

House Prices in Denmark and Sweden*

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1. Introduction

Fluctuations in the housing market often play a key role in the business cycle. This was particularly the case during the recent international financial crisis, which was triggered by a downturn in the U.S. housing market. Many other countries, including Denmark and Sweden, also experienced a long period with strong increases in real house prices in the run-up to the crisis. In Denmark this was followed by a sharp downturn, whereas Swedish house prices have so far remained at a historically high level. At the time of writing, many observers worry that the Swedish housing market may be seriously overvalued and that a future fall in house prices may threaten the country's economic and financial stability. In Denmark some economists also fear that the adjustment in house prices has not been completed so that further drops in real house prices will remain a drag on economic recovery.

This paper tries to improve our understanding of the drivers of real house prices. It does so by offering estimates of the evolution of fundamental house prices in Denmark and Sweden and by analyzing the relationship between fundamental and actual house prices. By studying the evolution of the gap between actual and fundamental house prices, we can identify episodes where positive or negative "bubbles" in the housing market seem to have been at play. In particular, we can throw some light on the issue whether house prices in Denmark and Sweden are currently overvalued.

Our method of analysis allows us to answer questions such as the following: What are the determinants of fundamental house prices? Do actual house prices tend to move towards fundamental prices? If so, how fast is the adjustment towards fundamental house prices? What are the factors driving the gap between actual and fundamental prices? Can economic policy help to reduce fluctuations in the house price gap, thereby contributing to macroeconomic stability?

Inspired by the work of Campbell and Shiller (1987, 1989) on fundamental stock prices, several authors such as Hott and Monnin (2008), Campbell, Davis, Gallin and Martin (2009), Hiebert and Sydow (2011), Costello, Fraser and Groenewold (2011), Ambrose, Eichholtz and Lindenthal (2012), European Commission (2012), and Bergman and Sørensen (2013) have recently attempted to estimate fundamental house prices by various methods. In this paper we

will use the method for estimating fundamental house prices laid out in detail by Bergman and Sørensen (2013). We will extend the analysis in that paper by offering confidence intervals for fundamental house prices and by studying the drivers of the gap between actual and fundamental prices.

The remainder of the paper is structured in the following way. In section 2 we describe the developments of house prices in Denmark and Sweden against the international background. Section 3 discusses whether real house prices are likely to display an upward secular trend, an issue which is important for evaluating the sustainability of recent house price developments. Section 4 applies the method of Bergman and Sørensen (2013) to estimate fundamental house prices in Denmark and Sweden and compares the evolution of fundamental and actual house prices. In section 5 we analyse how macroeconomic factors, including monetary policy, affect the gap between actual and fundamental house prices. Section 6 offers concluding comments and some reflections on the policy implications of our findings.

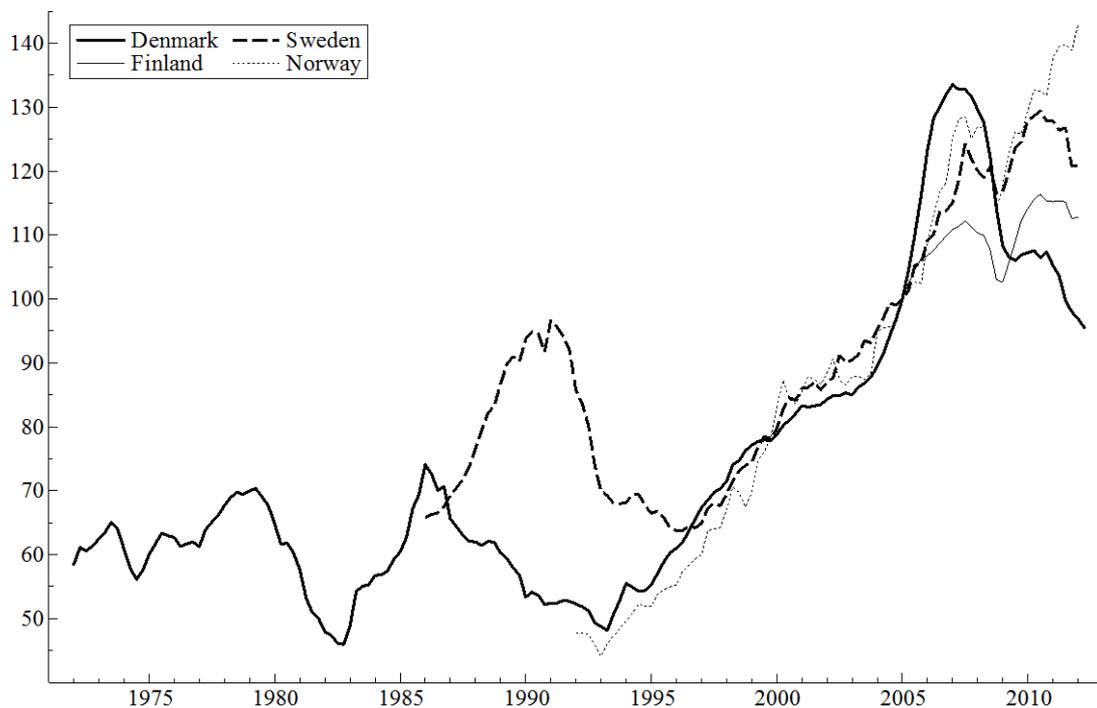
2. The Evolution of house prices in Denmark and Sweden

Figure 1 shows the evolution of quarterly real house prices in Denmark and Sweden since 1970. Several episodes stand out from the graph. The first one is the sharp and persistent increase in Danish house prices from around 1993 up until 2007. The rise in real house prices in Denmark was extremely steep in 2005-2006. We also note the sharp downturn in 2008-2009 and the further fall in 2011. A natural interpretation is that Denmark experienced a genuine housing bubble in the middle of the last decade. Consumer surveys as well as casual evidence suggest that the acceleration of house prices in 2005-2006 was driven by exuberant expectations of future capital gains on houses and that consumers became quite pessimistic about future price developments after the subsequent downturn. 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.

