gradual adjustment of actual prices to the level needed to equate the underlying housing demand with the existing housing stock. Thus the current house price depends in part on lagged house prices. The dynamic simulation in Figure 3.1 uses the lagged house prices predicted by the model (rather than the *actual* lagged prices) to calculate the price level in subsequent periods.

**Figure 3.1 Actual and estimated real house prices in Denmark**

Source: Simulation by Danmarks Nationalbank (2012, p. 27) based on the housing market model presented in Dam et al. (2011).

We also see that, following the sharp downturn in 2008–2009 and the further fall in 2011, Danish house prices are now considerably *lower* than predicted by the model.

A natural interpretation of these data is that Denmark experienced a genuine housing bubble in the middle of the last decade: even the best available models of the housing market failed to predict the strong upturn and the subsequent sharp downturn of house prices. Consumer surveys as well as casual evidence suggest that the upturn was driven by exuberant expectations of future capital gains on houses and that consumers became quite pessimistic about future price developments after the downturn. The housing market model described above assumes that expected future capital gains on houses are determined by a weighted average of actual past gains, but the model apparently fails to capture the volatile dynamics of expectations in recent years. Again, such rapidly shifting expectations seem to be characteristic of most bubble episodes across countries and time.

The soaring Danish house prices in the mid-2000s stimulated consumer demand (through its positive impact on household wealth) and housing investment and contributed significantly to the overheating of the Danish economy in 2006–2007. As a result of record-low unemployment, wage inflation accelerated, undermining the international wage competitiveness of Danish firms. When the housing bubble burst, construction activity and consumer confidence collapsed at the same time as Danish net exports suffered from the combination of the international economic crisis and weaker cost competitiveness. Concerns among international investors that the Danish housing market had become seriously overvalued also made it more difficult for Danish banks to obtain international funding as the international financial crisis unfolded. Thus the Danish housing bubble undoubtedly helps to explain why the growth of the Danish economy has been so anaemic over the last few years.

### 3.3 How do housing bubbles arise?

Since housing bubbles and their bursting can cause so much economic damage, it is useful to have an idea of how they arise. An extensive survey of alternative theories of housing bubbles is beyond the scope of this report, but below we will briefly sketch some of the bubble theories that have been offered in recent years.

Asset price bubbles are often seen as evidence of irrational market psychology, but in fact bubbles are not necessarily inconsistent with rational expectations and optimizing investor behaviour. The reason is that the price of an asset today depends in part on its expected price tomorrow, that is, on the expected capital gain. In a rational frictionless housing market, a house will trade at a price equal to the discounted value of the future housing services it produces, *provided* house prices are not expected to increase at a rate exceeding the discount rate (see section 5). The discounted value of future housing services is the fundamental house price. But suppose that for some reason market agents believe that house prices will rise at a rate exceeding the discount rate. The current house price will then exceed the fundamental price by a “bubble” component which will grow over time as long as the expectations of large price gains persist. In this situation the housing market can be in a rational expectations equilibrium where price expectations are validated as house prices are continuously bid up by anticipations of further price hikes. One might object that truly rational house buyers would not expect house prices to rise at a high rate forever, anticipating that houses would ultimately become so expensive that no one could afford to buy them. But if interest rates are low, the expected rate of house price inflation could exceed the discount rate even if it does not exceed the expected rate of income growth, so in a low-interest rate environment houses would not necessarily end up being prohibitively expensive even if there were a bubble in house prices. Moreover, even if market agents expect that an asset bubble will burst with a certain probability in each period, it could still be rational for them to invest in the asset if the expected capital gain in case the bubble does not burst is sufficiently high, as shown by Blanchard (1979).

Arce and López-Salido (2011) demonstrate how housing bubbles can arise under rational expectations when there are minimum collateral requirements tying the borrowing capacity of homeowners to the value of their houses. By limiting the volume of debt, collateral constraints restrict the supply of assets in the economy. In case of a large positive “funding shock” that increases the availability of credit, the interest on debt instruments may then become so low that it becomes more attractive for wealth owners to invest in houses for purely speculative purposes, that is, without actually living in them. Such speculative investment can fuel a housing bubble where house prices become detached from the discounted value of housing services. This confirms that housing bubbles are more likely to occur in a low-interest rate environment.

In recent years scholars working in the field of *behavioural finance* have developed an alternative to the theory of “rational bubbles”. These researchers draw on insights from psychology and social psychology to explain features of



asset market behaviour that seem inconsistent with rational expectations. Case and Shiller (2003) and Shiller (2005, 2007) have used elements from behavioural finance theory to explain how speculative bubbles in the housing market may arise and play out. Case and Shiller (2003, p. 321) characterize housing bubbles in the following way: “A tendency to view housing as an investment is a defining characteristic of a housing bubble. Expectations of future appreciation of the home are a motive for buying that deflects consideration from how much one is paying for housing services. That is what a bubble is all about: buying for the future price increases, rather than simply for the pleasure of occupying the home. And it is this motive that is thought to lend instability to bubbles, a tendency to crash when the investment motive weakens.” In itself, this description of a housing bubble is not inconsistent with the theory of rational bubbles. However, according to Case and Shiller the investment motive that drives the bubble is often founded on unrealistic beliefs. In particular, Shiller (2005) points out that many historical asset bubbles seem to have originated from widespread beliefs that a “new economic era” characterized by exceptionally strong and robust economic growth has dawned. Such beliefs may be nurtured by important technological innovations or the opening of new important markets. In a number of case studies Shiller has documented how “new era thinking” tends to get spread by “story-telling” among investors and in the news media. As the resulting optimistic beliefs drive up asset prices, a feed-back mechanism takes hold whereby rising asset prices reinforce the belief that prices will continue to rise in the future, inducing investors to bid up asset prices even further, and so on. In this way herding behaviour and so-called “emotional contagion” (where ever more investors are attracted by the stories of great capital gains to be made) may drive asset prices far away from fundamentals. The bubble bursts when some negative event or news undermines the belief in continued strong asset price gains. Once the market turns, the feed-back mechanism mentioned above works in reverse, as the observation of falling asset prices generates expectations of further drops.

Shiller’s theory of speculative bubbles has been criticized for being somewhat sketchy and imprecise. The contribution by Lux (1995) may be seen as an attempt to formalize the description of the herding behaviour that plays an important role in Shiller’s account of bubbles. Lux develops a model where some investors have information about fundamental asset values whereas others do not. The uninformed investors base their decisions to buy or sell the asset partly on the observed trading behaviour of other investors - this is the “herding” behaviour in the model – and partly on the actual realized asset returns, including capital gains. The tendency of uninformed investors to mimic each other can drive asset prices far away from fundamentals, but the market can turn around when observed realized asset returns deviate sufficiently from expected returns. Lux shows how such a market setting may cause transient asset price bubbles and lead to repeated fluctuations of asset prices around their fundamental values as the dominant mood of the market shifts between bullish and bearish beliefs.

Hong and Stein (1999) also emphasize the importance of the existence of different types of investors for the aggregate dynamics of asset markets. They

set up a model where one group of investors (“newswatchers”) acquires information relevant for the calculation of the fundamental asset price and where another investor group (“momentum traders”) base their asset price forecasts on the observed actual price changes. The information received by the individual newswatcher diffuses only gradually to other newswatchers, so in the short run the market underreacts to news about fundamentals. Hence the asset price adjusts only gradually towards its fundamental value. This gradual momentum in prices induces momentum traders to “chase the trend” and keep on buying the asset as long as the price is observed to go up, and vice versa. Hong and Stein demonstrate that this interaction between investor groups causes the asset price to overreact in the longer run by systematically overshooting or undershooting its fundamental value.

Daniel et al. (1998) and Barberis et al. (1998) likewise attempt to explain the observed tendency for asset prices to underreact to news about fundamentals in the short run, but to overreact in the longer run. These authors do not postulate that different investor groups react in a systematically different way. Instead, they assume that investors suffer from certain psychological biases that have been documented by psychologists and economists working in the field of experimental economics. In the model set up by Daniel et al. (1998), investors are *overconfident* in the sense that they overestimate their ability to predict the evolution of the asset price from the private information that they gather or receive. Investors are also taken to suffer from so-called *biased self-attribution*, meaning that they tend to put more weight on events and news that seem to confirm their prior beliefs regarding the likely evolution of asset prices, whereas they tend to downplay or neglect new information that seems to contradict their priors. In the model developed by Barberis et al. (1998) investors tend to overestimate the representativeness of recent events, e.g. recent significant changes in asset prices, so that they tend to regard these changes as representative of what could happen in the future even if the true statistical probability of a similar future event is low. Both of these theoretical models predict that asset prices will display positive momentum in the short run and so-called mean reversion (i.e. a tendency to revert to their average long-run level) in the long run.

The theoretical studies reviewed above are just a few examples of studies that seek to explain how asset price bubbles or “overreactions” in asset prices (including house prices) can occur. There is strong empirical evidence suggesting that house prices may in fact overshoot or undershoot their fundamental level for quite a while. According to Muellbauer and Murphy (2008, p. 5), “...almost the entire empirical literature on house-price determination agrees that the housing market is not efficient: systematic mispricing can persist...For example, a series of positive shocks to fundamentals can lead to rising prices and the expectation of further appreciation leading to greater and greater overvaluation. In due course, the increasing negative pull from fundamentals reduces the rate of appreciation. When prices eventually fall, the falls can be exaggerated by expectations of further falls.”

This statement by Muellbauer and Murphy is inspired by the finding of Abraham and Hendershott (1995) and numerous other researchers that the current rate of increase of house prices varies positively with the lagged rate of appreciation and negatively with the deviation of the current price level from the estimated fundamental level. The effect of the lagged rate of appreciation suggests that home buyers extrapolate observed capital gains into the future. Abraham and Hendershott (1995) refer to this mechanism as the “bubble-builder”. However, the expected capital gains apparently become smaller and eventually turn negative as the gap between actual and fundamental prices increase. This gap is the “bubble burster”; its presence in empirical house price equations indicates that fundamental values do in fact work as an anchor for actual prices in the long run. The analysis in Section 5 indicates that this is also the case in Sweden.

### 3.4 Is there a bubble in the Swedish housing market?

Although theoretical and empirical studies of housing bubbles abound, it remains very difficult to judge whether a housing bubble exists in a particular country at a particular time. In the beginning of this section we considered three alternative ways of evaluating whether the housing market is overvalued: we may ask if current real house prices are significantly above their long-run trend; whether current prices are substantially above the level predicted by existing econometric house price models, or whether such models predict a significant drop in future house prices. As we saw, it is not very satisfactory to rely on the first method. When evaluating whether the Swedish housing market is currently overpriced, we will therefore focus on the latter two criteria. A natural point of departure for our discussion is the newly developed house price model for Sweden presented in Claussen et al. (2011) and documented in detail by Claussen (2012).

This model consists of a single equation explaining the real house price ( $P$ ), but it may be seen as a reduced form of a model of housing demand and housing supply. Specifically, suppose that housing demand ( $D$ ) is given by the following extended version of the housing demand schedule considered in Section 2:

$$D = D(cP, Y, V) \quad (3.1)$$

Here  $V$  is the real value of household financial wealth,  $c$  is the real user cost of housing, and  $Y$  is real disposable income, as in Section 2. Suppose further that housing supply ( $H$ ) depends positively on the real house price and negatively on real building costs ( $C$ ) so that

$$H = H(P, C) \quad (3.2)$$

Setting  $H = D$ , we can use (3.1) and (3.2) to solve for the equilibrium house price to get an equation of the form

$$P = f(c, Y, V, C) \quad (3.3)$$

Applying Swedish data for the period from the first quarter of 1986 to the second quarter of 2011, Claussen (2012) estimates the long-run relationship

between the real house price and the variables on the right-hand side of (3.3), using the average real after-tax mortgage interest rate ( $r$ ) as a proxy for the user cost variable  $c$ . Judging from theoretical and statistical criteria, construction costs do not perform well as an explanatory variable, so in his preferred final estimate of the equilibrium house price, Claussen (2012) drops the variable  $C$ . He then ends up with the following estimate of the equilibrium real house price ( $P^e$ ) in Sweden,

$$\ln P^e = -17.04 + 1.30 \times \ln Y - 0.06 \times r + 0.12 \times \ln V \quad (3.4)$$

where  $\ln X$  denotes the natural logarithm of variable  $X$ . In line with a long tradition in empirical housing economics, Claussen assumes that the actual house price only gradually adjusts to the equilibrium level given by (3.4). Using standard criteria to eliminate statistically insignificant explanatory variables, he estimates the following error-correction model of the short-run dynamics of real house prices, where  $\Delta X_t$  signifies the change in variable  $X$  from period  $t-1$  to period  $t$ :

$$\begin{aligned} \Delta \ln P_t = & 0.001 - 0.08(\ln P_{t-1} - \ln P_{t-1}^e) + 0.21 \Delta \ln P_{t-1} + 0.55 \Delta \ln P_{t-3} - \\ & 0.16 \Delta \ln Y - 0.005(\Delta r_t + \Delta r_{t-3}) + \Delta \ln V_{t-1} \end{aligned} \quad (3.5)$$

Equation (3.5) has the same qualitative features as numerous other estimated error-correction models of house prices in the international literature: the current percentage rate of increase of house prices ( $\Delta \ln P_t$ ) depends positively on the lagged increase in house prices (here represented by the terms  $\Delta \ln P_{t-1}$  and  $\Delta \ln P_{t-3}$ ) and negatively on the error correction term  $\Delta \ln P_{t-1} - \ln P_{t-1}^e$  capturing the percentage deviation between the actual and the equilibrium house price. Since the model is estimated on quarterly data, the coefficient on the error correction term implies that, *ceteris paribus*, about 30 per cent of the gap between the actual and the equilibrium price is closed within a year.

The house price model summarized in (3.4) and (3.5) explains the recent evolution of the real house price in Sweden quite well. This is illustrated in Figure 3.2 which shows the result of a dynamic simulation of the model, starting in the first quarter of 1996.<sup>8</sup> We see that the model seems able to account for practically all of the increase in Swedish house prices since the mid-1990s. According to the model, house prices were roughly at their long-run equilibrium level in 2011. From the long-run relationship (3.4) Claussen (2012, p. 15) calculates that 62 per cent of the increase in house prices between 1996 and 2011 was caused by the growth in real disposable incomes; 26 per cent of the increase was due to falling mortgage interest rates, and about 8 per cent of the increase was driven by the rise in household financial wealth. Only 4 per cent of the increase is unexplained by the long-run house price equation.

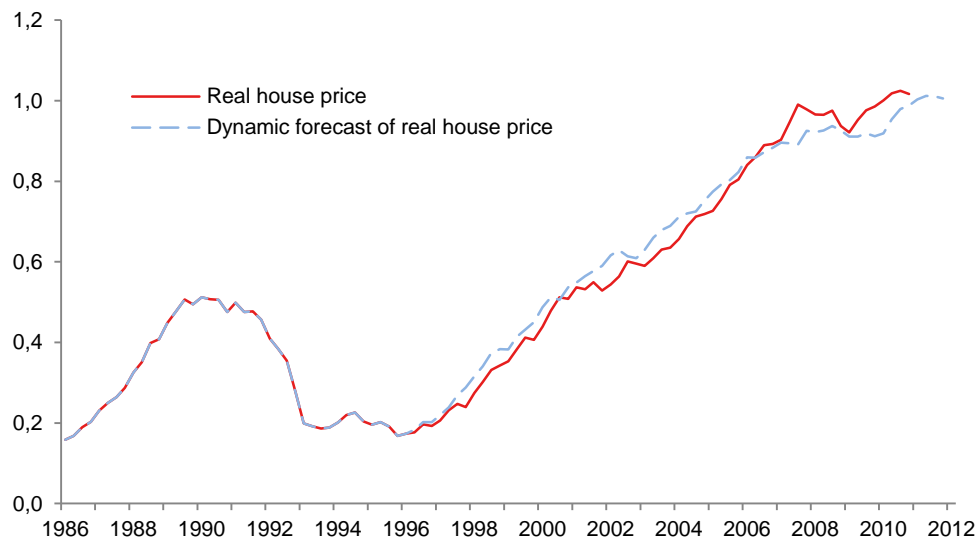
From this analysis it would seem that the surge in house prices during the last 15 years can be fully justified by the evolution of the fundamental variables

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<sup>8</sup> This simulation uses the actual historical levels of income, wealth and interest rates plus the level of lagged house prices predicted by the model to calculate the current house price. This procedure is identical to the one followed in the dynamic simulation of the Danish house price model illustrated in Figure 3.1.

driving housing demand and housing supply. By this criterion there is no sign of a housing bubble.

**Figure 3.2 Actual real house prices in Sweden and a dynamic forecast starting in 1996**

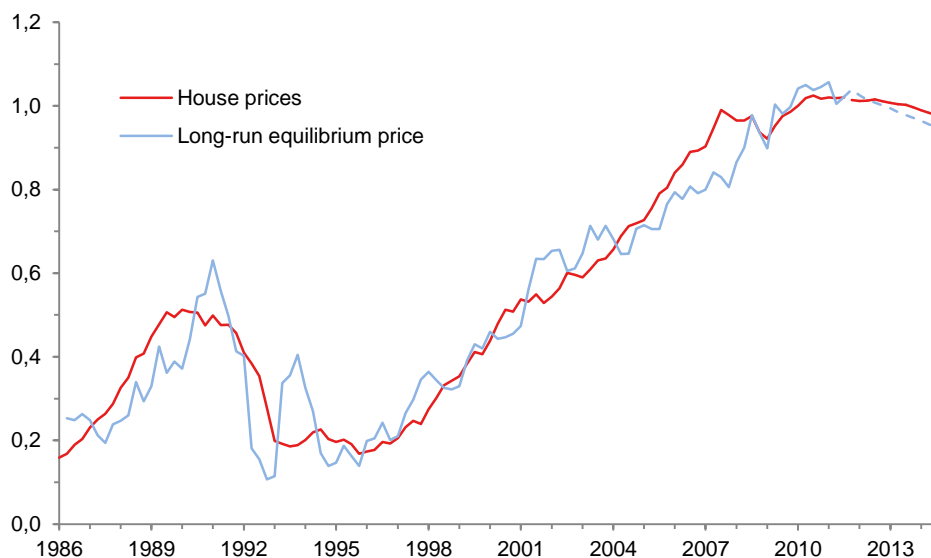


Note: The dynamic forecast is based on the house price model presented in Claussen (2012).