Figure 1: Quarterly real house prices in Denmark, Finland, Norway and Sweden 1970:1-2012:2 (2005:1=100).



Source: Statistics Denmark, Statistics Sweden and OECD.

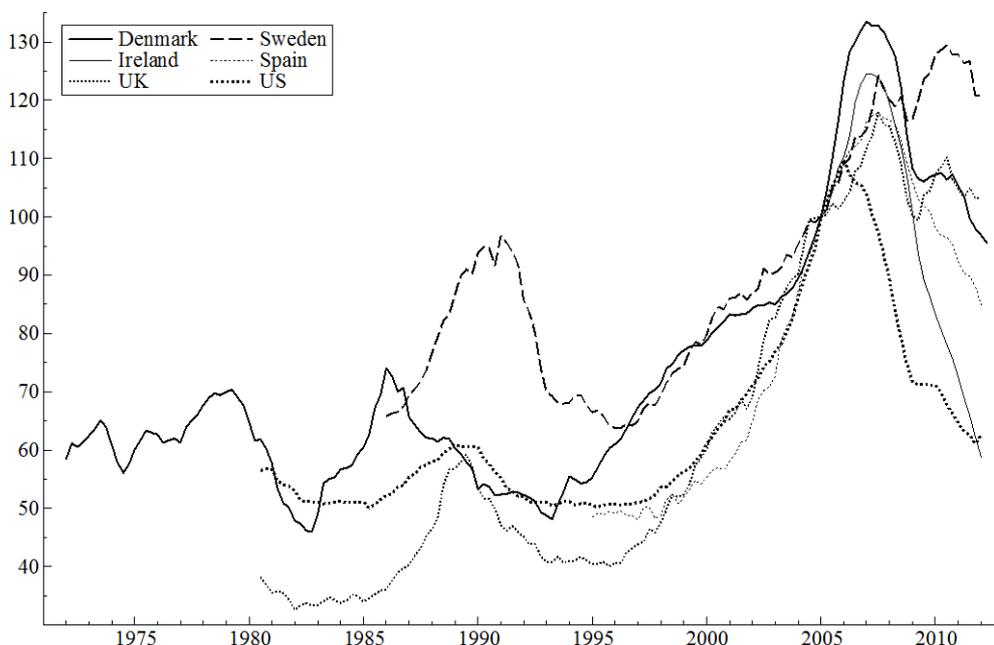
Second, the soaring house prices in Sweden in the run-up to the banking crisis in the early 1990s are clearly visible in the graph. After the banking crisis real house prices returned to the pre-crisis level in the mid-1990s, but they have increased steadily since 1997. The boom was interrupted by the 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.

The same is still true for Danish house prices, although they have fallen by significantly more than Swedish house prices during the last few years. The fact that house prices in both countries are still very high by historical standards explains why many observers worry whether a further downward adjustment is needed in the years to come.

In Figure 1 we also compare house prices in Denmark and Sweden to prices in two other Nordic countries, Finland and Norway. House prices in Finland seem to behave like house prices in Sweden to a large extent. Norwegian house prices increased strongly from 1992 and up until the international crisis of 2007-2008 and have rebounded vigorously in recent years. It is interesting that all four countries experienced rather similar house price developments up until 2007 whereas developments have been very different since then, especially in Denmark and Norway.

Figure 2 shows house prices in two countries (Ireland and Spain) that experienced a housing bubble during the last decade. Like Denmark, Spain and in particular Ireland have suffered from a serious housing market downturn since 2007, whereas Sweden stands out with a much better performance.

Figure 2: Quarterly real house prices in Denmark, Sweden, Ireland, Spain, UK and US 1970:1-2012:2 (2005:1=100).



Source: Statistics Denmark, Statistics Sweden and OECD.

Figure 2 also compares house prices in the two Nordic countries to those in the UK and the US. The housing bubble in the US is clearly outlined in the graph. Again we note the similarity of house price developments across countries in the years preceding the international crisis, with the proviso that the US market started to turn down before markets in the other countries. In the aftermath of the crisis, the Anglo-Saxon and the Danish housing markets have struggled to recover, whereas the Swedish market has so far been much more robust.

3. Do real house prices trend upwards?

In the run-up to the international financial crisis there were sharp increases in house prices in all the countries considered above, and in many countries prices are still very high by historical standards. This raises the question whether there are still “bubbles” in some housing markets? The answer depends in part on whether one can expect a sustained upward long-run trend in real house prices. Several of the graphs above might suggest that there is

indeed an underlying tendency for real house prices to increase, but the time span considered seems too short to allow a final judgement.

There is no consensus on this issue in the international academic literature. Shiller (2007) has argued that there is no evidence of a positive long-run trend in real house prices. Using long historical time series for house prices in the Netherlands, Norway and the US, Shiller shows that there are several prolonged cycles during the century from around 1890 to the early 1990s, but there is no clear upward or downward trend. The boom in house prices since the mid-1990s and up until the recent financial crisis was quite extraordinary in a long run historical perspective.

Many other economists share Shiller's view that real house prices are likely to remain constant over the long run. The argument is that, in a long-run equilibrium, the price of existing houses must equal the cost of building new houses of similar size and quality. If construction costs evolve in line with the general price level, it follows that nominal house prices must rise at the same pace as consumer prices.

However, 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 hypothesis that real house prices must stay constant in the long run 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.