Source: Claussen (2012, Figure 8).

Claussen (2012) also uses the model to forecast real house prices in the period 2012-2014, assuming that the explanatory variables develop roughly in line with the forecasts in the Sveriges Riksbank October 2011 Monetary Policy Report. The resulting forecast is shown as the dotted red line in Figure 3.3 (“ECM prediction of house prices”) which uses both of the model relationships (3.4) and (3.5), thus incorporating the normal short-run dynamics of house prices. The dotted blue line in Figure 3.3 shows the forecast of the long-run equilibrium house price based solely on equation (3.4). According to the simulations underlying Figure 3.3, real house prices will fall by about 5 per cent from the third quarter of 2011 to the fourth quarter of 2014. However, since the publication of the October 2011 Monetary Policy Report, the markets seem to have lowered their expectations of future interest rates. Based on these updated expectations, the house price model developed by Claussen predicts roughly constant real house prices over the next few years (Claussen, 2012, p. 17). According to the model, the growth of income and wealth would have to weaken substantially, or the level of interest rates would have to rise significantly to generate a large fall in house prices. Again, this analysis does not indicate the presence of a housing bubble.

**Figure 3.3 Actual and predicted real house prices in Sweden, including a forecast for 2012–14**



Note: The dynamic simulation is based on the house price model presented in Claussen (2011). The forecast for 2012–14 is based on the forecast for the explanatory variables contained in the Sveriges Riksbank October 2011 Monetary Policy Report.

Source: Claussen (2012, Figure 9).

The econometric analysis by Claussen (op. cit.) is carefully executed, using state-of-the-art techniques, and his house price model probably represents the best possible empirical error-correction model of Swedish house prices over the estimation period considered. However, one may wonder about the future robustness of the model. One concern is that the model estimates assume that the real mortgage interest rate is not a stationary variable because it does not seem to be so within the estimation period.<sup>9</sup> But economic theory as well as the long-run historical evidence suggests that real interest rates are in fact stationary over the long term. Hence the model will probably not fit the data very well over a longer period, as recognized by Claussen himself (see Claussen, 2012, footnote 12).

A second worry arises when one considers the quantitative features of the estimated long-run relationship (3.4). According to this relationship a one per cent increase in real disposable income is on average associated with a 1.3 per cent increase in real house prices. If financial wealth evolves roughly in line with income over the long run, as seems likely, equation (3.4) even implies that real house prices will tend to grow by more than 1.4 per cent for every one per cent increase in real income. Assuming that the real user cost is stationary in the long run and that the budget share of housing expenses cannot go on increasing forever, the definition of the budget share given in (2.1) then implies that the real housing stock must be *falling* as economic growth proceeds. This can only occur if housing supply is falling over time despite a sustained increase in real house prices. Such a scenario does not seem very plausible.

<sup>9</sup> Technically, Claussen assumes that the real mortgage rate is integrated of order one, meaning that the period-by-period *change* in the interest rate (but not its level) is a stationary process.

To state the problem in more precise terms, suppose for concreteness that the housing supply schedule (3.2) takes the form

$$H = A \cdot \left(\frac{P}{C}\right)^b, \quad (3.6)$$

where  $A$  and  $b$  are positive constants. This specification assumes that housing supply increases with the ratio of house prices to construction costs, as suggested by economic theory. Claussen (2012, p. 8) reports that, according to the Swedish data, a rise in house prices systematically drives up construction costs, perhaps because it weakens competition and raises the demand for the inputs used in the building industry.<sup>10</sup> Suppose therefore that construction costs are given by a function like

$$C = Z \cdot P^\gamma, \quad (3.7)$$

with  $Z$  and  $\gamma$  again being positive constants. Using the definition of the budget share (2.1) along with (3.6) and (3.7), and assuming that the budget share and the user cost must be constant in the long run, we can now derive the following long-run relationship between the growth rate of real income and the growth rate of real house prices:

$$\Delta \ln P = \frac{1}{1+b(1-\gamma)} \cdot \Delta \ln Y. \quad (3.8)$$

As noted, the estimated long-run house price equation (3.4) indicates that real house prices will grow by about 1.3–1.4 per cent when real income grows by one per cent. According to (3.8) this can only happen if  $\gamma$  is greater than one, that is, if construction costs increase by *more* than one per cent when house prices go up by one per cent. In other words, construction costs would have to systematically outpace house prices over the long run so that the housing stock keeps on shrinking. Such a scenario does not seem very likely.

If we assume instead that  $\gamma$  is less than one, thereby leaving room for some increase in housing supply as real house prices go up, the estimated coefficient on income in (3.4) implies that the budget share of housing expenses will keep on rising over time (assuming that the real interest rate is stationary in the long run). As argued earlier, such a situation does not seem sustainable either. The reason why real house prices in Sweden have been able to grow substantially faster than real incomes since the mid-1990s without seriously squeezing household budgets is that real interest rates fell substantially over this period.

In summary, it is hard to believe that the estimated relationship between house prices and income in (3.4) will remain stable over time. The large estimated coefficient on income may reflect that some common factor not included in (3.4) caused an unusually strong correlation between house prices and incomes during the estimation period; a period characterized by a very uneven pace of economic growth. The strong fluctuations in growth may have been accompanied by large swings in expected future incomes which have affected

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<sup>10</sup> Claussen finds strong evidence that house prices “Granger-cause” construction costs, meaning that past house prices help to predict the current level of construction costs.

the growth of current income as well as the growth in house prices. For example, the deep recession in the first part of the 1990s may have been exacerbated by unusually pessimistic growth expectations which helped to depress current income as well as house prices. Conversely, if expectations of future (permanent) income became much more optimistic after the turn-around of the Swedish economy in the mid-1990s, they would have boosted current income as well as house prices through their positive impact on the demand for housing and other goods during the economic recovery. At a later stage of the boom when the economy moved towards full capacity utilization, optimistic growth expectations may have continued to stimulate the growth of output and incomes by boosting business investment in new capacity at the same time as they continued to drive up house prices. In other words, if expectations regarding future incomes and future house prices undergo unusually large swings during a certain period, this may be reflected in an unusually strong correlation between current incomes and current house prices.

This hypothesis regarding the reason for the large coefficient on income in equation (3.4) is highly speculative and very difficult to test because of the difficulties of measuring expectations about the future. But if the current high level of Swedish house prices has been generated in part by rather optimistic expectations about future income growth, one would expect a fall in house prices when expectations revert to a more “normal” level.

In any case, while it is certainly relevant to evaluate the current state of the housing market through the lens of an econometric house price model, the discussion above indicates that this is not an entirely fool proof way of judging whether the market is currently overvalued. It is therefore useful to supplement the preceding analysis by other complementary methods of evaluating the sustainability of current house prices. This is the agenda for the next two main sections.



## 4 User costs, rents and incomes

### 4.1 The user cost of owner-occupied housing

The alternative to owning one's dwelling is to rent it. If renting becomes more expensive relative to owning, more people will be inclined to buy a house. Hence house prices may be expected to increase. On the other hand, if house prices were to go up a lot, more people would favour rental housing, so falling demand for houses would likely drive down future house prices relative to the level of rents. Thus it is often argued that if the ratio of house prices to rents is high by historical standards, it is a sign that houses are overpriced and may be headed for a decline, and vice versa. In a similar vein it is argued that if the ratio of house prices to disposable incomes is unusually high, it signals that houses are overvalued relative to what people can afford in the long run, and vice versa.

For these reasons it is very common to evaluate the state of the housing market by comparing the current house-price/rent ratio and the house-price/income ratio to the "normal" historical level of these ratios. The problem with these popular measures is that the house price is only one of several determinants of an owner-occupier's cost of housing services. To evaluate whether the cost of owning has indeed gone up (or down) relative to the alternative of renting and relative to disposable income, we must look at all components of the total cost of the housing service a home-owner provides for himself.

This requires us to clarify the concept of the user cost of owner-occupied housing to which we have already briefly referred. The user cost is the cost of the housing service obtained by investing one krona in a home. In the appendix we show that the real user cost is given by the following formula:

$$c = i(1 - \tau^i) - \pi + \tau + \delta - \bar{g} + \mu(\sigma_g^2, \beta, \rho) + \alpha m. \quad (4.1)$$

The variable  $i$  is the nominal mortgage interest rate,  $\tau^i$  is the capital income tax rate (against which interest payments may be deducted),  $\pi$  is the expected rate of consumer price inflation,  $\tau$  is the effective property tax rate, defined as the total property tax bill divided by the current market value of the house,  $\delta$  is the rate of depreciation of the house, indicating the expenses on housing repair needed to maintain the value of the house, and  $\bar{g}$  is the expected percentage real capital gain on the house over the time period considered (more precisely:  $100 * \bar{g}$  is the expected percentage real capital gain). If the housing investment is fully debt-financed, the user cost component  $i(1 - \tau^i) + \tau + \delta$  represents the homeowner's nominal cash expenses, while  $\pi + \bar{g}$  is his nominal capital gain. If the housing investment is equity-financed, the home-owner foregoes the after-tax interest income he could have earned by investing his wealth in the capital market, so  $i(1 - \tau^i)$  is still part of the (opportunity) cost of housing.

The term  $\mu(\sigma_g^2, \beta, \rho)$  in (4.1) is a risk-premium motivated by the fact that buying a house is a risky investment because of the uncertainty about future house prices. While this uncertainty means that the home-owner may score a

future capital gain in excess of the expected rate  $\bar{g}$ , it also implies a risk that the actual gain on the house will fall short of  $\bar{g}$  and that it may even turn into a loss. When consumers are risk averse, they will require a premium to be willing to accept this uncertainty about the actual capital gain. According to the analysis in the appendix, the risk premium  $\mu(\sigma_g^2, \beta, \rho)$  increases with the variance of the rate of real capital gain,  $\sigma_g^2$ , with the ratio of housing costs to expenses on other goods and services,  $\beta$ , and with the consumer's degree of risk aversion, captured by the parameter  $\rho$  which is the so-called coefficient of relative risk aversion.<sup>11</sup>

The final term on the right-hand side of (4.1) is not usually included in standard user cost formulas, but the analysis in the appendix shows that it must be incorporated in so far as home buyers are subject to borrowing constraints. Specifically, the parameter  $\alpha$  indicates the minimum fraction of the purchase price of the house that the home-buyer must finance out of his own accumulated net saving. This parameter captures the minimum *down-payment* that mortgage banks and/or the regulatory authorities may require from home-buyers. An equivalent constraint would be a maximum *loan-to-value ratio* stating the maximum allowable ratio of debt to the purchase price of the house. In our notation, the maximum loan-to-value ratio would be given by  $1 - \alpha$ . The variable  $m$  in (4.1) indicates the amount that a credit-constrained home-buyer would be willing to pay for the right to borrow an extra krona. Notice that  $m$  is positive *only* in so far as the existence of the down-payment constraint or the loan-to-value constraint forces the home-buyer to reduce his current consumption below the level he would have preferred in the absence of the constraint. This situation may be particularly relevant for many first-time home-buyers. The tighter the borrowing constraint, that is, the more the lacking ability to borrow (more) forces the home-buyer to reduce current consumption below the preferred level, the larger the value of  $m$  will be. Thus the value of  $m$  may differ significantly across different individuals; in particular, it will be zero for consumers who are not credit-constrained.

## 4.2 The evolution of user costs in Sweden

We will now track the evolution of the average user cost of owner-occupied housing in Sweden. For this purpose we need estimates of the variables and parameters entering our user cost formula (4.1).

According to the theory underlying the user cost formula, the interest rate  $i$  is in principle a risk-free rate (see the appendix). This suggests that we should measure it by some interest rate on short-term bonds. However, according to

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<sup>11</sup> When a consumer has constant relative risk aversion, the fraction of his wealth that they would be willing to give up to avoid risk altogether is proportional to  $\rho$ . It should be noted that the simple model in the appendix only accounts for the asset price risk faced by a home-owner. It abstracts from the fact that since households that do not own must rent, they can insure themselves against future fluctuations in rents by investing in owner-occupied housing. The risk premium required by home-owners will then depend on the balance between the asset price risk and the rent risk, as shown by Sinai and Souleles (2005). However, the conclusions drawn below do not depend on the size or even on the sign of the required risk premium on owner-occupied housing, since we will pragmatically treat that premium as a constant in our quantitative analysis.

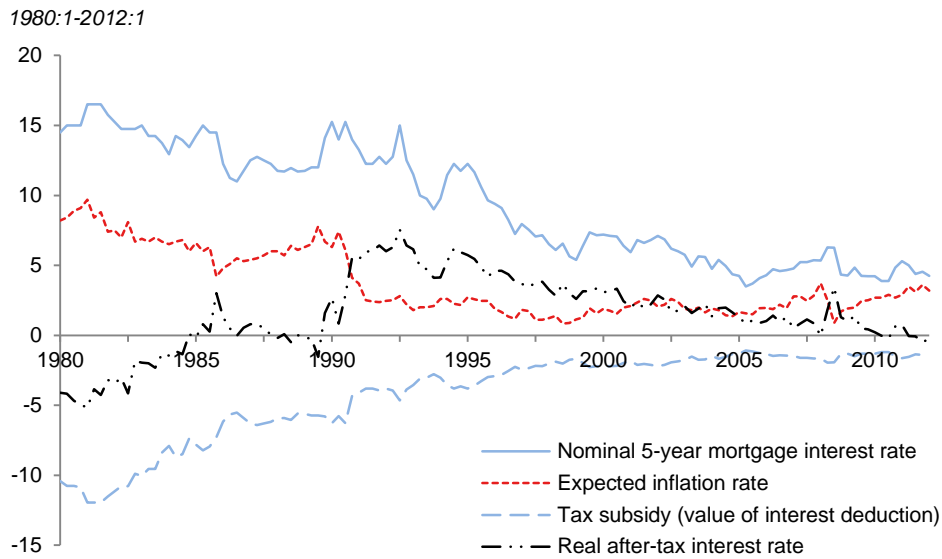
the so-called expectations hypothesis of the term structure of interest rates, the interest rate on a long-term bond with  $n$  years to maturity equals the average of the expected short-term interest rates over the coming  $n$  years, plus a risk premium.<sup>12</sup> If the long-term interest rate exceeds the short rate by more than a normal risk premium, it signals that short-term rates are expected to increase in the future. Since higher interest rates tend to drive house prices down (and vice versa), potential home-owners should then expect that house prices will rise by less than they would otherwise have done. As emphasized by Himmelberg, Mayer and Sinai (2005, p. 79), this provides an argument for using a long-term rather than a short-term interest rate in the user cost formula. The reason is that, since the expected rate of increase of house prices is usually unobservable, practical applications of a formula like (4.1) typically set the variable  $\bar{g}$  equal to the average rate of capital gain observed over the entire span of years considered. This procedure does not capture the fact that expectations of higher future interest rates are likely to reduce the expected future capital gain on houses, and vice versa. But since the long-term interest rate reflects expectations of future short-term rates, we may offset this likely bias in the measurement of expected capital gains by using a long rate in the user cost formula. In line with Englund (2011), we therefore measure the nominal interest rate  $i$  in (4.1) by the five-year mortgage bond rate. Like Englund (op. cit.) we also measure the capital income tax rate  $\tau^i$  as the median rate applicable for taxpayers with interest deductions, while the expected inflation rate  $\pi$  is measured on the basis of survey data on consumer expectations regarding the rise in consumer prices.

With these data we can illustrate the evolution of the real after-tax interest rate  $i(1 - \tau^i) - \pi$ , shown in Figure 4.1. The figure also shows the developments of the nominal interest rate  $i$  and of the tax component  $\tau^i * i$  indicating how much the income tax system has reduced the net interest rate over the period via the deductibility of interest expenses.

We see that the annual real after-tax interest rate rose from a level of about minus five per cent in the early 1980s to a level of about plus five per cent in the mid-1990s, despite a fall in the nominal interest rate. This significant rise in the real net interest rate resulted from a drop in inflation combined with tax reforms that reduced the tax subsidy to owner-occupied housing. Since the mid-1990s the real net interest rate has trended downwards due to a continued fall in the nominal interest rate.

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<sup>12</sup> This follows from an arbitrage condition requiring that the expected risk-adjusted return on investment in a sequence of short-term bonds equals the return on investment in a long-term bond.

**Figure 4.1 The after-tax real interest rate (%) in Sweden and its components**

Source: Updated from Englund (2011) with data from Ecwin.