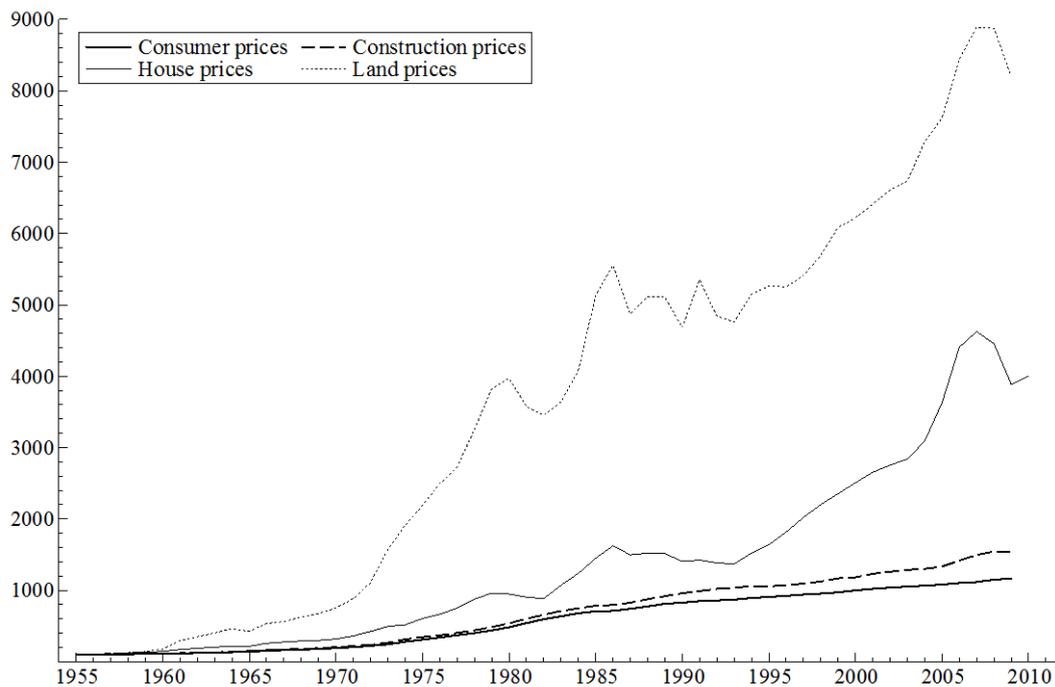
Consider first the likely evolution of land prices. Since the total supply of land is fixed, it may be hard to increase the supply of land used for housing purposes without driving up the relative (real) price of land. Moreover, the long-run output growth in other sectors is also likely to raise the total demand for land, thereby driving up its relative price. For both of these reasons we would expect a long run tendency for real house prices to increase due to a rise in real land prices.

Furthermore, if productivity growth in the building industry is relatively slow, 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.

Figures 3 and 4 show that construction costs (excluding the price of land) have indeed increased at a faster rate than consumer prices in Denmark and Sweden in recent decades and that land prices have increased at a much faster pace in both countries. In such an environment the total real cost of supplying a new housing unit will tend to increase over time, generating an upward trend in real house prices. In Denmark, such a trend has been visible since around 1960. In Sweden, the tendency for real input costs and real house prices to go up is only manifest in the relatively short time span since the mid-1990s, allowing no strong conclusions.

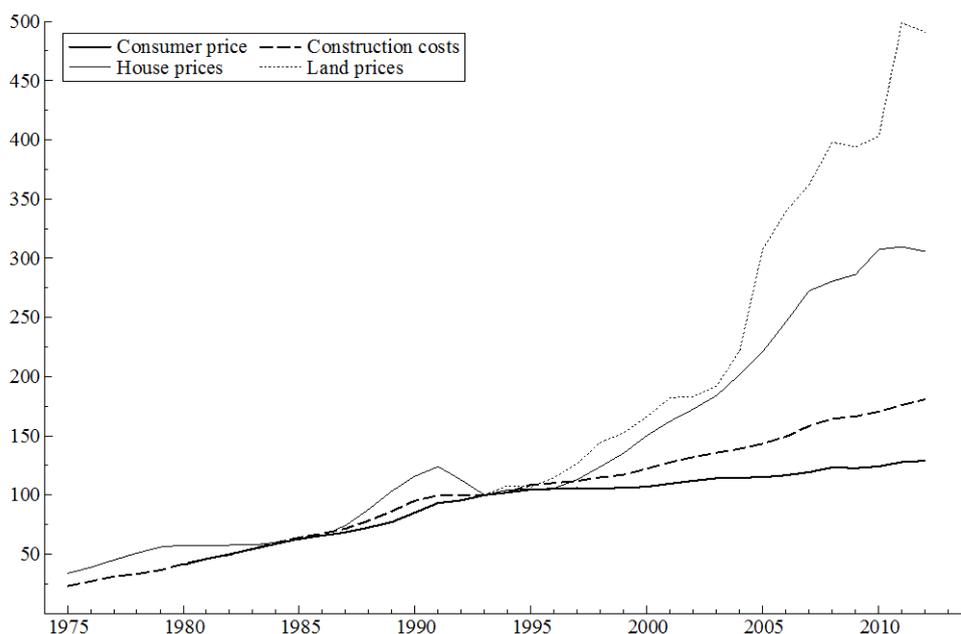
Figure 3. Consumer prices, house prices, land prices and construction costs in Denmark (1955=100).



Note: Construction costs include wages, materials prices and overhead costs. 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.

Figure 4: Consumer prices, construction costs, house prices and land prices in Sweden (1993=100).



Note: Construction costs include wages, materials prices and overhead costs. All prices and costs are measured in nominal terms. The land price is the price of agricultural land.

Source: Statistics Sweden.