The remaining parameters in the user cost formula (4.1) are the effective property tax rate,  $\tau$ , the depreciation rate,  $\delta$ , the expected real capital gains rate,  $\bar{g}$ , the risk premium,  $\mu$ , and the term capturing borrowing constraints,  $\alpha m$ . The depreciation rate is likely to be quite stable over time and is often estimated to be around 2 per cent per year. In contrast, the other terms will probably fluctuate as the business cycle moves through its various stages, although they are likely to be roughly stationary over the long run unless there are major structural and institutional changes in the housing market and the capital market (we shall discuss the impact of such changes in section 6). Unfortunately we cannot directly observe the values of  $\bar{g}$ ,  $\mu$  and  $\alpha m$ . Pragmatically, we therefore follow earlier applied studies and treat the magnitude  $\tau + \delta - \bar{g} + \mu + \alpha m$  as a constant.<sup>13</sup> With this assumption the variation over time in the user cost is determined solely by the variation in the real after-tax interest rate displayed in Figure 4.1.

### 4.3 The evolution of imputed versus actual rents

We can now specify the real cost of the housing service flowing from a physical unit of owner-occupied housing. By definition, this cost, denoted  $R^H$ , is given by the product of the user cost and the real house price:

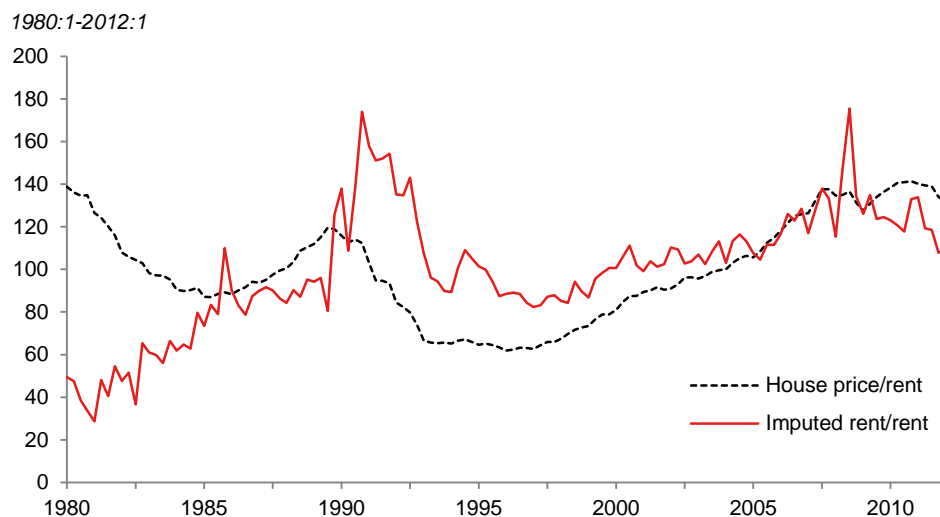
$$R^H \equiv Pc = P[i(1 - \tau^i) - \pi + \tau + \delta - \bar{g} + \mu + \alpha m] \quad (4.2)$$

The variable  $R^H$  is usually referred to as the *imputed rent*. This is the relevant real cost of owner-occupied housing which may be compared to the real rent  $R$  paid for rental housing. In Figure 4.2 we illustrate the evolution of the ratio of imputed to actual rents,  $R^H/R$ . For concreteness, we have followed Englund

<sup>13</sup> In section 6 we will discuss how the effective property tax rate may have changed over time and how this may modify our conclusions.

(2011) and set  $\tau + \delta - \bar{g} + \mu + \alpha m = 0.07$  when calculating the term in the square bracket in (4.2). The variable  $R$  is measured by the rent component in the Swedish consumer price index.

**Figure 4.2 The ratio of imputed to actual rents and the ratio of house prices to rents in Sweden**



Note: Average over the entire period = 100.

Source: Own calculations, based on the data underlying Figure 4.1 and data on house prices and rents from Statistics Sweden.

For comparison, Figure 4.2 also shows the development of the ratio of house prices to rents,  $P/R$ . Since the data for  $P$  and  $R$  are given as index numbers, we have normalized the observed values of the ratios  $R^H/R$  and  $P/R$  so that their average value over the period considered is equal to 100. A value considerably above (below) 100 in a given year therefore indicates that owning was relatively expensive (cheap) in that year, compared to the historical norm.

Figure 4.2 illustrates why the popular focus on the house-price/rent ratio may be misleading: since the mid-1990s this ratio has risen much more than relative cost of owner-occupied housing measured by the ratio of imputed rents to rents in the rental housing sector.

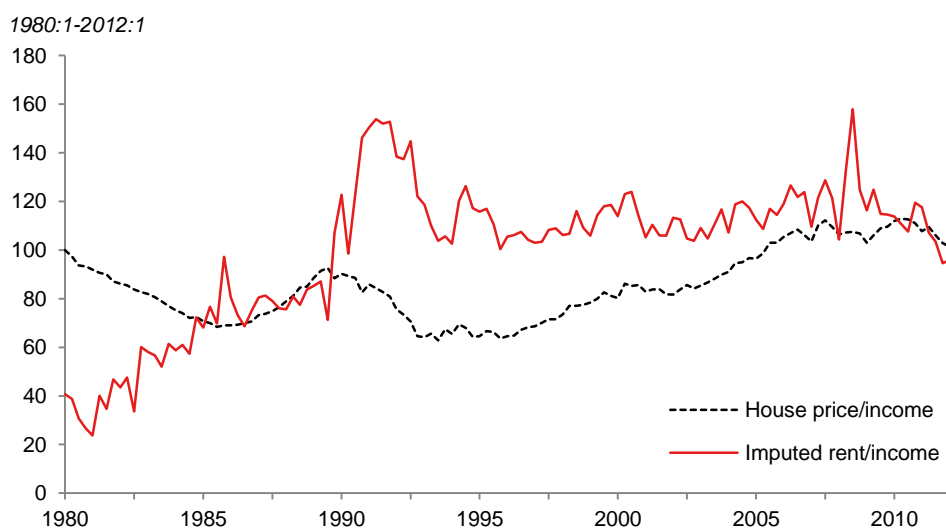
#### 4.4 The evolution of imputed rents relative to income

The ratio of imputed to actual rents measures the relative cost of owning versus renting. A complementary metric is the ratio of imputed rent to disposable income which measures the cost of owner-occupied housing relative to ability to pay. If this ratio is unusually high (low), one might argue that houses are overvalued (undervalued).

In Figure 4.3 we show a time series for  $R^H/Y$ , where  $Y$  is aggregate real disposable household income. The figure also includes a time series for the ratio of house prices to income,  $P/Y$ , which is often used as an indicator of the affordability of owner-occupied housing. Both ratios are normalized so that their average value over the whole period is 100.

If one were focusing on the evolution of the house-price-to-income ratio since the mid-1990s, one might conclude that the Swedish housing market currently seems seriously overvalued. However, once again we get a less dramatic conclusion when the imputed rent rather than the house price is used to measure the housing cost. Because the user cost has trended downwards for many years, the imputed-rent-to-income ratio has fluctuated around a roughly constant level since the mid-1990s, despite the sharp increase in real house prices.

**Figure 4.3 The ratio of imputed rent to disposable income and the ratio of house prices to disposable income in Sweden**



Note: Average over the entire period = 100.

Source: Own calculations, based on the data underlying Figure 4.1 and data on house prices and disposable incomes from Statistics Sweden.

#### 4.5 Summing up: What do our measures of imputed rents tell about the current state of the Swedish housing market?

From the early 1980s to the early 1990s the real cost of owner-occupied housing (measured by the imputed rent) rose significantly relative to real rents in the rental sector and relative to real disposable incomes. This development reflected Sweden's transition from a high-inflation to a low-inflation country as well as ambitious tax reforms which reduced the large initial tax subsidy to owner-occupied housing. However, since the early 1990s the ratios of imputed rents to incomes and rents have hovered around a roughly constant trend, despite the large increase in real house prices. If Swedish house prices were not overvalued in the mid-1990s where the Swedish economy was recovering from a severe economic crisis, it is therefore hard to argue from figures 4.2 and 4.3 that house prices are currently significantly overvalued.

On the other hand, the period since the mid-1990s is relatively short in a long-term historical perspective, so it is unclear whether current Swedish house prices are really close to their long-run equilibrium level. The next section seeks to throw further light on this issue.

## 5 Fundamental versus actual house prices

The simulations of the empirical house price model presented in section 3 and the analysis of the ratios of user costs to rents and incomes in section 4 can be seen as alternative ways of evaluating whether house prices are currently out of line with their long-run equilibrium level. However, the analysis in both sections applied a measure of user cost where the expected percentage capital gain on houses was assumed to be constant. This assumption was made for pragmatic purposes, due to the difficulty of measuring expectations, but it is not very likely to hold in practice. Moreover, the previous analysis did not allow us to evaluate whether current house prices are based on “realistic” expectations about the future evolution of house prices.

In the present section we will try to make up for these shortcomings by presenting estimates of the level of “fundamental” house prices in Sweden. The fundamental house price is the equilibrium house price that would prevail if households had “rational” expectations about the “fundamental” variables which determine the future value of the housing service delivered by their house. Since these fundamentals – such as the future levels of income, interest rates and rents – will also determine future house prices, we might also say that the current fundamental house price is based on realistic expectations about future house prices.

In general we would expect actual house prices to deviate from fundamental house prices at any point in time, partly because of the various frictions that prevent an instantaneous adjustment of prices to their equilibrium level (see the discussion in section 3), and partly because consumers may not always have realistic expectations about the future fundamentals determining future house values. However, economic theory suggests that actual house prices will tend towards their fundamental level over the longer run. Whether this is actually the case is an empirical question which we will address below.

In the next subsection we will define the concept of the fundamental house price in more precise terms. We will then explain how we have estimated fundamental house prices in Sweden and present our estimates. In the last part of the section we will analyse whether there is a systematic tendency for actual house prices to move towards the fundamental level and how fast such convergence takes place. The analysis underlying the results presented below is documented in detail in Bergman and Sørensen (2012).

### 5.1 Determinants of the fundamental house price

The fundamental house price can be derived from our expression for the imputed rent ( $R_t^H$ ) stated in equation (4.2). This expression includes the expected percentage real capital gain on the house, defined as  $\bar{g} \equiv (P_{t+1}^e - P_t)/P_t$ , where  $P_{t+1}^e$  is the expectation formed in the current period about the house price that will prevail in the next period.

Defining the constant term  $\eta \equiv \tau + \delta + \mu + \alpha m$ , we can then write (4.2) as

$$R_t^H = [i_t(1 - \tau_t^i) - \pi_t + \eta]P_t - (P_{t+1}^e - P_t),$$

which can be rearranged to give

$$P_t = \frac{R_t^H + P_{t+1}^e}{1 + \gamma_t}, \quad \gamma_t \equiv i_t(1 - \tau_t^i) - \pi_t + \eta, \quad (5.1)$$

where  $\gamma_t$  is the user cost of owner-occupied housing, *excluding* the expected capital gain. Equation (5.1) shows explicitly how the current house price depends on the house price expected to prevail in the next period. But next period's house price will in turn depend on the expected house price in period  $t+2$ , which will depend on the house price expected to prevail in period  $t+3$ , and so on. Using this insight, Bergman and Sørensen (2012) show that equation (5.1) implies

$$P_t = \frac{R_t^H}{1 + \gamma_t} + \frac{R_{t+1}^{He}}{(1 + \gamma_t)(1 + \gamma_{t+1}^e)} + \frac{R_{t+2}^{He}}{(1 + \gamma_t)(1 + \gamma_{t+1}^e)(1 + \gamma_{t+2}^e)} + \dots, \quad (5.2)$$

where  $R_{t+j}^{He}$  and  $\gamma_{t+j}^e$  are the values of  $R_t^H$  and  $\gamma_{t+j}$  expected at time  $t$  to prevail in period  $t+j$ .

Equation (5.2) states our definition of the fundamental house price. We see that the fundamental house price equals the discounted value of the current and the expected future imputed rents. The relevant discount rate is the user cost of housing excluding the expected capital gain.

The house price equation in (5.2) assumes that future real house prices are not expected to grow at a rate exceeding  $\gamma_{t+j}$  forever. If this assumption does not hold, the expression for the *actual* house price will consist of the infinite sum on the right-hand side of (5.2) *plus* a positive “bubble element” reflecting that home buyers are willing to pay not only for the future housing services but also for the prospect of large capital gains. From the definition in (5.1) we see that  $\gamma_t$  exceeds the after-tax real interest rate. If house prices kept on growing at a rate greater than  $\gamma_t$ , it would therefore be possible to score permanent pure profits by constantly borrowing to invest (more) in real estate. Such a situation is hardly sustainable, so although housing bubbles may exist temporarily (as we discussed in section 3), our formula for the fundamental house price (5.2) rules them out through the assumption that real house prices are not expected to grow at a rate that permanently exceeds  $\gamma$ .

As mentioned, our notion of the fundamental house price assumes that households have rational expectations regarding the future imputed rents included in formula (5.2). Hence the expected future values of  $R^H$  must be consistent with an equilibrium in the housing market.

To check the robustness of the estimates of fundamental house prices, Bergman and Sørensen (2012) follow Hott and Monnin (2008) and consider two alternative models of housing market equilibrium when deriving estimates for  $R_{t+j}^{He}$ .

The first model, denoted the “rent” model, is based on the idea from section 4 that a housing market equilibrium requires a stable relationship between the



cost of rental housing and the imputed rent on owner-occupied housing of similar quality, that is:

$$R_t^H = \omega R_t, \quad \omega \geq 1. \quad (5.3)$$

If the market for rental housing is free and the two forms of housing are perfect substitutes, arbitrage between them will ensure that  $\omega = 1$ . However, in Sweden the level of rents is negotiated between organizations representing tenants and landlords, and rents are supposed to be set at a “fair” level. According to Englund (2011, p. 32) this means that rents in the major cities are typically below the (estimated) free-market level, so access to rental housing is to some degree rationed. In that case the parameter  $\omega$  in (5.3) is above 1. For tractability, our rent model is based on the bold assumption that  $\omega$  is roughly constant over the long run. In that case we can use (5.3) to infer the expected future imputed rents if we can develop a reliable method of forecasting the level of rents in the market for rental housing.

However, since the degree of regulation and rationing in the rental housing market may not be constant over time, the assumption of a constant value of  $\omega$  may be problematic. Bergman and Sørensen (2012) therefore also consider a “supply-and-demand model” (S-D model) in which imputed rents adjust so as to equilibrate the supply of and demand for housing services. The S-D model assumes that the aggregate long-run demand for housing services ( $D$ ) varies positively with aggregate real disposable income ( $Y$ ) and negatively with imputed rents so that

$$D_t = k Y_t^{\varepsilon_Y} (R_t^H)^{-\varepsilon_R}, \quad (5.4)$$

where  $k$  is a constant,  $\varepsilon_Y$  is the long-run income elasticity of housing demand, and  $\varepsilon_R$  is a price elasticity measuring the numerical long-run elasticity of housing demand with respect to the imputed rent. The aggregate supply of housing services is proportional to the aggregate housing stock ( $H$ ), and the proportionality factor may be normalized at unity by appropriate choice of units. In a housing market equilibrium we thus have  $H_t = D_t$ . From (5.4) this implies

$$R_t^H = k^{1/\varepsilon_R} Y_t^{\varepsilon_Y/\varepsilon_R} H_t^{-1/\varepsilon_R} \quad (5.5)$$

Using equation (5.5) and an appropriate procedure for forecasting  $Y_t$  and  $H_t$ , one can estimate the expected future imputed rents, provided one has realistic estimates of the elasticities  $\varepsilon_R$  and  $\varepsilon_Y$ .

When forecasting the future discount rates  $\gamma_{t+j}$  and the variables needed to calculate the expected future imputed rents in (5.2), Bergman and Sørensen (2012) assume that households act “as if” they were using a Vector Autoregression (VAR) model describing the historical interaction of the variables  $R$ ,  $Y$ ,  $H$ ,  $\gamma$  and the actual real house price (this is the sense in which expectations are assumed to be rational). Bergman and Sørensen (2012) describe in detail how the VAR model is specified and estimated. The estimation procedure assumes that the average level of actual real house prices observed over the estimation period corresponded to the average level of fundamental house prices over that period. In other words, it is assumed that there was no systematic under- or overvaluation of house prices over the

estimation period taken as a whole. The model was estimated using quarterly Swedish data for the period 1986:1 to 2012:1. The starting point for the estimation period was dictated by data availability, but it can also be justified by the fact that the Swedish capital market was rather heavily regulated until the mid-1980s.

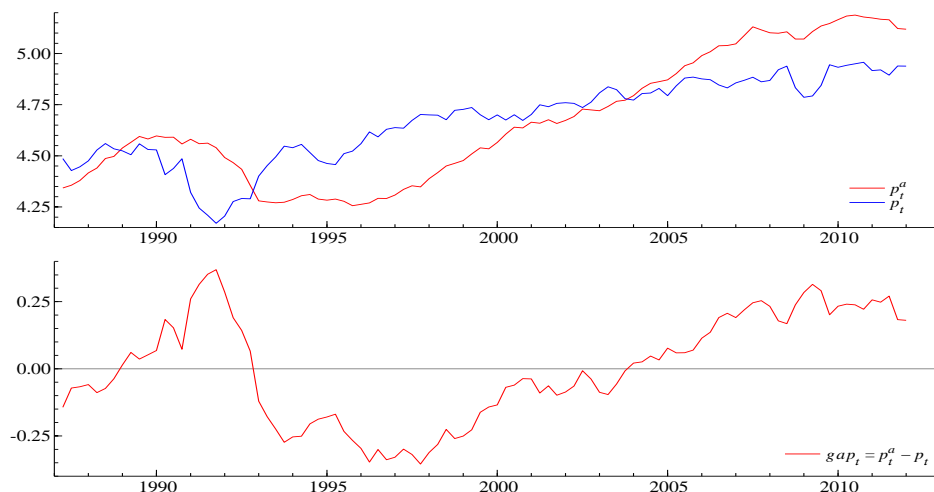
To apply the supply-and-demand model of the housing market, one needs to choose specific values for the income and price elasticities of housing demand. As mentioned by Englund (2011), most international studies indicate that the income elasticity of housing demand is around 1 whereas the numerical price elasticity is below 1. The bulk of the international studies surveyed by Girouard et al. (2006) also find that house prices react more than proportionally to changes in housing supply, implying that the numerical price elasticity of housing demand is less than one. The benchmark calculations presented below therefore assume that  $\varepsilon_Y = 1$  and  $\varepsilon_R = 0.5$ . However, we will analyse the sensitivity of the results from the S-D model to variations in the income and price elasticities.

## 5.2 Fundamental versus actual house prices in Sweden

The upper part of Figure 5.1 shows the evolution of actual real house prices in Sweden along with the estimates of the fundamental house price based on the rent model. The variable  $p_t^a$  is the logarithm of the actual real house price in quarter  $t$ , and  $p_t$  is the logarithm of the estimated fundamental real house price in that quarter. The “gap” variable  $p_t^a - p_t$  shown in the lower part of Figure 5.1 therefore measures the relative deviation of the actual from the fundamental house price. For example, if the gap is 0.20, the actual level of house prices is roughly 20 per cent above the fundamental level.

**Figure 5.1 Actual real house prices and estimated fundamental house prices in Sweden**

1986:1-2012:1

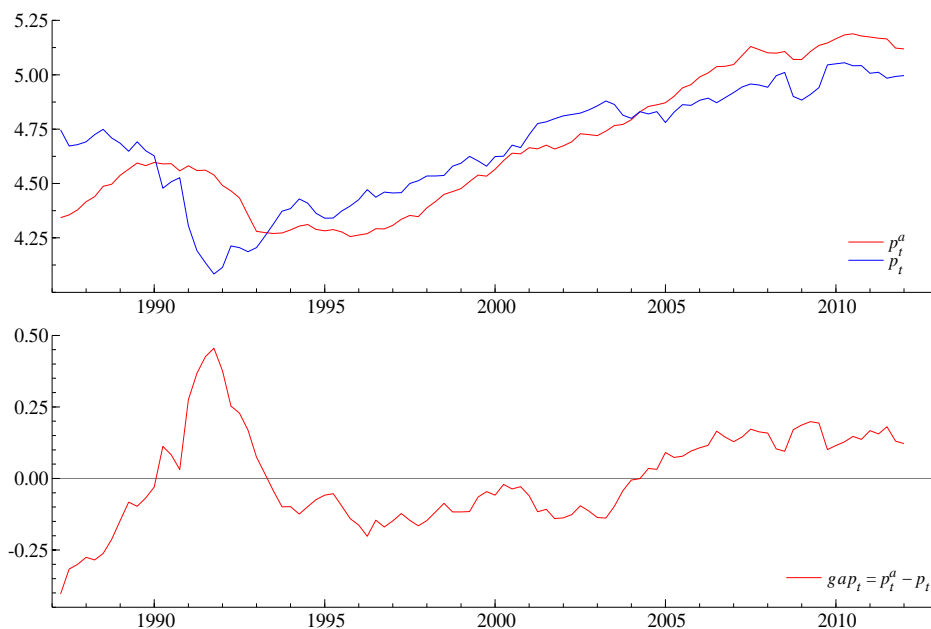


Note: Estimates based on rent model.  
Source: Bergman and Sørensen (2012).

For comparison, Figure 5.2 shows the difference between actual and fundamental house prices according to the benchmark version of our S-D model. According to both models the fundamental house price fluctuated more sharply than the actual house price during the crisis years of the early 1990s, reflecting that actual house prices only adjust gradually to shifts in housing demand and supply, for the reasons explained in section 3. We also see that, in contrast to actual house prices, fundamental house prices do not appear to have risen very much since the mid-1990s. The rent model indicates that Swedish real house prices were overvalued by around 18 per cent in the first quarter of 2012, whereas the S-D model suggests that the degree of overvaluation (measured by the house price gap) was only 12 per cent.

**Figure 5.2 Actual real house prices and estimated fundamental house prices in Sweden**

1986:1-2012:1



Note: Estimates based on Supply-and-Demand model with  $\varepsilon_Y = 1$  and  $\varepsilon_R = 0.5$ .

Source: Bergman and Sørensen (2012).

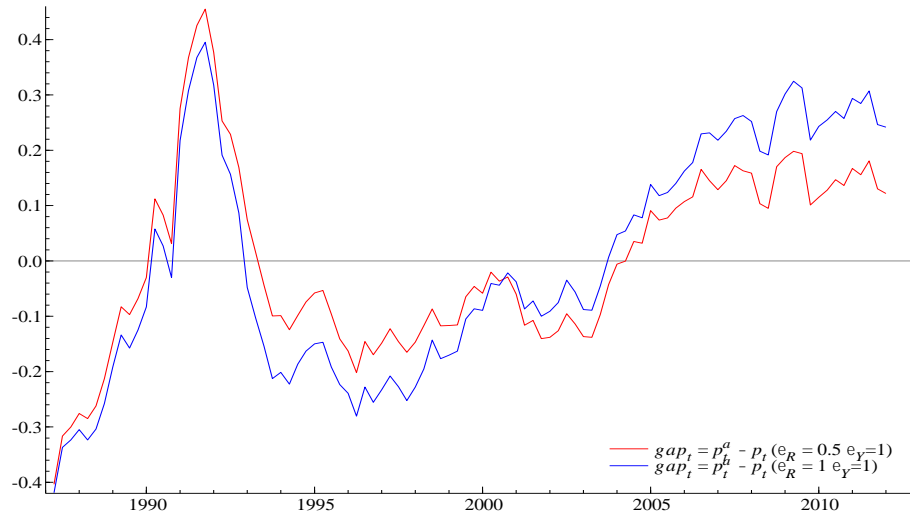
### 5.3 Sensitivity analysis

The benchmark version of the S-D model used in Figure 5.2 assumes a (numerical) price elasticity of housing demand equal to 0.5. This is not far from the price elasticity of around 0.3 estimated by Brownstone and Englund (1991) and Englund et al. (1995), but it is somewhat lower than the estimate for Sweden presented by Brusewitz (1998) who found a price elasticity close to 1.

Against this background Figure 5.3 shows how the percentage gap between the actual and the fundamental house price varies according to the S-D model if we set the numerical price elasticity of housing demand equal to 1.0 rather than 0.5 while keeping the income elasticity at 1.0. We see that a higher price elasticity increases the current gap between actual and fundamental house

prices. Presumably the reason is that, with a larger price elasticity, the strong income growth during the last decade (and the resulting strong growth in housing demand) requires a smaller increase in the fundamental house price to balance supply and demand in the housing market.

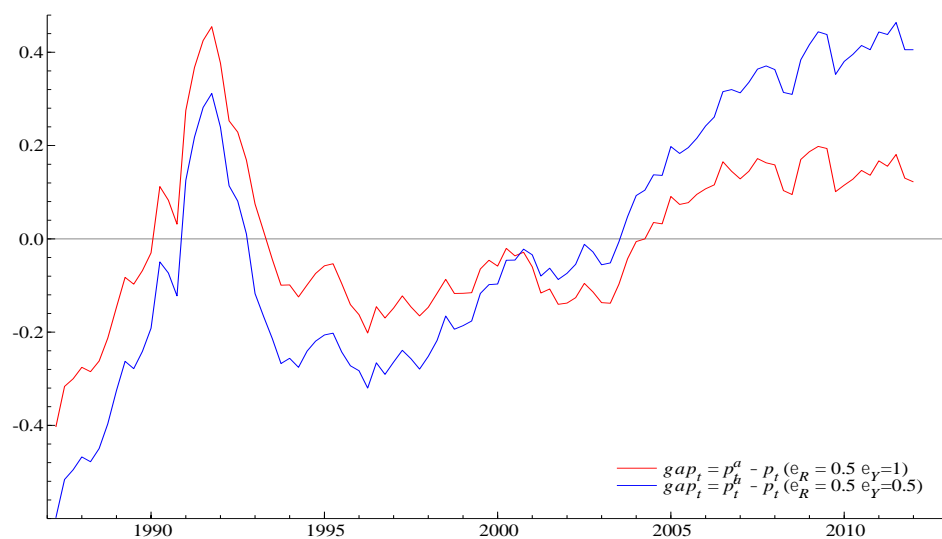
**Figure 5.3 Sensitivity of the house price gap to the price elasticity of housing demand**



Note: (estimates of  $p_t^a - p_t$  based on Supply-and-Demand model with  $\varepsilon_Y = 1$ ).  
Source: Bergman and Sørensen (2012).

While it is quite common to assume that the income elasticity of housing demand is around 1, some earlier Swedish studies have estimated somewhat lower income elasticities, as noted above. In Figure 5.4 we illustrate the sensitivity of the estimated fundamental house price to a lower income elasticity, keeping the numerical price elasticity of housing demand fixed at 0.5.

**Figure 5.4 Sensitivity of the fundamental house price to the income elasticity of housing demand**



Note: Estimates of  $p_t^a - p_t$  based on Supply-and-Demand model with  $\varepsilon_R = 0.5$ .  
Source: Bergman and Sørensen (2012).

The figure shows that if the income elasticity is only half the value assumed in our benchmark case, current house prices are much further above their fundamental level. Most likely this is because a lower income elasticity would imply that the strong income growth since the mid-1990s has had a smaller positive impact on the underlying demand for housing services and hence a smaller positive effect on fundamental house prices.

## 5.4 Do actual house prices converge on fundamental prices?

The fundamental house price is only of practical interest in so far as actual house prices tend to move towards the fundamental level. To check whether and how fast actual prices converge on fundamental prices, Bergman and Sørensen (2012) analyse the statistical relationship between actual and fundamental house prices. In particular, they estimate a so-called Vector Error Correction Model of the following form, where  $\varepsilon_{1t}$  and  $\varepsilon_{2t}$  are stochastic “shock” terms:

$$\begin{aligned} \Delta p_t^a = & \alpha_1(p_t^a + \beta p_t) + \mu_{11}\Delta p_{t-1}^a + \mu_{12}\Delta p_{t-2}^a + \dots + \mu_{1n-1}\Delta p_{t-n+1}^a + \\ & \eta_{11}\Delta p_{t-1} + \eta_{12}\Delta p_{t-2} + \dots + \eta_{1n-1}\Delta p_{t-n+1} + \varepsilon_{1t} \end{aligned} \quad (5.6)$$

$$\begin{aligned} \Delta p_t = & \alpha_2(p_t^a + \beta p_t) + \mu_{21}\Delta p_{t-1}^a + \mu_{22}\Delta p_{t-2}^a + \dots + \mu_{2n-1}\Delta p_{t-n+1}^a + \\ & \eta_{21}\Delta p_{t-1} + \eta_{22}\Delta p_{t-2} + \dots + \eta_{2n-1}\Delta p_{t-n+1} + \varepsilon_{2t} \end{aligned} \quad (5.7)$$

Recall that  $p_t^a$  is the logarithm of the actual real house price in quarter  $t$ , and  $p_t$  is the logarithm of the estimated fundamental real house price in that quarter. A “ $\Delta$ ” in front of a variable indicates the change in that variable from the previous to the current quarter. If actual house prices tend to converge on fundamental house prices, one would expect that the parameter  $\beta$  in (5.6) would be equal to minus 1 and that the parameter  $\alpha_1$  would be significantly negative so that (5.6) takes the form

$$\begin{aligned} \Delta p_t^a = & \alpha_1(p_t^a - p_t) + \mu_{11}\Delta p_{t-1}^a + \mu_{12}\Delta p_{t-2}^a + \dots + \mu_{1n-1}\Delta p_{t-n+1}^a + \\ & \eta_{11}\Delta p_{t-1} + \eta_{12}\Delta p_{t-2} + \dots + \eta_{1n-1}\Delta p_{t-n+1} + \varepsilon_{1t}, \quad \alpha_1 < 0. \end{aligned} \quad (5.8)$$

Equation (5.8) implies that if actual house prices exceed fundamental house prices, there will be a tendency for actual real house prices to fall, and vice versa. Furthermore, if the evolution of actual house prices tends to be governed by the changes in the fundamental house prices, one would expect that at least some of the  $\eta$ -parameters in (5.8) will differ significantly from zero. Moreover, if actual house prices are in fact driven by fundamental prices, and not the other way round, one would expect the parameter  $\alpha_2$  as well as the  $\mu$ -parameters in (5.7) to be zero.

According to the statistical analysis in Bergman and Sørensen (2012), the Swedish data broadly support the hypothesis that equation (5.6) takes the form (5.8) with a significantly negative value of  $\alpha_1$  and  $\eta$ -parameters significantly

different from zero. Furthermore, according to the data one cannot reject the hypothesis that  $\alpha_2$  and the  $\mu$ -parameters in (5.7) are equal zero. These findings are in line with the idea that fundamental house prices serve as an “anchor” for actual house prices over the long run and that movements in fundamental house prices cause movements in actual prices.

However, the analysis in Bergman and Sørensen (2012) also indicates that deviations between actual and fundamental house prices can persist for a very long time. To illustrate this, Bergman and Sørensen use the estimated version of the model (5.6) and (5.7) to calculate how quickly the gap between the actual and the fundamental house price is closed, following a shock to the fundamental or to the actual price. The red curve in the upper part of Figure 5.5 shows the evolution of the gap between the (log of the) actual and the fundamental house price when the fundamental price is exposed to a permanent positive shock of “average” size (a one-standard-deviation shock). In the lower part of Figure 5.5 the red curve indicates the evolution of the house price gap when the actual house price is exposed to a positive one-standard-deviation shock.<sup>14</sup>

The blue curves in the figures delineate 95 per cent confidence intervals for the estimates: with a probability of 95 per cent, the actual evolution of the house price gap will fall within the blue curves. The estimates in Figure 5.5 are based on the benchmark version of the S-D model.

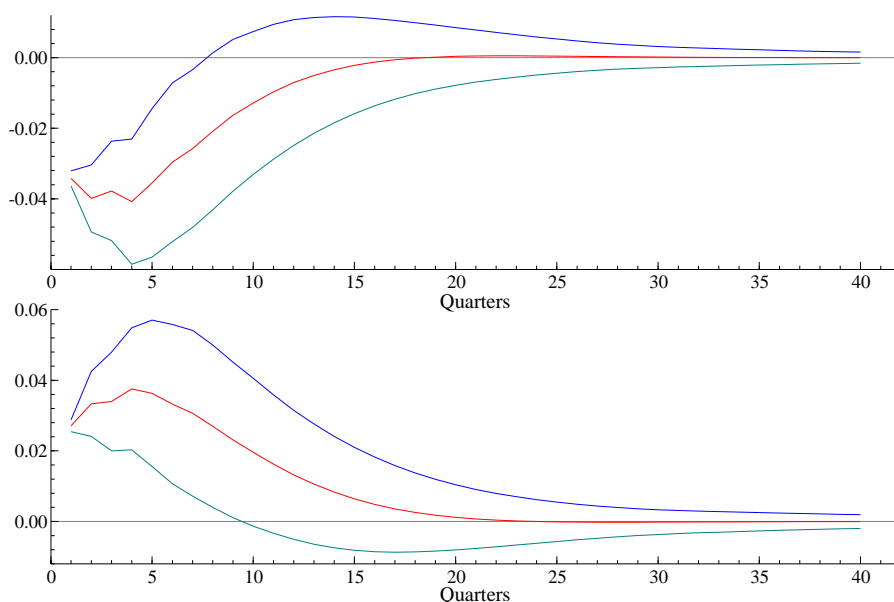
According to the central estimates given by the red curves, it takes about 20 quarters, i.e., about 5 years, before actual house prices have roughly adjusted to the fundamental level, following a price shock to the housing market. In the rent model (not illustrated here), the adjustment process takes even longer.

Bergman and Sørensen (2012) also use the estimated impulse-response functions in Figure 5.5 to calculate the so-called “half-life” of the house price gap. The half-life measures the number of years it takes before half the gap between the actual and the fundamental house price is closed after the housing market is hit by a one standard deviation shock to either the fundamental house price or the actual house price. Table 5.1 shows the estimated half-lives based on the two models of the housing market. We see that it takes somewhat longer to close half of the house price gap after a shock to the actual house price than after a fundamental price shock.

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<sup>14</sup> Because the actual house price is driven by the fundamental price, a permanent shock to the latter will have permanent effects on actual as well as fundamental house prices, whereas a shock to the actual price will only have temporary effects of the two prices.

**Figure 5.5 Estimated evolution of the house price gap following a one-standard-deviation shock to the fundamental house price (upper part) or to the actual house price (lower part)**



Note: Estimates based on the Supply-and-Demand model with  $\epsilon_Y = 1$  and  $\epsilon_R = 0.5$ .  
 Source: Bergman and Sørensen (2012).

**Table 5.1 Estimated half-lives of the house price gap**

Years	Shock to fundamental house price (permanent shock)	Shock to actual house price (transitory shock)
Rent model	3.19	9.90
S-D model with $\epsilon_Y = 1, \epsilon_R = 0.5$	2.21	2.97
S-D model with $\epsilon_Y = \epsilon_R = 1$	1.87	4.91

Source: Bergman and Sørensen (2012).