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 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:

$$\text{Housing supply} \quad H = H(P) \quad (1)$$

$$\text{Housing demand} \quad D = D(cP, Y) \quad (2)$$

$$\text{Equilibrium} \quad H = D \quad (3)$$

$$\text{Budget share of housing} \quad B = \frac{cPH}{Y} \quad (4)$$

Equation (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), indicating that housing demand depends (negatively) on the cost of housing services, cP , and (positively) on disposable income. Equation (3) is the condition for equilibrium between housing demand and housing supply, and (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 $dc = 0$. Using equations (1) through (4) we then find that

$$\frac{dP}{P} = \left(\frac{\varepsilon_Y}{\varepsilon_H + \varepsilon_R} \right) \frac{dY}{Y}, \quad (5)$$

$$\frac{dB}{B} = \left[\frac{\varepsilon_H (\varepsilon_Y - 1) + \varepsilon_Y - \varepsilon_R}{\varepsilon_H + \varepsilon_R} \right] \frac{dY}{Y}, \quad (6)$$

$$\varepsilon_R \equiv -\frac{\partial D}{\partial cP} \frac{cP}{D}, \quad \varepsilon_Y \equiv \frac{\partial D}{\partial Y} \frac{Y}{D}, \quad \varepsilon_H \equiv \frac{dH}{dP} \frac{P}{H},$$

where dX indicates the absolute change in variable X , ε_R is the numerical elasticity of housing demand with respect to the cost of housing services, ε_Y is the elasticity of housing demand with respect to real disposable income, and ε_H is the price elasticity of housing supply.¹

¹ In other words, ε_R measures the percentage decrease in housing demand in case of a 1 percent increase in the real housing cost, ε_Y is the percentage increase in housing demand generated by a 1 percent increase in real income, and ε_H is the percentage increase in housing supply induced by a 1 percent increase in the real house price.

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 is generally a finite number. According to equation (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 term (that is, unless $\varepsilon_H \rightarrow \infty$).

However, if economic growth creates a growing scarcity of building sites, the elasticity of housing supply is likely to be finite. In that case equation (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 (6) the answer is: not necessarily. For example, if the income and price elasticities of housing demand are both equal to 1, it follows from (6) that the budget share of housing expenses will be constant over the long run even if the elasticity of housing supply is finite.²

As mentioned, equations (5) and (6) assume that the real user cost of housing is stationary over the long run. In Figure 5 we show the evolution of the real user cost of owner-occupied housing in Denmark and Sweden. We use the real after-tax interest rate on 5-year mortgage loans plus a constant risk premium (assumed to be 7 percent in both countries) as a proxy for the real user cost of owner-occupied housing.

According to the upper graph in Figure 5 the real user cost in Denmark varied around a level of 6 percent during the ten years from 1974 to 1984. From the mid-1980s the mean value seemed to increase permanently, but after a peak in 1987 the Danish user cost fell slowly over time until 2012. There were three main drivers behind these developments. First of all, the rates of nominal interest and inflation came down significantly after 1982 as a consequence of Denmark's shift to a hard currency peg.³ Since the tax code allows full deductibility of nominal interest expenses, a parallel drop in the nominal interest rate and the rate of inflation will drive up the real after-tax interest rate. This helps to explain the rise in the Danish user cost between 1983 and 1987. Second, the tax rate on capital income against which mortgage interest expenses can be deducted was substantially reduced as a result of a

² According to the empirical estimates in Brusewitz (1998), the income and price elasticities are indeed close to 1 in Sweden.

³ See Bergman, Hutchison and Jensen (2013) for a thorough analysis of this change in the Danish policy regime.

tax reform taking effect in 1987. This explains the sharp increase in the user cost in that year. Third, the downward trend in international real rates of interest since that time has tended to reduce the user cost in recent decades.

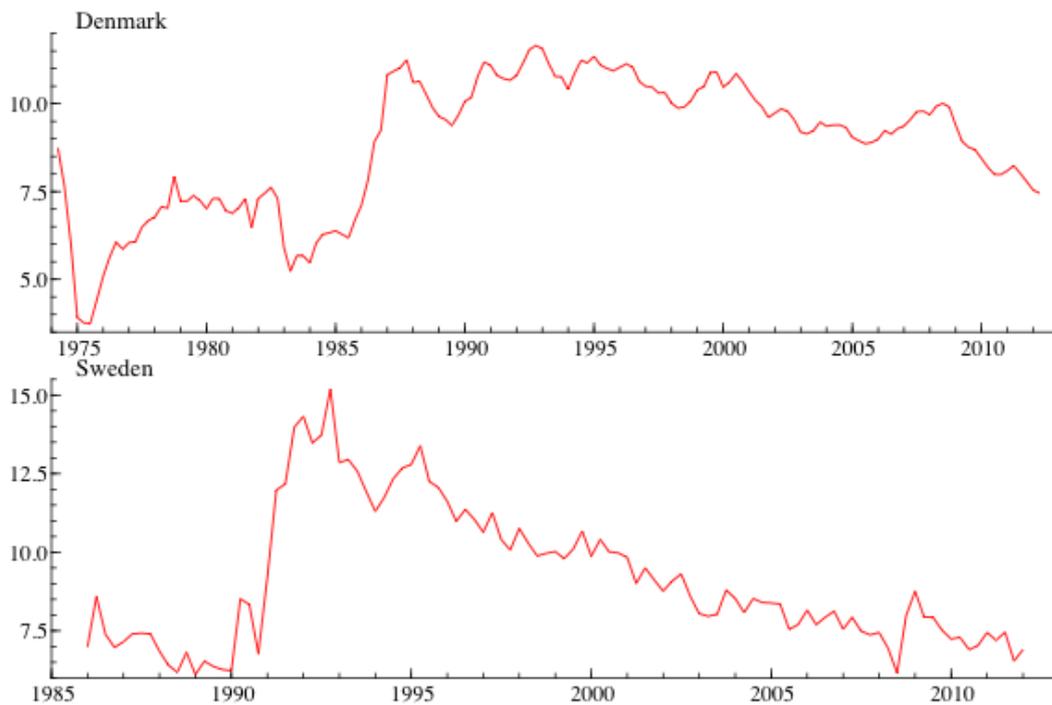
In Sweden we see that the user cost rose sharply in the early 1990s. This was due to a special combination of an increase in the nominal interest rate triggered by a foreign exchange crisis, a sharp drop in the expected inflation rate, and the significant cut in the capital income tax rate implied by the ambitious tax reform of 1990-1991. However, since the early 1990s the user cost has tended to move back towards the level prevailing in the 1980s, due to a continued fall in the nominal interest rate.