## 5.5 Conclusions on fundamental versus actual house prices in Sweden

The analysis of Bergman and Sørensen (2012) summarized above suggests that, in early 2012, Swedish house prices were significantly above the level warranted by fundamentals such as the level of rents, disposable incomes, user costs and total housing supply. According to economic theory the fundamental house price is the present discounted value of the rationally expected future imputed rent yielded by the house. If the imputed rent on owner-occupied housing moves in line with the level of rents in the rental housing sector, real house prices in Sweden appeared to be around 18 per cent above the fundamental level in early 2012, assuming that house prices were neither systematically overvalued nor undervalued over the period 1986–2012 as a whole. If imputed rents are instead adjusting to balance aggregate supply and demand in the housing market, Swedish real house prices seemed to be about 12 per cent above the fundamental level under the most plausible assumptions regarding

the income and price elasticities of housing demand, although this version of the model suggests that the degree of overvaluation of the housing market could be significantly higher. It should be stressed that these estimates are subject to considerable statistical uncertainty.

The analysis of Bergman and Sørensen also indicates that actual house prices tend to converge on fundamental house prices over the long run, but the speed of convergence is quite slow. In other words, while the underlying fundamentals are likely to put downward pressure on Swedish house prices in the years to come, the analysis does not suggest an imminent crash of the housing market.



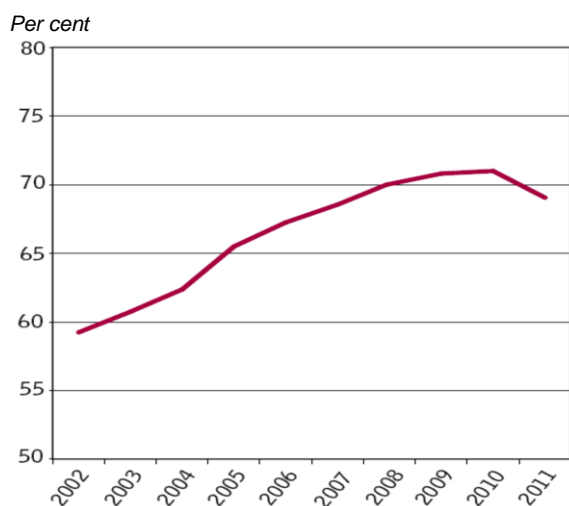
## 6 Further perspectives on Swedish house prices

The analysis of fundamental house prices in the previous section includes the factors that are usually considered to be the most important determinants of house prices. The analysis suggested that Swedish house prices are currently overvalued. In the present section we will consider whether this conclusion needs to be modified once we allow for some further factors which may have influenced housing demand in Sweden. We will also discuss how factors on the supply side of the housing market may affect the risk of a housing market downturn. Finally, we will consider the likely impact on the macro economy in case a serious housing market downturn was to occur.

### 6.1 Financial innovation and housing demand

The analysis in section 4 showed that the user cost of owner-occupied housing will tend to be higher the greater the degree of credit rationing, that is, the larger the number of home buyers who are subject to borrowing constraints and the tighter these constraints are.<sup>15</sup> In sections 4 and 5 we assumed that the degree of credit rationing has been constant over time. However, it is quite likely that the degree of credit rationing has actually fallen in recent years due to financial innovations. As shown in Figure 6.1, the average ratio of loans to the market value of newly bought Swedish homes increased significantly over the last decade. This suggests that access to credit has become easier. According to Finansinspektionen (2012, p. 9) the use of interest-only loans (i.e., housing loans with no amortisation) has also become more widespread in recent years.

**Figure 6.1 Average loan-to-value ratio for new home purchases in Sweden**



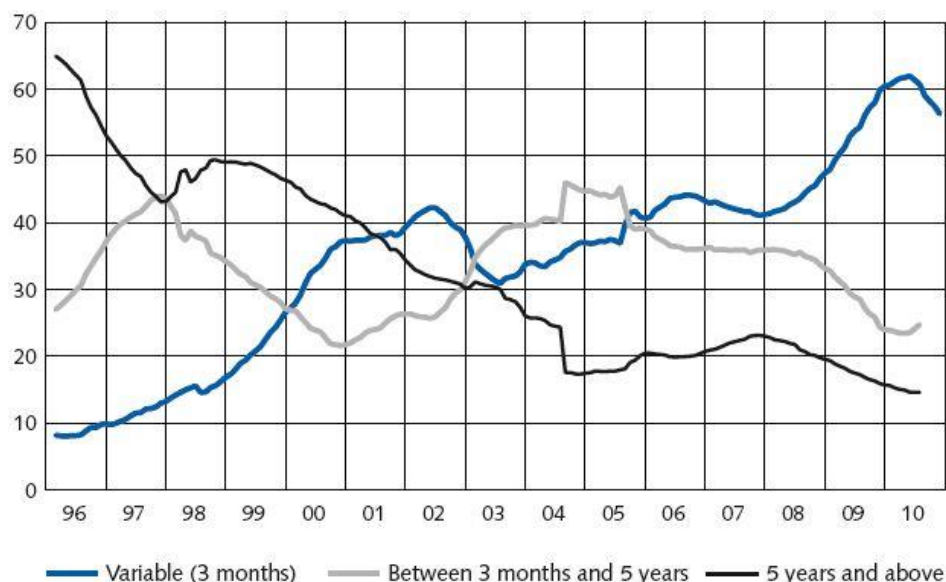
Source: Finansinspektionen (2012, p. 6).

<sup>15</sup> Recall that the impact of borrowing constraints is captured by the term  $am$  in the user cost expression (4.1).

Consistent with this trend, Frisell and Yazdi (2010) report that the average amortization period for Swedish mortgage loans rose from 49 years in 2002 to 89 years in 2009. These authors estimate that the longer amortization period has reduced the average annual amortization expense from 2 per cent to 1.1 per cent of the purchase price of a house. Moreover, Figure 6.2 shows that the share of variable-interest-rate housing loans linked to short-term market interest rates has increased dramatically at the expense of more traditional long-term mortgage loans with interest rates fixed for five years or more. Since short-term interest rates are usually lower than long-term rates, this development may also have loosened liquidity constraint for many home buyers.

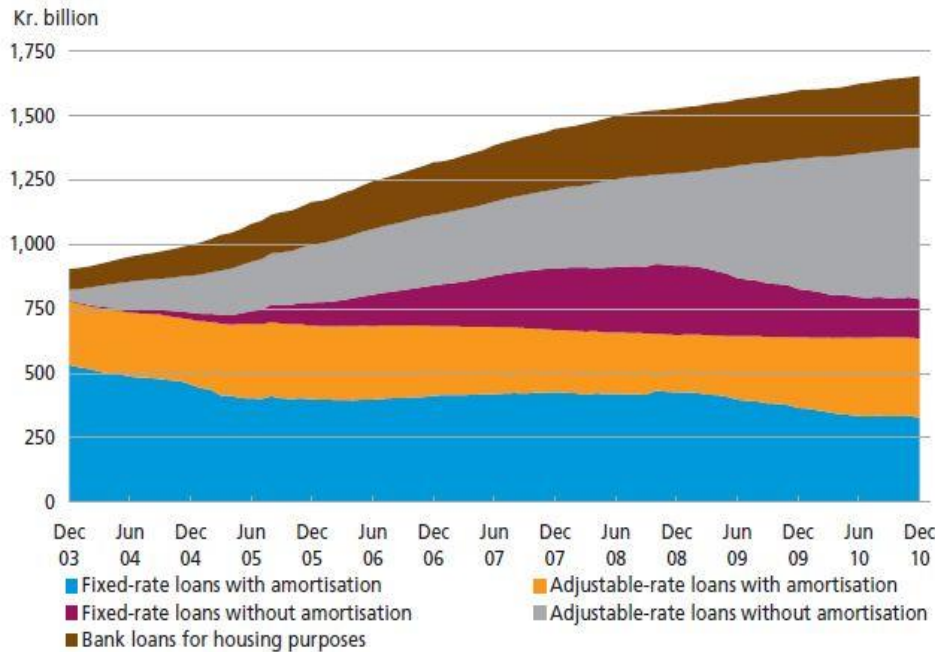
The Danish market for housing finance has gone through similar developments, as illustrated in Figure 6.3: the use of interest-only loans and adjustable-interest rate loans linked to short-term market interest rates has increased dramatically over the last decade. The Danish experience suggests that such financial innovations can have a substantial impact on housing demand. For home-buyers who are liquidity-constrained or simply short-sighted, the first-year cash payment on their mortgage may matter more for their housing demand than the conventional user cost of owner-occupied housing. To test this hypothesis, Dam et al. (2011) develop an empirical error-correction model of the Danish market for owner-occupied housing where housing demand is driven by disposable income and a modified user cost variable which is a weighted average of the conventional user cost and the minimum required first-year cash payment per krone of housing investment, given the types of mortgage finance available in the year considered.

**Figure 6.2 Breakdown of Swedish mortgage institutions' outstanding stock of loans by original fixed interest periods**



Sources: Sveriges Riksbank and Statistics Sweden.

**Figure 6.3 Composition of mortgage loans granted to Danish homebuyers**



Source: Dam et al. (2011, Figure 2.5), based on data from Danmarks Nationalbank.

In our previous notation this modified user cost  $c^m$  may be rewritten as

$$c^m = [\theta i^s + (1 - \theta)i^l](1 - \tau^i) - \pi + \tau + \delta + \theta(A + \pi), \quad 0 < \theta < 1 \quad (6.1)$$

where  $i^s$  is the lowest interest rate payable on adjustable-rate loans,  $i^l$  is the interest rate on long-term fixed-interest-rate loans, and  $A$  is the first-year nominal amortization payment on the most “favourable” mortgage loans obtainable in the market (so that  $A + \pi$  is the real amortization of debt, accounting for inflation).<sup>16</sup> According to conventional economic theory, rational forward-looking home-buyers do not consider amortization to be a cost since it is a form of saving, and they do not perceive short-term loans to be cheaper than long-term loans, since an upward-sloping yield curve ( $i^s < i^l$ ) indicates that future short-term interest rates will go up and/or that variable-rate short-term debt is riskier for borrowers than fixed-rate long-term debt. In these circumstances the parameter  $\theta$  in (6.1) should be zero. However, for a liquidity-constrained home-buyer there is a gain from lower cash payments today even if that means higher payments tomorrow. In that case we have  $\theta > 0$ . Furthermore, for a myopic individual living “from hand to mouth”, the only thing that matters for housing demand is the first-year out-of-pocket expense on housing. For such an individual  $\theta = 1$ .

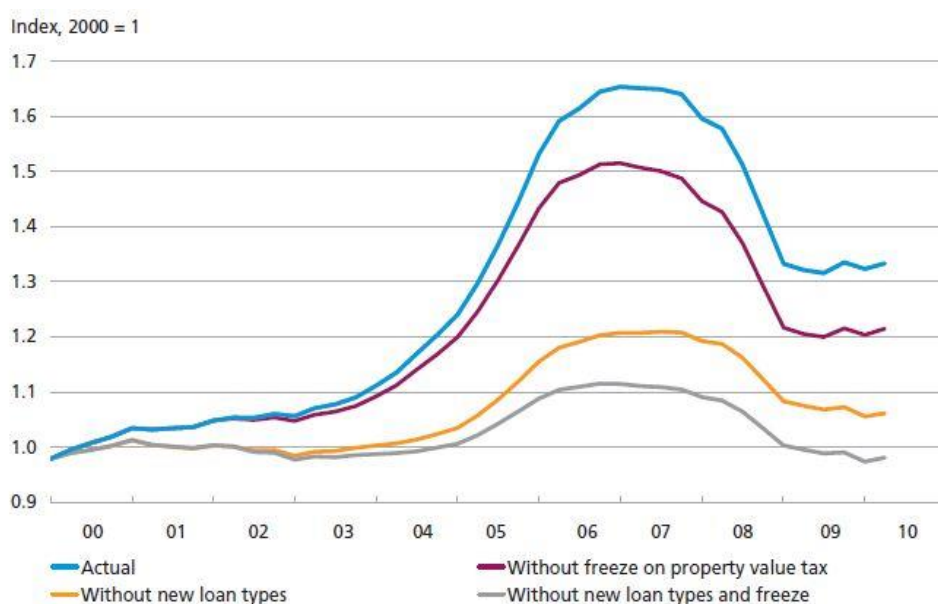
<sup>16</sup> Equation (6.1) emerges by rearranging the definition

$$\begin{aligned} c^m &\equiv \theta y + (1 - \theta)c, \\ y &\equiv i^s(1 - \tau^i) + A + \tau + \delta, \\ c &\equiv i^l(1 - \tau^i) - \pi + \tau + \delta, \end{aligned}$$

where  $c$  is a conventional user cost (excluding the expected capital gain), and  $y$  is the minimum required first-year cash payment. In this context we interpret the depreciation rate  $\delta$  as out-of-pocket expenses on repair and maintenance.

Estimating their housing market model on Danish data, Dam et al. (2011) found that the best fit was obtained for  $\theta = 0.6$ , suggesting that a substantial fraction of Danish home buyers are either liquidity-constrained or myopic. The model allows an estimate of the effects of financial innovation on house prices. For example, as mortgage loans with shorter interest-rate adjustment periods become available, the minimum interest rate  $i^s$  in (6.1) will tend to fall, and when home buyers get access to loans without amortization, the variable  $A$  drops to zero. According to the model, the resulting fall in the modified user cost was responsible for a major part of the strong increase in Danish house prices in the middle of the 2000s. This is illustrated in Figure 6.4. The blue line records the actual increase in house prices and the yellow line shows the estimated increase that would have occurred in case the new forms of housing finance had not been introduced (as indicated in the figure, the freezing of nominal property taxes introduced from 2002 also contributed to the Danish housing bubble).

**Figure 6.4 Actual Danish house prices and estimated house prices in counterfactual scenarios without new loan types and without the property tax freeze**



Source: Dam et al. (2011, Figure 3.4).

The Danish experience suggests that innovations in housing finance may have contributed significantly to the increase in Swedish house prices in recent years. To the extent that Swedish home buyers are credit-constrained and/or myopic, financial innovations may have reduced the perceived cost of owner-occupied housing. In that case the fundamental level of Swedish house prices may have increased. On the other hand, in the presence of credit constraints and myopia the recent 85 per cent cap on the loan-to-value ratio introduced by the Swedish Financial Supervisory Authority (Finansinspektionen) should tend to depress the fundamental house price level.

## 6.2 Property taxes and housing demand

Because of the lack of data, the effective property tax rate  $\tau$  was assumed to be constant in the quantitative analysis in sections 4 and 5. This subsection discusses the main changes in  $\tau$  that may have occurred in Sweden and what these changes may imply for the evaluation of the current state of the housing market.

In Sweden homeowners are subject to the recurrent property tax (fastighetsavgift), capital gains tax (which may be rolled over when the gain is reinvested in a new home) and stamp duties payable on real estate transactions. The effective property tax rate is defined as the annuity value of these various taxes measured relative to the current market value of the home. Until 2008 homeowners with total taxable wealth above a certain threshold were also subject to a wealth tax on their real estate.

In recent decades the effective property tax rate is likely to have changed significantly on at least two occasions. The first occasion was the “Tax Reform of the Century” implemented in 1990–1991. Before that reform Swedish homeowners paid income tax on an imputed rent calculated on the basis of the assessed property value. In addition, owner-occupied housing was subject to the four types of tax mentioned above. The 1990–1991 reform abolished the tax on imputed rent, but at the same time the recurrent property tax was raised from 0.47 per cent to 1.5 per cent of the assessed property value, and the capital gains tax was tightened. The net result of the tax reform was an increase in the tax burden on real estate, including owner-occupied housing (Ministry of Finance, 1991). After the reform the Swedish tax system implied a roughly neutral tax treatment of investment in owner-occupied housing and business investment (Finanspolitiska rådet, 2008, pp. 221–223).

The tax policy changes implemented in 2006–2008 constitute the other likely major change in the effective property tax rate. As mentioned, the wealth tax was scrapped in 2008, and the recurrent property tax was significantly reduced over the period 2006–2008. From 2008 the central government tax on immovable property was completely abolished and replaced by a very low property tax payable to the local municipality. Whereas the previous property tax was proportional to the assessed value of the property, the new property tax for villas is a fixed amount of 6,000 SEK per year, although with a cap equal to 0.75 per cent of the assessed property value. For apartment buildings the new property tax amounts to 1,200 SEK per apartment, with a cap of 0.4 per cent of the property value. For the bulk of all residential property, this reform means that the tax is no longer related to the market value of the property and that the recurrent property tax is significantly lower than before. To make up for part of the resulting revenue loss, the tax rate on realized capital gains on owner-occupied villas and apartments was raised from 20 to 22 per cent. To limit lock-in effects, taxpayers were previously allowed to defer all of their capital gains tax bill in so far as they reinvested their gains in a new residential property, but under the new rules the amount of gain that may be deferred is capped at 1.6 million SEK. Moreover, to limit the benefit from tax

deferral, taxpayers are obliged to include an imputed interest rate of 1.67 per cent of the deferred capital gain in their annual taxable capital income.