Overall, we consider the Danish and Swedish evidence to be consistent with the theoretically well-founded idea that the user cost is stationary in the long run.

More generally, the analysis in this section suggests that neither economic theory nor the available evidence implies that real house prices should necessarily remain constant over the long run. The mere fact that real house prices in Denmark and Sweden have risen substantially in recent decades does not allow us to conclude that housing markets in the two countries are currently overvalued. To resolve this issue, we shall have to dig deeper.

Below we shall therefore attempt to estimate fundamental house prices in Denmark and Sweden and compare them to actual house prices. This will enable us to evaluate more formally whether there have been bubbles in the two housing markets and to analyze the drivers of gap between actual and fundamental house prices.

Figure 5: The real user-cost of owner-occupied housing in Denmark and Sweden (percentage points).



Note: We have assumed that the risk premium is equal to 7%.

4. Estimates of fundamental house prices in Denmark and Sweden

In this section we present estimates of the level of fundamental house prices in Denmark and Sweden. The analysis underlying the results presented below is documented in detail in Bergman and Sørensen (2013).

The fundamental house price is defined as the equilibrium house price that would prevail if households had rational expectations about the underlying fundamental determinants of house prices. Those fundamental variables such as the future levels of income, interest rates, and housing supply determine the future value of the housing service delivered by a house.

The fundamental house price may deviate from the actual house price, partly because consumers may not always have realistic (rational) expectations about the future fundamentals that determine the future value of housing services, and partly because of

various frictions that prevent an instantaneous adjustment of the house price to its equilibrium level, i.e., its fundamental value. However, economic theory suggests that the actual house price should move towards its fundamental level over the long run.

The fundamental house price can be derived from the following expression for the imputed rent in period t (R_t^H), defined as the real cost of the housing service flowing from a physical unit of owner-occupied housing:

$$R_t^H = [i_t(1-\tau_t^i) - \pi_t + \eta]P_t - (P_{t+1}^e - P_t). \quad (7)$$

Here i_t is the nominal mortgage interest rate, τ_t^i is the capital income tax rate, π_t is the expected rate of inflation, η is the sum of the effective property tax rate, the real rate of depreciation of the housing stock and a premium for risk and credit constraints,⁴ P_t is the real price of a unit of owner-occupied housing, and P_{t+1}^e is the expected real price at time $t+1$ given the information available at time t . In the case where the housing investment is fully debt-financed, the term $[i_t(1-\tau_t^i) + \eta]P_t$ is the homeowner's nominal cash expenses whereas $\pi_t P_t + (P_{t+1}^e - P_t)$ is the expected nominal capital gain. Rearranging the expression above, we obtain

$$P_t = \frac{R_t^H + P_{t+1}^e}{1 + \gamma_t}, \quad \gamma_t \equiv i_t(1-\tau_t^i) - \pi_t + \eta, \quad (8)$$

where γ_t is the user cost of owner-occupied housing, *excluding* the expected capital gain. This equation 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 (2013) show that

$$P_t = \frac{R_t^H}{1 + \gamma_t} + \frac{R_{t+1}^{He}}{(1 + \gamma_t)(1 + \gamma_{t+1}^e)} + \frac{R_{t+2}^{He}}{(1 + \gamma_t)(1 + \gamma_{t+1}^e)(1 + \gamma_{t+2}^e)} + \dots, \quad (9)$$

where R_{t+j}^{He} and γ_{t+j}^e are the values of R_t^H and γ_{t+j} expected at time t to prevail in period $t+j$. Iterating forward we find that

$$P_t = E_t \left[\sum_{i=0}^{\infty} \frac{R_{t+i}^H}{\prod_{j=0}^i (1 + \gamma_{t+j})} \right]. \quad (10)$$

⁴ Sørensen (2013, appendix) sets up a formal model of the user cost that explains the determinants of the premium for risk and credit constraints.

This equation defines 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. Note that we have assumed that the discounted sum on the right-hand side is finite, i.e., we assume that the real imputed rent grows at an average rate lower than the average value of the discount rate. This is equivalent to ruling out “bubbles” in the housing market.⁵

The expected future imputed rents are not directly observable, so we need a model to pin down the expected future values of R_t^H . There are different ways to proceed, but here we will consider the so-called supply-demand model discussed by Hott and Monnin (2008). In particular, assume that imputed rents adjust in order to equilibrate the supply of and demand for housing services and that the demand for housing services (D_t) depends on aggregate real disposable income and the imputed rent in the following way,

$$D_t = BY_t^{\varepsilon_Y} (R_t^H)^{-\varepsilon_R} \quad (11)$$

where B is a constant, ε_Y is the income elasticity of housing demand, and ε_R is a price elasticity measuring the numerical 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 housing market equilibrium we thus have $H_t = D_t$. This implies that

$$R_t^H = B^{1/\varepsilon_R} Y_t^{\varepsilon_Y/\varepsilon_R} H_t^{-1/\varepsilon_R}. \quad (12)$$

Using this equation 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 ε_R and ε_Y .

When forecasting the future discount rates γ_{t+j} and the variables needed to calculate the expected future imputed rents, Bergman and Sørensen (2013) assume that households act as if they were using a Vector Autoregression (VAR) model describing the historical interaction

⁵ While we assume that there are no bubbles in the *fundamental house price*, we do not rule out that there may be occasional bubbles in the actual house price. The gap between the actual and the fundamental house price can be used to assess whether there are prolonged deviations from the fundamental value and to provide an estimate of the degree of overvaluation or undervaluation.

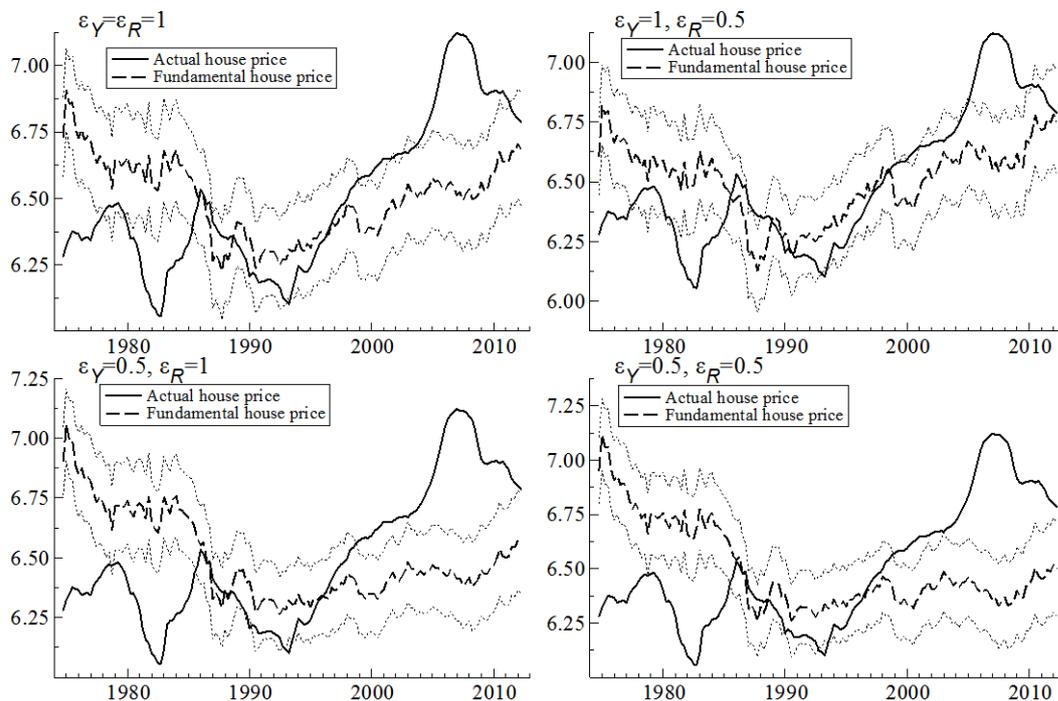
of the variables R , Y , H , γ and the actual real house price (this is the sense in which expectations are assumed to be rational). Bergman and Sørensen (2013) describe in detail how the VAR model is specified and estimated. The estimation procedure assumes that the average level of actual real house 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 Danish and Swedish quarterly data. The sample period for Denmark is 1974:1-2012:2 and for Sweden it is 1986:1-2012:1. The starting point for the estimation period was dictated by data availability. Bergman and Sørensen (2013) provide a detailed definition and description of data sources. The Danish data we use were taken from Statistics Denmark while the Swedish data is provided by Statistics Sweden.

To apply the supply-and-demand model of the housing market, one needs to choose specific values for the income and price elasticity 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. On the other hand, using Swedish micro data, Brusewitz (1998) found that the income and price elasticities were both very close to 1. Given the uncertainty regarding the true parameter values, we will illustrate the sensitivity of our results to variations in these elasticities.

Figures 6 and 7 show our estimates of fundamental and actual real house prices as well as 90% confidence bands for the fundamental price. The confidence bands were computed from a standard bootstrap on the VAR model that is used to forecast the variables determining the fundamental house price. Exploiting the estimates from the VAR model, we use a non-parametric bootstrap with 500 replications to estimate the uncertainty of the VAR-based forecasts. There are four graphs in each figure, corresponding to four different combinations of the income and price elasticities of housing demand (ε_Y and ε_R). 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.

Consider first Figure 6 showing actual and estimated fundamental house prices in Denmark. The fundamental house price is falling until around 1990 and then increasing again. The main reason is that the user cost increased significantly during the 1980s whereas it followed a slightly declining trend in the 1990s and 2000s, as we saw in Figure 5. According to our estimates actual house prices undershot the fundamental level during most of the 1980s and again in the early 1990s. This was followed by a period where actual house prices were not significantly different from the fundamental level, but from the late 1990s and onwards, Danish house prices became significantly overvalued. This conclusion is relatively robust to alternative assumptions concerning the income and price elasticities of housing demand, although the degree of undervaluation or overvaluation differs. In 2012 Danish house prices were significantly overvalued (outside the confidence band for the fundamental price level) in two cases, i.e., for $\varepsilon_Y = 0.5$ and $\varepsilon_R = 1.0$, and when $\varepsilon_Y = \varepsilon_R = 0.5$.

Figure 6. Denmark: Actual house prices and estimated fundamental house prices with 90 percent confidence bands.