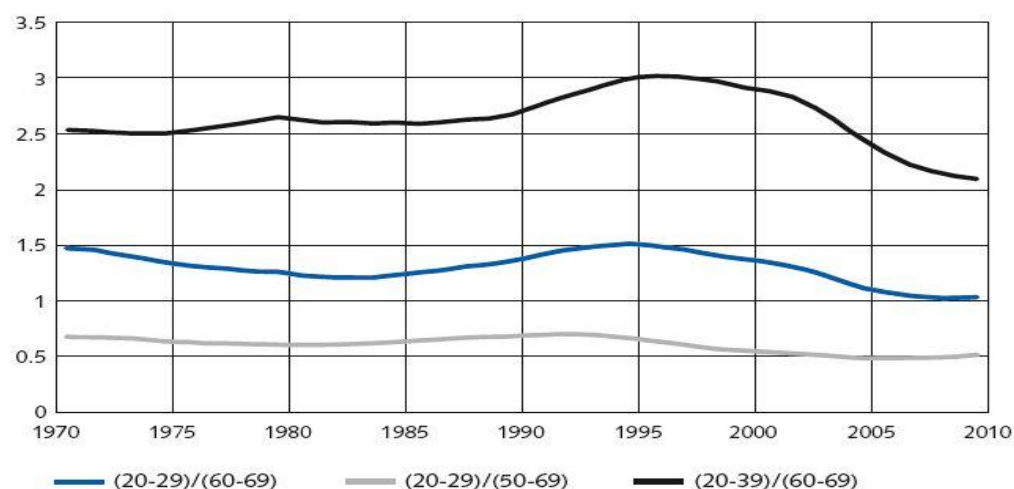
Despite this tightening of the capital gains tax, the net result of the 2008 property tax reform was that investment in owner-occupied housing is now much more lightly taxed than investment in business assets (Finanspolitiska rådet, 2008, p. 223). It is difficult to assess the magnitude of the drop in the effective property tax rate caused by 2008 property tax reform, since the annuity value of the realization-based capital gains tax depends on the expected number of years between ownership changes and the extent to which realized capital gains are reinvested. However, there is no doubt that the property tax reform tended to raise the fundamental level of house prices by reducing  $\tau$ . The estimates of fundamental house prices presented in section 5 do not account for this effect. This is another reason why our previous analysis may overstate the degree to which the Swedish housing market is currently overvalued.

### 6.3 Population and housing demand

The analysis in section 5 assumes that housing demand is determined by disposable incomes, user costs and rents. But aggregate housing demand may also be influenced by changes in the age structure of the population. Most people tend to move from smaller to larger homes until around the age of 40 as they establish families with children, and in a later stage of the life cycle they tend to move from larger to smaller homes. A larger share of young relative to old people may therefore tend to raise the aggregate demand for housing for any given level of incomes, user costs and rents.

Has Sweden experienced such a change in the population age structure that could help to explain the strong increase in house prices in recent years? According to Figure 6.5 the answer is: no! On the contrary, the proportion of people in the age groups 20–29 and 20–39 has fallen since 1995. If anything, this should have exerted a downward pressure on real house prices.

**Figure 6.5 The proportion of young people to old people in Sweden**

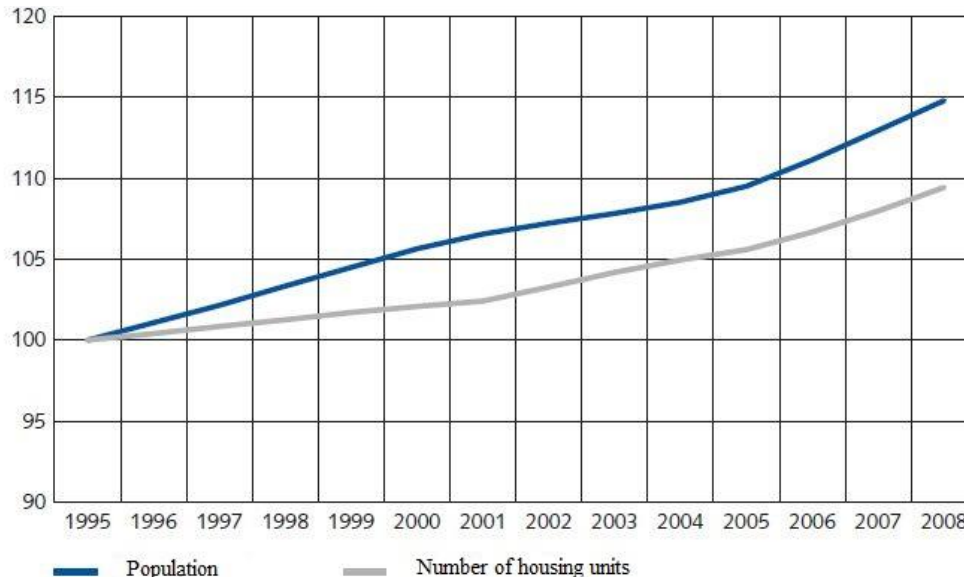


Source: Englund (2011, figure 15), based on data from Statistics Sweden.

However, as pointed out by Englund (2011, p. 45), international empirical studies have found it difficult to identify a stable relationship between the population age structure and house prices. The reason may be that such demographic changes occur rather slowly and are fairly predictable, so the construction industry may be able to adjust the supply of housing in time to accommodate the changes in housing demand without the need for significant price changes.

Even if the size and age structure of the population were constant, the average level of house prices might still be affected by migration flows. In recent decades the Swedish population has tended to concentrate more in the large metropolitan areas like Stockholm, Göteborg and Malmö. In such areas the supply of new housing may be relatively inelastic due to a shortage of land, whereas housing supply may be more elastic in the less densely populated provincial areas from where the migrants come. The upward pressure on house prices in the metropolitan areas with a rising population may therefore be greater than the downward pressure on prices in regions with a falling population. In that case migration towards the large cities will drive up the average level of house prices across the country as a whole. As we saw in Figure 2.2, the increase in house prices has indeed been very strong in the Swedish metropolitan areas. This is consistent with Figure 6.6 which shows that the Stockholm population has grown more rapidly since 1995 than the number of homes in the Stockholm area.

**Figure 6.6 Population and housing stock in Stockholm (1995=100)**



Source: Frisell and Yazdi (2010, figure 4), based on data from Statistics Sweden.

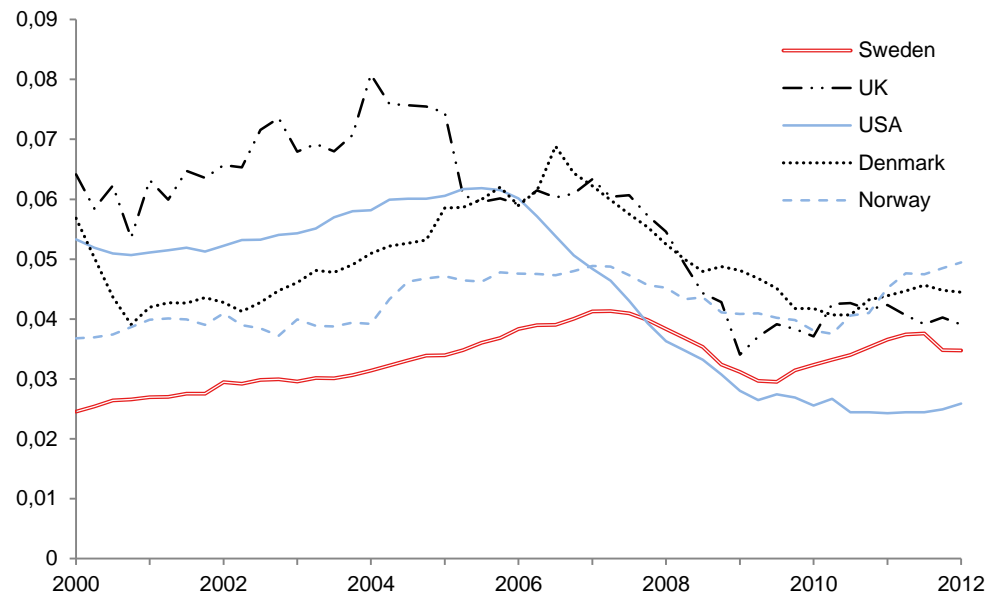
In summary, whereas the recent changes in the population age structure do not provide any explanation for the rapid increase in real house prices since the mid-1990s, the population shifts towards the large cities probably gave a boost to the average level of house prices, given the difficulties of expanding the

housing stock in the metropolitan areas. This observation points to the importance of the elasticity of housing supply which we consider below.

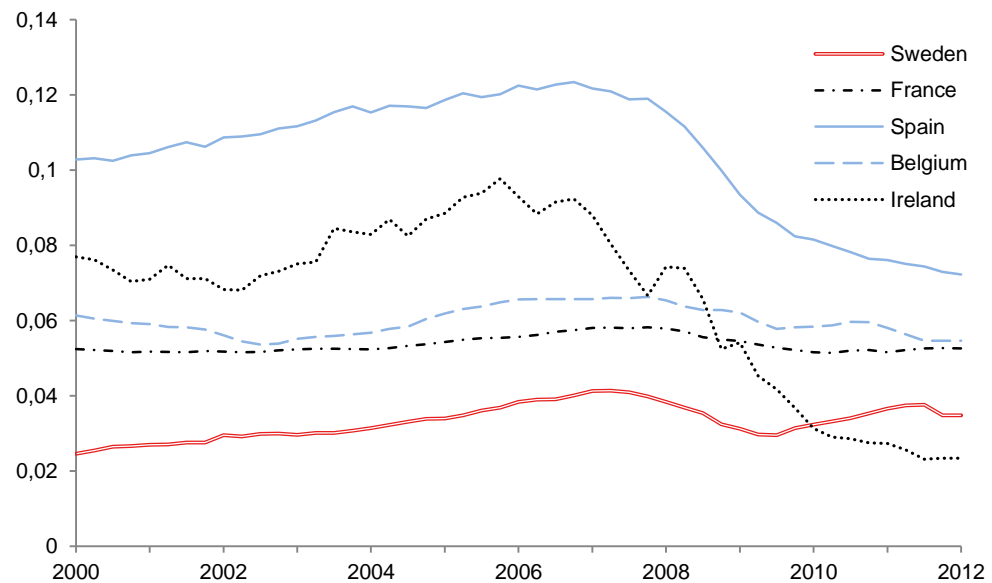
## 6.4 The supply side of the housing market: is Sweden special?

Despite the rapid increase in house prices, the ratio of housing investment to GDP has remained lower in Sweden than in most other countries, as shown in Figure 6.7a and 6.7b.

**Figure 6.7a Ratio of housing investment to GDP in selected OECD countries**



**Figure 6.7b Ratio of housing investment to GDP in selected OECD countries**



Sources for both figures: OECD.



On this basis many observers conclude that the elasticity of housing supply has recently been quite low in Sweden (see, for example, Englund, 2011, p. 48). One might therefore worry whether we will see a delayed supply response, that is, a large future increase in Swedish construction activity which will cause a big drop in future house prices. However, as we shall see below, there is no basis for claiming that housing supply in Sweden has recently been very inelastic by international standards.

In section 2 we explained that housing investment is likely to increase with the ratio of house prices to construction costs, sometimes denoted “Tobin’s Q” for the housing market. The Swedish data displayed in Figure 6.8 lend some support to this hypothesis.

**Figure 6.8 Housing investment (index) and the ratio of house prices to construction costs (Tobin’s Q) in Sweden**



Source: Englund (2011, figure 18).

For a given level of Tobin’s Q, one would also expect the absolute volume of housing investment to vary in proportion to the size of the economy, measured by GDP. A simple housing investment function capturing these ideas is:

$$\frac{I}{Y} = a \cdot \left(\frac{P}{C}\right)^b \quad (6.2)$$

The variable  $I$  is real housing investment,  $Y$  is GDP,  $P$  is the level of real house prices,  $C$  is the level of real construction costs, and  $a$  and  $b$  are positive constants. The parameter  $b$  is the elasticity of the housing investment ratio  $I/Y$  with respect to Tobin’s Q for the housing market ( $P/C$ ). Now suppose that, at time zero, the house price level is  $P_0$ . By definition, the level of real house prices at time  $t$  will then be

$$P_t = P_0 e^{xt}, \quad (6.3)$$

where  $e$  is the exponential function and  $x$  is the average growth rate of real house prices between time zero and time  $t$ . Similarly, if  $C_0$  is the level of construction costs at time zero, the construction cost level at time  $t$  will be

$$C_t = C_0 e^{gt}, \quad (6.4)$$

where  $g$  is the average growth rate of real construction costs over the time span considered. By inserting (6.3) and (6.4) in (6.2), taking logarithms, and calculating differences, one finds that

$$\frac{\Delta \ln(I/Y)}{\Delta \ln P} = b \left( 1 - \frac{g}{x} \right), \quad (6.5)$$

$$\Delta \ln(I/Y) \equiv \ln(I_t/Y_t) - \ln(I_0/Y_0), \quad \Delta \ln P \equiv \ln P_t - \ln P_0.$$

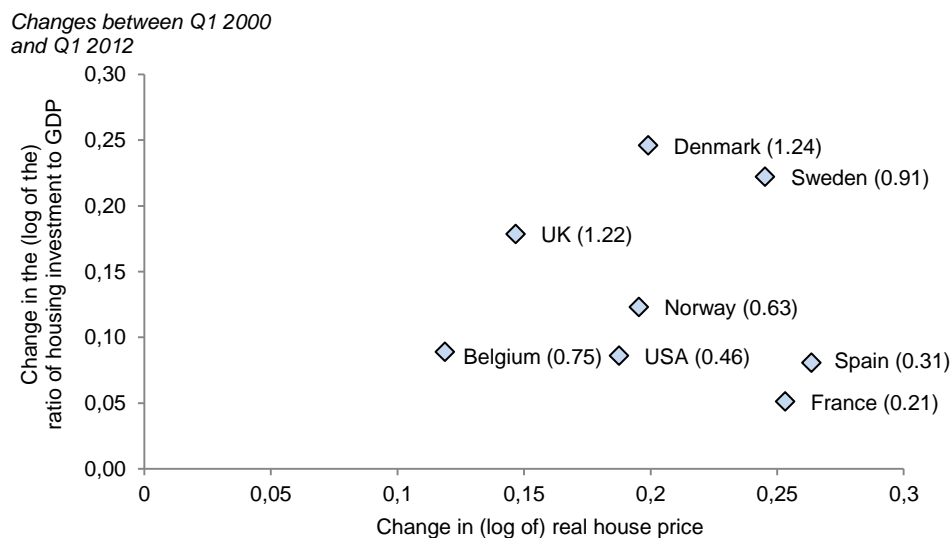
The magnitudes  $\Delta \ln(I/Y)$  and  $\Delta \ln P$  reflect the relative changes in the housing investment ratio and the level of house prices, respectively. Figure 6.9 plots these variables for Sweden and a number of other OECD countries, using the first quarter of 2000 as the starting point and the first quarter of 2012 as the end point. The number in brackets indicated for each country is the ratio between  $\Delta \ln(I/Y)$  and  $\Delta \ln P$ . According to equation (6.5) a relatively low value of this ratio could reflect either a low elasticity of housing investment with respect to Tobin's  $Q$  (a low value of  $b$ ) or a relatively high ratio of construction cost inflation to house price inflation (a high value of  $g/x$ ). In both cases we might say that the supply side of the housing market is relatively inflexible.<sup>17</sup>

Measured in this way we see from Figure 6.9 that the Swedish construction industry has in fact responded fairly vigorously to the boom in house prices over the last decade, compared to the response of housing investment to house price changes in other countries. Among the countries considered, only Denmark and the UK saw a stronger reaction of housing investment to house price inflation than Sweden. In a country like the US the response of residential investment to house prices was only half as strong as in Sweden.

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<sup>17</sup> In particular, a high value of  $g/x$  suggests that workers and entrepreneurs in the building industry are good at converting a rise in house prices into higher wages and profits for themselves rather than into higher building activity.

**Figure 6.9 The reaction of housing investment ratios to changes in real house prices**



Note: The numbers in brackets show the value of the fraction stated on the left-hand side of eq. (6.5).  
Source: Own calculations, based on OECD data.

This analysis highlights the importance of distinguishing between the average *level* of the housing investment ratio over the economic cycle and the *change* in the investment ratio induced by a change in house prices. Since the big construction boom in the late 1980s and early 1990s (see Figure 6.8) the average level of housing investment in Sweden has been relatively low by international standards, but it has responded quite significantly to the rise in house prices in recent years. *Ceteris paribus*, a more flexible housing supply dampens the long run fluctuations in house prices. The brief cross-country study above therefore gives no reason to believe that the Swedish housing market is particularly prone to house price fluctuations due to rigidities on the supply side of the market. If anything, the analysis suggests the opposite.<sup>18</sup>

## 6.5 Downside risks and potential threats to financial and real economic stability

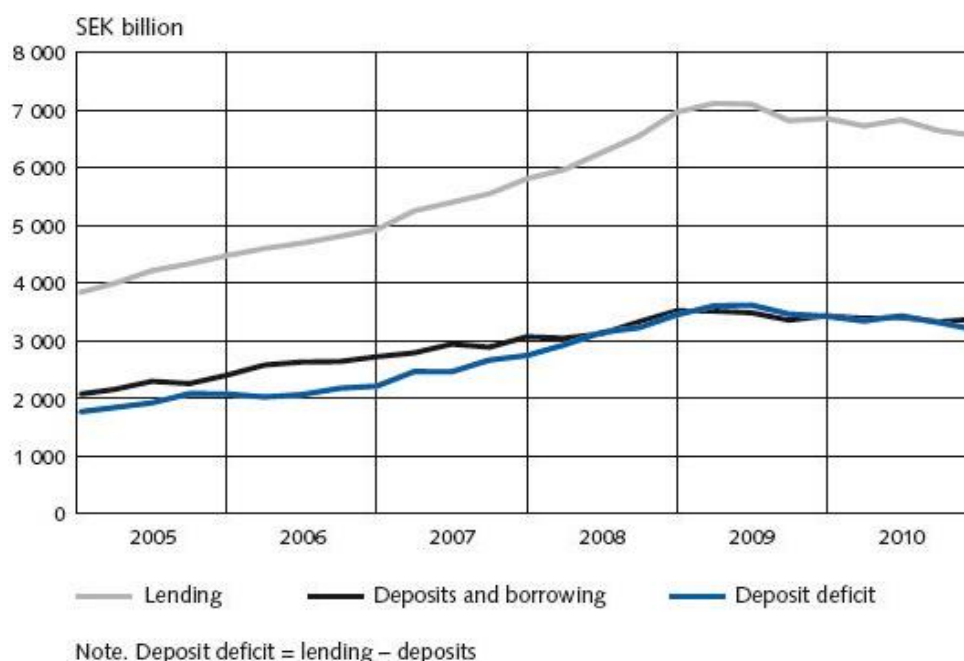
The econometric analysis in section 5 indicates that although Swedish house prices may currently be significantly above the long-run fundamental house prices, the adjustment towards the fundamental price level is likely to be slow and gradual. However, if the Swedish economy were hit by some unexpected negative shock, the resulting downturn in the housing market is likely to be stronger and faster in a situation where house prices seem overvalued from a long-run perspective. Against this background, this subsection will briefly discuss how a serious decline in house prices would affect the financial sector and the real economy.

<sup>18</sup> One caveat to this conclusion is the Swedish system of urban planning which tends to create a longer lag between planning and building than in most other countries, as emphasized by Hüfner and Lundsgaard (2007).

A fall in house prices would have a direct effect on financial stability through its immediate impact on financial sector balance sheets and an indirect effect via the fall in economic activity. The direct effect on financial stability would work mainly through the market for covered bonds. As illustrated in Figure 6.10, the major Swedish banks have a large deposit deficit, i.e., their total lending exceeds their total deposits by a substantial amount. A large part of this deficit is financed by the issue of covered bonds.

A covered bond is a claim on the issuing institution. If the issuer is unable to meet its obligations, the holder of the bond has priority access to the cash flows from the so-called “cover pool” which consists of specially-selected collateral linked to the bonds. In Sweden the cover pool for covered bonds consists mainly of mortgage loans granted to Swedish homeowners. More than a third of Swedish covered bonds is held by foreign investors; most of the rest is held by Swedish insurance companies, banks and other financial institutions. The foreign investors are themselves mainly financial institutions.

**Figure 6.10 Lending and deposits of the major Swedish banks**



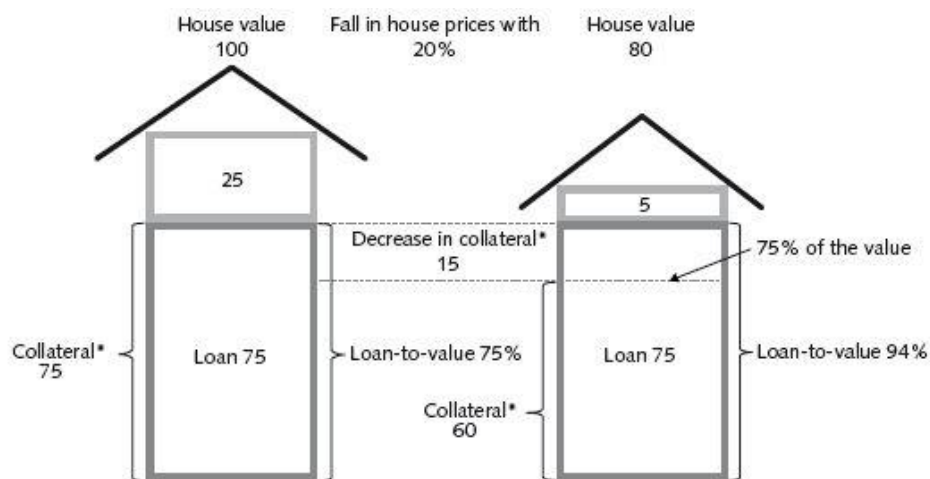
Source: Janzén et al. (2011, diagram 7).

The loans in the cover pool remain on the balance sheet of the issuing (mortgage) bank. According to the law only loans up to a limit of 75 per cent of the current market value of the mortgaged residential property may be included in the cover pool. Further, a loan must be removed from the cover pool if the borrower is late in paying. Because of these regulations, covered bonds are perceived as high-quality assets and all Swedish covered bonds are currently given an AAA rating.

Figure 6.11 shows how the cover pool is affected by a drop in house prices in the case where a mortgage loan amounting to 75 per cent of the initial property value of 100 was granted and included in the cover pool. If the market value of

the house drops to 80, the mortgage bank is only allowed to include 75 per cent of this amount (=60) in the cover pool. In other words, the contribution to the cover pool from this particular mortgage loan falls by 15 (=75-60), that is, by 20 per cent of the initial pool of 75.

**Figure 6.11 Effect on cover pool of a drop in house prices when the initial loan-to-value ratio is 75 per cent**



\* Collateral eligible for cover pool

Source: Janzén et al. (2011, diagram 6).

If a fall in house prices reduces the bank's cover pool to a level below the value of the covered bond issue, the bank must add so-called substitute assets to the pool. The substitute assets must be high-quality assets such as loans to municipalities and the central government or cash reserves obtained from the sale of liquid assets. The example in Figure 6.11 shows that if the cover pool corresponds to the maximum loan-to-value ratio of 75 per cent, a drop in house prices by, say, 20 per cent will also reduce the cover pool by 20 per cent. If banks had already fully exhausted their cover pool through bond issues before the drop in house prices occurred, they would then have to add a corresponding amount to the pool. This could easily cause a liquidity squeeze on the banking system.

The potential for a liquidity crisis is exacerbated by the maturity mismatch between the covered bonds and the underlying mortgage loans in the cover pool. The mortgage loans are typically granted for a period of 20-30 years, whereas the covered bonds issued by banks usually have a maturity of 3-5 years. This creates a refinancing risk as the covered bonds have to be rolled over.

However, according to Janzén et al. (2011) the cover pools of Swedish banks only amount to between 40 and 60 per cent of property values. Moreover, the cover pools exceed the value of covered bond issues by a considerable amount: the excess of the aggregate pool over aggregate bond issues amounted to 45 per cent of the value of outstanding bonds in 2011. Janzén et al. (2011) estimate that a 20 per cent decline in house prices would reduce this so-called

over-collateralisation by about 10 percentage points. These numbers suggest that even a large drop in house prices would not trigger a serious liquidity crisis for the Swedish banking system.

Still, as emphasized by Janzén et al. (2011), the experience from the recent international financial crisis indicates that a serious drop in Swedish house prices would increase the perceived risk associated with Swedish covered bonds. This would make it more difficult and expensive for Swedish banks to refinance their covered bond issues, resulting in a tightening of credit conditions in the Swedish economy. Such a scenario would be particularly likely if a downturn in the Swedish housing market were to occur simultaneously with renewed international financial and economic turmoil.

Moreover, in addition to the direct negative impact on Swedish banks through the market for covered bonds, a housing market downturn would have a negative indirect effect on financial and economic stability via its impact on the macro economy. It is well documented that a fall in house prices reduces private consumption by reducing household wealth. As we have seen above, a drop in house prices also tends to reduce the volume of housing investment by lowering the value of Tobin's Q for the housing market. When economic activity declines in response to falling consumption and investment demand, banks will experience increased credit losses as some households and firms will be unable to service their debts. This will further undermine financial stability. As credit risks increase and the value of the collateral offered by debtors declines, a tightening of credit conditions will follow, adding further downward pressure on economic activity. The central bank may counteract these contractionary forces by lowering the policy interest rate, but only as long as it does not hit the zero bound on the nominal interest rate.

Claussen et al. (2011) simulate two alternative models of the Swedish economy in an attempt to quantify the macroeconomic effects of a 20 per cent drop in house prices triggered by an exogenous drop in the demand for housing. The interpretation of this scenario is that households suddenly lose their confidence in the sustainability of current house prices ("the housing bubble bursts"). When evaluated by means of the Dynamic Stochastic General Equilibrium model of the Swedish economy developed by Walentin and Sellin (2010), such a shock to house prices reduces GDP by 1.1 per cent in the year following the shock, but GDP starts to recover slowly already in the second year after the shock, in part due to a cut in the monetary policy interest rate. However, this model does not account for the credit losses in the banking sector that would almost surely occur as a result of the downturn, so it probably underestimates the negative impact of the collapse in house prices.

Claussen et al. (2011) therefore also simulate the effects of the drop in house prices in a so-called Bayesian Vector Autoregressive (BVAR) model which describes the interaction between house prices, consumer prices, GDP and the interest rate on short-term government bonds observed historically in the Swedish economy. According to this model a 20 per cent decline in house prices would cause a 2.0 per cent drop in GDP in the first year and a further 0.2 per cent decline in the second year. If the drop in house prices were instead triggered by a downturn of the business cycle rather than being purely

exogenous, the fall in GDP would be 2.3 per cent in the first year and a further 1.3 per cent in the second year after the shock.

Even though the negative effects predicted by the BVAR model are by no means negligible, they still seem relatively small, considering that a 20 per cent decline in house prices in a single year is indeed a very large shock to the housing market. The relatively modest effect may partly reflect that housing investment makes up a smaller fraction of GDP in Sweden than in most other countries. But the experience from the recent financial crisis also suggests that standard economic models are not very good at accounting for economic fluctuations when the economy is hit by large shocks outside the normal range of variation. In exceptional times a loss of confidence may trigger strong negative and highly non-linear feedback loops between the financial sector and the real economy that are not captured by standard economic models. Therefore, if the Swedish housing market were to turn down in reaction to an international economic and financial crisis, the negative impact on the Swedish economy would probably be larger than suggested by the model simulations reported above.

## 7 Summary and conclusions

### 7.1 Summary of main findings

After having fluctuated around a roughly constant long-run trend from the early 1950s to the mid-1990s, real house prices in Sweden rose at an average annual rate of almost 6 per cent between 1995 and 2011. Many observers therefore worry whether the Swedish market for owner-occupied housing is now seriously overvalued so that the Swedish economy may be headed for a large drop in house prices.

The present report adopted several alternative approaches in an attempt to answer this difficult question. As a starting point, *Section 2* investigated whether a permanent upward trend in real house prices could really be sustainable in the long run? The main reason for expecting a secular increase in real house prices is that real land prices are likely to trend upwards as land becomes increasingly scarce. The analysis showed that real house prices could indeed go on increasing over time without forcing households to spend an ever larger share of their budgets on housing expenses, provided the income and price elasticities of housing demand are roughly equal to one. Such a scenario would require that the real housing stock grows at a slower pace than real disposable income. We saw that this has in fact been the case in Sweden since the mid-1980s. At the same time we noted that the average annual increase in real house prices in Sweden since the mid-1990s seems to be well above the rate that could be sustained in the long run.

*Section 3* gave a selective review of the economic theory of housing bubbles as a basis for discussing whether Sweden currently experiences such a bubble. A housing bubble may be said to exist if house prices deviate significantly from the level implied by the relevant economic fundamentals like interest rates and income and if this deviation does not reflect the normal time lags and market frictions that prevent an instantaneous adjustment of house prices to their equilibrium level. Our review of the literature showed that housing bubbles are most likely to occur when interest rates are unusually low, as is currently the case.

In operational terms, one may fear the existence of a housing bubble if current house prices significantly exceed the level predicted by the best available econometric models of the housing market. We therefore considered an econometric model of Swedish house prices recently developed in Sveriges Riksbank. According to this model the boom in Swedish house prices since the mid-1990s may be very well explained by the evolution of disposable income, the after-tax real interest rate and financial household wealth. Based on a macroeconomic forecast, the model predicts only a modest decline in real house prices over the next few years. However, we argued that the model may not be a reliable predictor of future house prices because it implies an implausibly strong response of house prices to income growth. To maintain a constant budget share of housing expenses, the model requires that the real housing stock will have to *fall* over time as real income grows. Such a scenario



seems unlikely. The strong estimated response of house prices to incomes may reflect that both of these variables have been influenced by a third omitted variable over the estimation period. We speculated that the omitted variable could be large swings in expected future income growth, driven by the large medium-term fluctuations in Swedish economic activity during most of the estimation period from the mid-1980s until today.

*Section 4* turned to another method of evaluating the state of the housing market, based on the concepts of the user cost of housing and the imputed rent. The user cost is the cost of the housing service obtained by investing one krona in a home. It consists of the after-tax real interest rate on mortgage loans plus additional terms capturing depreciation, property taxes, credit constraints, and a risk premium. At the same time any expected real capital gain on a house reduces its user cost. For the purpose of empirical analysis, the factors other than the real after-tax interest rate were assumed to be constant, since they are hard to observe. The imputed rent is the real cost of the housing service flowing from a physical unit of owner-occupied housing. It is given by the product of the user cost and the real house price per physical housing unit.

Since the alternative to owning is renting, one may expect that a high level of imputed rents relative to the rents charged in the rental housing sector will put downward pressure on house prices by reducing the demand for owner-occupied housing, and vice versa. *Section 4* therefore considered the evolution of the ratio of imputed rents to actual rents in Sweden since the beginning of 1980. In early 2012 this ratio was about 9 per cent above its average level over the entire period since 1980, suggesting a slight overvaluation of current house prices.

We also considered the evolution of the ratio of imputed rent to disposable household income. A relatively high value of this ratio indicates that owner-occupied housing is less affordable than normally so that house prices may be expected to fall, and vice versa. Our analysis revealed that in early 2012 the imputed rent/income ratio was actually slightly below its average value since 1980. Overall, the empirical exercises in *Section 4* did not suggest that Swedish houses are currently overpriced to any significant degree.

Because the user cost includes the expected real capital gain on owner-occupied housing, the demand for such housing – and hence the current level of house prices – will depend inter alia on expected future house prices. The analysis in sections 3 and 4 did not enable us to evaluate whether current Swedish house prices are based on realistic expectations about the future evolution of house prices. To make up for this shortcoming, *Section 5* presented estimates of the level of fundamental house prices, defined as the equilibrium house price that would prevail if households had rational expectations about the fundamental variables such as the future levels of incomes, interest rates and rents that will determine the future value of the housing service delivered by their house. More precisely, the fundamental house price is the present value of the rationally expected future imputed rents, where the discount rate is given by the user cost excluding the expected capital gain.

We considered two alternative hypotheses about the way in which expectations about future imputed rents are formed. In our so-called “rent model” we assumed that imputed rents are expected to move in line with the level of rents in the market for rental housing. In our “Supply-and-Demand (S-D)” model we assumed instead that future imputed rents are expected to settle at the level that will equate housing demand (which depends on future disposable incomes and future imputed rents) with housing supply (which is proportional to the future housing stock). In line with the idea of rational expectations, we assumed that households forecast the future level of rents, incomes and housing stocks as if they were using an empirical Vector Autoregression Model of the historical interactions among these variables as well as their interaction with the actual real house price. Our estimation procedure also assumed that the average level of fundamental house prices corresponded to the average level of actual house prices over the estimation period from the first quarter of 1986 to the first quarter of 2012. In other words, we assumed that house prices were neither systematically overvalued nor undervalued relative to their fundamental level over this period.

The two models of fundamental house prices suggested that actual real house prices in Sweden were between 12 and 18 per cent above the fundamental house prices in early 2012. According to the S-D model current house prices could even be further above the fundamental level if the long-run income elasticity of housing demand is significantly smaller than one, as some earlier Swedish studies have suggested. However, the analysis in Section 5 also revealed that although fundamental house prices do serve as a driver of and an “anchor” for actual house prices in the long run, the actual prices adjust rather slowly and gradually towards the fundamental level. Thus the analysis of Section 5 did not suggest an imminent collapse of the Swedish housing market, although it did indicate that the market is currently overvalued.

In *Section 6* we finally considered a number of other factors that could modify the conclusion of the previous section. Based on recent empirical evidence from Denmark, we argued that the innovations in housing finance over the last 10-15 years have probably increased equilibrium house prices by loosening liquidity and credit constraints. The lowering of the effective level of property taxes since 2006 has likewise tended to increase fundamental house prices by lowering user costs. The continued migration of people towards the large cities may also tend to drive up the average house price level for the country as a whole because housing supply is likely to be less elastic in the metropolitan areas than in the thinly populated provincial regions from where people migrate. For all of these reasons the Swedish housing market may be less overvalued than indicated by the analysis in Section 5.

We also considered the role of the supply side of the Swedish housing market. Since the ratio of housing investment to GDP is still lower in Sweden than in many other countries despite the recent surge in house prices, one might worry whether we are likely to see a delayed increase in building activity that would cause a sharp drop in house prices as a result of a strong future increase in housing supply. However, our analysis showed that construction activity in Sweden has in fact responded more elastically to the rise in house prices than

observed in many other OECD countries. This does not suggest a significant risk of a large delayed increase in housing supply.

Despite the modifying factors mentioned above, the findings of Section 5 suggest that the Swedish housing market could take a serious downturn if the Swedish economy were hit by an unexpected negative shock, say, due to renewed international economic and financial turmoil. In that case there could be a direct negative effect on financial stability in Sweden via the market for covered bonds and a negative indirect effect on economic and financial stability via the fall in macroeconomic activity. However, as discussed in Section 6, the value of the collateral (cover pools) backing up Swedish covered bonds exceeds aggregate bond issues by a considerable amount and the aggregate outstanding mortgage loans included in the cover pools add up to considerably less than the maximum loan-to-value ratio of 75 per cent allowed by the law. This suggests that the Swedish covered bond market could withstand a substantial drop in house prices without forcing Swedish banks into a serious liquidity crisis, although some tightening of credit conditions must be expected as banks find it more expensive to roll over their issues of covered bonds.