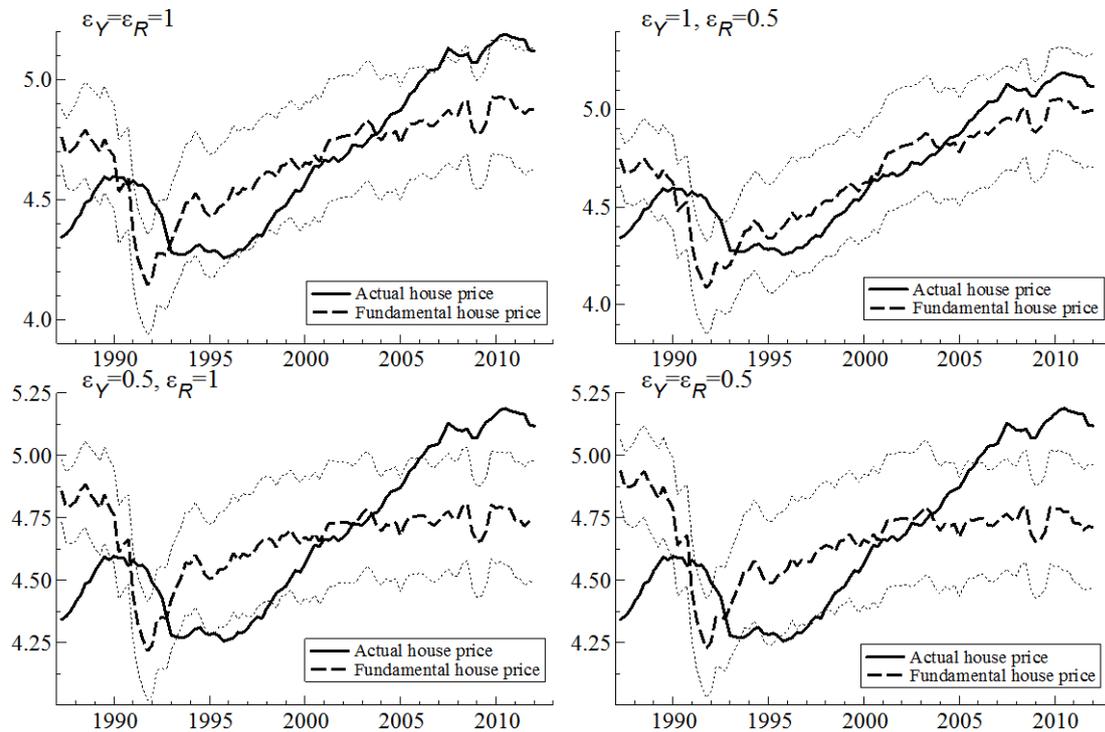


Note: Dotted lines represent the 90 percent confidence band around the estimated fundamental house price computed using bootstrap simulations with 500 trials.
Source: Bergman and Sørensen (2013).

Figure 7 shows the actual and the estimated fundamental house prices for Sweden. 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, due to the market frictions explained in Sørensen (2013, sec. 3.1). 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 estimates suggest that Swedish real house prices were overvalued in the first quarter of 2012, although actual house prices were within the confidence band for the fundamental price level in the case where $\varepsilon_Y = 1.0$.

Figure 7. Sweden: Actual house prices and estimated fundamental house price with 90 percent confidence bands.



Note: Dotted lines represent the 90 percent confidence band around the estimated fundamental house price computed using bootstrap simulations with 500 trials.

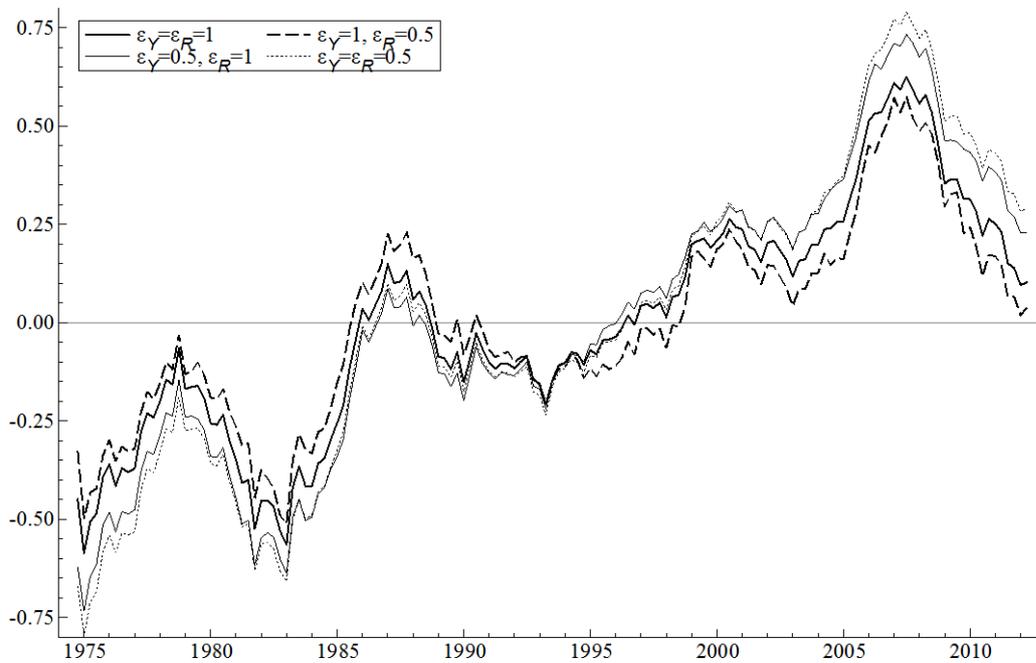
Source: Bergman and Sørensen (2013).

Figures 8 and 9 show the estimated relative gaps between the actual and the estimated fundamental house prices, taken from Figures 6 and 7 above. We see that for an income elasticity of housing demand equal to 1, which is probably the most plausible case, a lower price elasticity of housing demand implies a larger current overvaluation of housing markets in both countries. The reason is that, with a lower price elasticity of housing demand the strong income growth since the mid-1990s would require a larger increase in house prices to

equilibrate housing demand and housing supply. In this way lower price elasticities would justify a higher level of current house prices.