Section 6 also reported model simulations by Sveriges Riksbank of the fall in macroeconomic activity in case of a large unexpected drop in Swedish house prices. The simulations suggest a relatively modest negative impact on Swedish GDP. This may partly reflect the relatively small size of the construction sector in Sweden. However, the experience from the recent financial crisis has shown that standard economic models are not very good at accounting for economic fluctuations when the economy is hit by large shocks outside the normal range of variation. In exceptional times a loss of confidence may trigger strong negative feedback loops between the financial sector and the real economy that are not captured by standard economic models. Therefore, if the Swedish housing market were to turn down in reaction to an international economic and financial crisis, the negative impact on the Swedish economy would probably be larger than suggested by the model simulations reported in Section 6.

## 7.2 Conclusion

Weighting all the evidence summarized above in an overall judgement of the current state of the Swedish housing market is difficult. The empirical house price model discussed in Section 3 and the estimates of the ratios of imputed rents to rents and incomes presented in Section 4 do not indicate that Swedish house prices were overvalued to any significant degree in 2012. However, the analysis of fundamental house prices in Section 5 has a stronger theoretical foundation, and the empirical analysis in that section indicated that actual house prices do in fact move towards the fundamental price level, albeit slowly and gradually. According to the estimates in Section 5, house prices in 2012 were about 15 per cent above their fundamental level, and possibly more. Although this estimate is rather uncertain, and even though the analysis of Section 6 pointed to several neglected factors that could have raised

fundamental house prices in recent years, a cautious reading of the evidence gives reason to expect downward pressure on Swedish real house prices in the years to come.

And if the Swedish economy were to be hit by a large negative shock, the downward adjustment of house prices could become more rapid than the analysis of Section 5 would suggest.

## Appendix: User costs, uncertainty and borrowing constraints

Section 4 of this report introduced an expression for the real user cost of owner-occupied housing, allowing for credit constraints and uncertainty regarding future house prices. The present appendix documents how this user cost expression may be derived from a model of optimal consumer behaviour. For simplicity, we consider a two-period model, but similar results could be derived from a more general model where the consumer lives for many periods.

We use the following notation:

$P_t$	=	real price of a unit of owner-occupied housing at the end of period $t$ , ( $t = 1,2$ )
$H$	=	physical housing stock
$C_t$	=	real consumption of other goods during period $t$ , ( $t = 1,2$ )
$Y_t$	=	real after-tax labour and transfer income in period $t$ , ( $t = 1,2$ )
$S$	=	net financial saving measured in real terms
$D$	=	net financial debt measured in real terms
$r$	=	risk-free real interest rate after tax
$\tau$	=	property tax rate
$\delta$	=	rate of depreciation of the housing stock
$\mu$	=	risk premium in user cost
$\theta$	=	rate of time preference
$\rho$	=	coefficient of relative risk aversion
$E[X]$	=	expected value of variable $X$ , given the information available in period 1

### A simple model of consumer behaviour

We consider a consumer whose life cycle is divided into two periods, indicated by subscripts 1 and 2. During the first period he does not own a house, so his first-period utility is  $u(C_1)$ , where the consumption aggregate  $C_1$  may be taken to include consumption of rental housing services, but no services from owner-occupied housing.

At the end of period 1 the consumer buys a house, so during period 2 he consumes a flow of owner-occupied housing services in proportion to the housing stock, generating a utility flow  $h(H)$ . He also consumes other goods and services during period 2, yielding utility  $u(C_2)$ . At the end of period 2 the consumer sells his house and consumes the proceeds along with any net financial wealth he may have accumulated. When he buys the house at the end of period 1, the consumer does not know its stochastic future sales price; he

only knows its probability distribution. Hence the exact amount which can be spent on other goods in period 2 is uncertain ex ante, so the consumer makes his savings decision and housing investment decision with the purpose of maximizing his expected lifetime utility,  $E[U]$ , given by

$$E[U] = u(C_1) + \frac{E[u(C_2)]}{1+\theta} + \frac{h(H)}{1+\theta},$$

$$u' > 0, \quad u'' < 0, \quad h' > 0, \quad h'' < 0 \quad (1.1)$$

Note that since all variables other than the end-of-period 2 house price are non-stochastic, there is no uncertainty regarding the variables  $C_1$  and  $H$ , and hence no uncertainty regarding the utility flows  $u(C_1)$  and  $h(H)$ . Notice also that these flows are discounted at the time preference rate  $\theta$  since they accrue in the future.

The savings undertaken during the first period may be invested in financial assets, or they may be used to purchase a house at the real house price  $P_1$  prevailing at the end of period 1, where house prices are measured in units of the numeraire good  $C$ . Thus the first-period budget constraint is

$$S + P_1H = Y_1 - C_1, \quad (1.2)$$

The consumer may go into debt in order to finance his housing investment. However, we assume that a home buyer faces a down-payment constraint which means that he must have accumulated net savings amounting to at least a fraction  $\alpha$  of the value of the house. In other words, the consumer faces the restriction

$$Y_1 - C_1 \geq \alpha P_1H, \quad \alpha \geq 0. \quad (1.3)$$

During the second period the housing stock depreciates at the rate  $\delta$ . To maintain the house until the end of the period the consumer must therefore incur the maintenance expenses  $\delta P_1H$ .<sup>19</sup> In period 2 the consumer must also pay property tax at the rate  $\tau$  based on the value of the house at the time of purchase, so his property tax bill in period 2 is  $\tau P_1H$ . At the end of the second period he sells the house at the unit price  $P_2$  and consumes the proceeds. He also pays back his debt with interest and consumes whatever net financial wealth he previously accumulated, plus the interest accrued. Hence the consumer's budget constraint for the second period is

$$C_2 = (1+r)S + P_2H + Y_2 - (\tau + \delta)P_1H, \quad (1.4)$$

where  $r$  is the risk-free after-tax real interest rate. Using (1.2) to eliminate  $S$  from (1.4), we can write the consumer's intertemporal budget constraint as

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<sup>19</sup> We assume here that the price of replacing a unit of housing is  $P_1$ , corresponding to the price of a housing unit at the time of the initial purchase. In other words, the house price is assumed to stay constant until the end of period 2 where it changes to  $P_2$ .

$$C_2 = (1+r)(Y_1 - C_1) + Y_2 - \hat{c}P_1H,$$

$$\hat{c} \equiv r + \tau + \delta - \left(\frac{P_2 - P_1}{P_1}\right). \quad (1.5)$$

The variable  $\hat{c}$  is the real user cost of housing in the absence of risk and borrowing constraints. We wish to derive a user cost expression that allows for these factors. To do so, we use (1.5) to eliminate  $C_2$  from the utility function (1.1). We then maximize the resulting expression with respect to  $C_1$  and  $H$ , subject to the down-payment constraint (1.3). This exercise leads to the following first-order conditions, where  $\lambda$  is the Lagrange multiplier associated with the credit constraint:

$$u'(C_1) = \left(\frac{1+r}{1+\theta}\right) E[u'(C_2)\hat{c}P_1] + \lambda, \quad (1.6)$$

$$h'(H) = E[u'(C_2)\hat{c}P_1] + \alpha\lambda(1+\theta)P_1. \quad (1.7)$$

Whenever the down-payment constraint is binding,  $\lambda$  will be positive; in a perfect capital market it would be zero. We will now rewrite (1.7) to obtain an expression for the user cost of owner-occupied housing.

We start by noting from (1.5) that second-period consumption can be written as a function of the realized relative capital gain on housing, denoted by  $g$ :

$$C_2(g) \equiv (1+r)(Y_1 - C_1) + Y_2 - (r + \tau + \delta)P_1H - gP_1H, \quad g \equiv \frac{P_2 - P_1}{P_1} \quad (1.8)$$

From (1.8) we see that

$$C_2'(g) = P_1H. \quad (1.9)$$

Using the definitions of  $\hat{c}$  and  $g$ , we can define the function

$$u'(C_2)\hat{c}P_1 = u'(C_2(g))(r + \tau + \delta - g)P_1 \equiv f(g). \quad (1.10)$$

According to (1.9) and (1.10), the first derivative of this function is

$$f'(g) = u''(C_2(g))(r + \tau + \delta - g)P_1^2H - u'(C_2(g))P_1. \quad (1.11)$$

For convenience, we assume that the consumer has constant relative risk aversion so that

$$\rho \equiv -\frac{C_2 u''(C_2)}{u'(C_2)} \quad (1.12)$$

is a constant.

We may then write the derivative in (1.11) as

$$f'(g) = -u'(C_2(g)) \left[ 1 + \rho \frac{(r+\tau+\delta)P_1H}{c_2(g)} \right] P_1. \quad (1.13)$$

Exploiting (1.12) and (1.13), we find after some manipulations that

$$f''(g) = \left( \frac{\rho\beta}{\hat{c}} \right) [2 + (1 + \rho)\beta] u'(C_2), \quad \beta \equiv \frac{cP_1H}{c_2}, \quad (1.14)$$

where  $\hat{c}$  is defined in (1.5), and  $\beta$  is second-period spending on housing relative to spending on other goods. Let us now make the following second-order Taylor approximation of the expression  $u'(C_2)cP_1$  around the point  $g = \bar{g}$ , where  $\bar{g} \equiv E[g]$  is the expected relative capital gain on the house,  $\bar{C}_2 = C_2(\bar{g})$  is the expected level of consumption of non-housing goods in period 2, and  $\bar{c} \equiv E[\hat{c}] = r + \tau + \delta - \bar{g}$  is the expected user cost (still abstracting from risk and borrowing constraints):

$$\begin{aligned} u'(C_2)\hat{c}P_1 &\equiv f(g) \approx f(\bar{g}) + f'(\bar{g})(g - \bar{g}) + \frac{f''(\bar{g})}{2}(g - \bar{g})^2 = u'(\bar{C}_2)\bar{c}P_1 - \\ u'(\bar{C}_2) &\left[ 1 + \rho \frac{(r+\tau+\delta)P_1H}{\bar{c}_2} \right] P_1(g - \bar{g}) + \left( \frac{\rho\beta}{\bar{c}} \right) \left[ 1 + \left( \frac{1+\rho}{2} \right) \beta \right] u'(\bar{C}_2)(g - \bar{g})^2. \end{aligned} \quad (1.15)$$

Taking the expected value of the expression in (1.15), we find

$$\begin{aligned} E[u'(C_2)\hat{c}P_1] &\approx u'(\bar{C}_2)P_1 \left( \bar{c} + \rho\beta \left[ 1 + \left( \frac{1+\rho}{2} \right) \beta \right] \frac{\sigma_g^2}{\bar{c}P_1} \right), \\ \sigma_g^2 &\equiv E[(g - \bar{g})^2], \end{aligned} \quad (1.16)$$

where  $\sigma_g^2$  is the variance of the relative capital gain on the house. Inserting (1.16) into the first-order condition (1.7), rearranging, and using the definition of  $\bar{c}$ , we end up with the following expression,

$$\frac{h'(H)}{u'(\bar{C}_2)} = P_1(r + \mu + \tau + \delta - \bar{g} + \alpha m), \quad (1.17)$$

where

$$\mu \equiv \rho\beta \left[ 1 + \left( \frac{1+\rho}{2} \right) \beta \right] \frac{\sigma_g^2}{\bar{c}P_1}, \quad (1.18)$$

and

$$m \equiv \frac{\lambda(1+\theta)}{u'(\bar{C}_2)}. \quad (1.19)$$

The left-hand side of (1.17) is the marginal rate of substitution between consumption of owner-occupied housing and other consumption, measuring how much the consumer would be willing to pay for an additional unit of owner-occupied housing, given his expected level of other consumption. Optimal consumer behaviour implies that this marginal willingness to pay



equals the actual relative price of the services from owner-occupied housing, stated on the right-hand side of (1.17). The bracket on the right-hand side gives the expression for the user cost we were looking for, accounting for risk and credit constraints. The parameter  $\mu$  in (1.17) is a risk premium motivated by the uncertainty regarding future house prices. From (1.18) we see that the risk premium increases with the consumer's risk aversion, measured by  $\rho$ , with the budget share of housing costs,  $\beta$ , and with the variance of future house prices relative to the expected user cost in the absence of risk and credit constraints,  $\sigma_g^2/\bar{c}P_1$ . All of this is very intuitive.

The parameter  $m$  appearing in (1.17) and defined in (1.19) measures the consumer's marginal willingness to pay for the ability to borrow an extra krona at the time he buys his house. We see that this marginal willingness to pay is scaled up by the rate of time preference ( $\theta$ ) because the extra debt only has to be repaid later. If there is no down-payment constraint so that  $\alpha = 0$ , we see from (1.17) that the term including  $m$  drops out of the user cost formula, since in that case the consumer can borrow as much as he likes for the purpose of buying a house. Again this is quite intuitive.

The more the down-payment constraint is binding, the larger the value of  $m$  will be. We may use the first-order condition (1.6) to throw some further light on the determinants of  $m$ . For this purpose we define the function

$$z(g) \equiv u'(C_2(g)). \quad (1.20)$$

Taking the derivatives of this function and invoking the assumption of constant relative risk aversion again, we find

$$z'(g) = -\rho u'(C_2(g)) \frac{P_1 H}{C_2(g)} \quad z''(g) = \left(\frac{\rho\beta}{\bar{c}}\right) (1 + \rho) u'(C_2(g)). \quad (1.21)$$

To a second-order approximation, we have

$$\begin{aligned} u'(C_2) \equiv z(g) &\approx z(\bar{g}) + z'(\bar{g})(g - \bar{g}) + \frac{z''(\bar{g})}{2}(g - \bar{g})^2 \\ &= u'(\bar{C}_2) - \rho u'(\bar{C}_2) \frac{P_1 H}{\bar{c}_2} (g - \bar{g}) + \left(\frac{\rho\beta}{\bar{c}}\right) (1 + \rho) u'(\bar{C}_2) (g - \bar{g})^2 \end{aligned} \quad (1.22)$$

Taking the expected value of the expression in (1.22), we get

$$E[u'(C_2)] \approx u'(\bar{C}_2) \left[ 1 + \rho \left(\frac{1+\rho}{2}\right) \left(\frac{\beta\sigma_g}{\bar{c}}\right)^2 \right], \quad \sigma_g \equiv \sqrt{\sigma_g^2}, \quad (1.23)$$

where  $\sigma_g$  is the standard deviation of the capital gain on the house. Now, when the consumer has constant relative risk aversion, we may write his utility function as

$$u(C_t) = \frac{C_t^{1-\rho}}{1-\rho}, \quad t = 1, 2,$$

implying

$$\frac{u'(C_1)}{u'(\bar{C}_2)} = \left(\frac{\bar{C}_2}{C_1}\right)^\rho. \quad (1.24)$$

Inserting (1.23) in the first-order condition (1.6), rearranging, and using (1.24), we obtain

$$m \equiv \frac{\lambda(1+\theta)}{u'(\bar{C}_2)} \approx (1+\theta) \left(\frac{\bar{C}_2}{C_1}\right)^\rho - (1+r)(1+\varphi),$$

$$\varphi \equiv \rho \left(\frac{1+\rho}{2}\right) \left(\frac{\beta\sigma_g}{\bar{c}}\right)^2. \quad (1.25)$$

We see that the consumer's marginal willingness to pay for the right to borrow an extra krona increases with his expected level of second-period consumption relative to first-period consumption. Since the consumer is credit-constrained in the first period, we would expect the ratio  $\bar{C}_2/C_1$  to increase with the ratio of second-period income to first-period income,  $Y_2/Y_1$ , but in general  $\bar{C}_2/C_1$  will depend on all the parameters of the model, so (1.25) is only an indirect characterization of  $m$  rather than the full solution.

To see the direct link between the above results and those reported in section 4 of the report, note that if  $i$  is the nominal interest rate,  $\tau^i$  is the capital income tax rate (against which interest payments may be deducted), and  $\pi$  is the expected inflation rate, the real after-tax interest rate is

$$r \equiv i(1 - \tau^i) - \pi. \quad (1.26)$$

Inserting this into the expression on the right-hand side of (1.17), we arrive at the user cost formula presented in equation (4.1) in the report.

The simple model above includes only one risky asset (housing) and one kind of uncertainty (regarding house prices). If there are several risky assets and types of uncertainty, the determination of the risk premium in the user cost of housing becomes more complex. For example, if the consumer's future labour income is risky, due to uncertainty about future wages and employment opportunities, and if the macroeconomic business cycle generates a positive correlation between future labour income and future house prices, this positive covariance will tend to drive up the required risk premium on housing investment because home-owners are likely to suffer capital losses on their houses at the same time as they face increased risks of a drop in their labour income.

On the other hand, if home-owners with positive net wealth have the opportunity to invest in other financial or real assets with a rate of return that tends to vary negatively with the rate of return on housing investment, this possibility to diversify a home-owner's overall portfolio risk will tend to reduce the required risk premium in the user cost of housing. In models with many risky assets and many forms of uncertainty, the required risk premia on individual assets will generally depend on their covariances with other assets and risky activities, and often it will be difficult to derive analytical solutions

for the individual risk premia. Berkovic and Fullerton (1992) is an example of a study that analyses housing investment as part of a portfolio choice between several risky assets, and Davidoff (2006) is an example of a study investigating the impact of labour income risk on housing investment. Finally, our model abstracts from the fact that since households that do not own must rent, they can insure themselves against future fluctuations in rents by investing in owner-occupied housing. The risk premium required by home-owners will then depend on the balance between the asset price risk and the rent risk, as shown by Sinai and Souleles (2005).

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