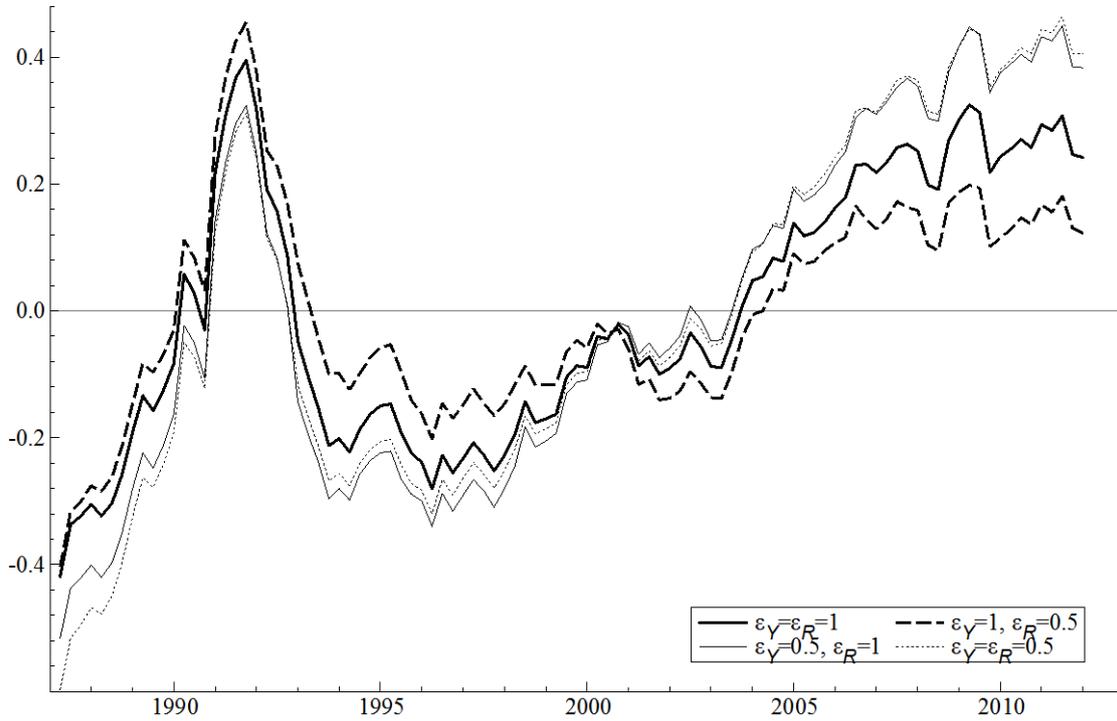
According to figures 8 and 9 the price elasticity of housing demand does not have much influence on the size of the house price gap when the income elasticity is as low as 0.5. In this case fluctuations in income induce smaller shocks to (fundamental) housing demand, and the robust income growth since the mid-1990s therefore provides a smaller boost to fundamental house prices. As a consequence, lower income elasticities of housing demand imply a higher degree of current overvaluation of housing markets in both countries.

Figure 8: The gap between actual and fundamental house prices in Denmark.



Source: Bergman and Sørensen (2013).

Figure 9: The gap between actual and fundamental house prices in Sweden.



Source: Bergman and Sørensen (2013).

One interesting question is whether the actual price tends to converge towards the fundamental price? The underlying theoretical model of the fundamental house price used in the calculations states that the fundamental house price equals the discounted value of expected future imputed rents. In the short and medium term actual house prices may deviate from the fundamental price level due to various frictions and due to temporary house price bubbles, but in the long run one would expect actual prices to converge on fundamental prices. Empirically this would imply that the gap between actual and fundamental prices is mean-reverting. Looking at Figures 8 and 9 it is not clear whether the estimated gaps are in fact mean-reverting. However, according to the formal tests in Bergman and Sørensen (2013) one cannot reject the null hypothesis that the gaps are stationary.⁶ This indicates that the fundamental house price does indeed serve as an anchor for the actual house price.

⁶ This conclusion is based on tests of the linear restriction that the gap is stationary within a bivariate vector error correction model including the actual and the estimated fundamental house price. Johansen tests suggest that there is one cointegration vector present in the system and that the gap is stationary for both Danish and Swedish data regardless of our assumption concerning the elasticities ϵ_Y and ϵ_R .

5. *Determinants of the gap between actual and fundamental house prices*

We now ask whether macroeconomic variables and monetary policy affect the house price gaps depicted in Figures 8 and 9. Our aim is to explain why the gap is closed or opened. The analysis is based on the following regression,

$$gap_t = \alpha + X_t\beta + \varepsilon_t \quad (13)$$

where $gap_t = p_t^a - p_t$, X_t is a vector of explanatory variables and ε_t is the regression residual. The vector X_t contains macroeconomic variables (the business cycle measured as output growth, unemployment and credit growth), indicators of household views on the current economic situation and expectations about the future development of the economy (measured by various consumer confidence indicators), and a money market interest rate reflecting the stance of monetary policy. The data appendix defines all variables.

We expect that households become more pessimistic during an economic downturn and therefore reduce their housing demand. An increase in unemployment or slower output growth would then reduce actual house prices. Moreover, if households tend to become unduly pessimistic during recessions and overly optimistic during booms, business fluctuations may cause larger fluctuations in actual house prices than in the fundamental house prices warranted by rational expectations about the future. In that case slower economic growth and rising unemployment will tend to reduce the house price gap $p_t^a - p_t$, and vice versa.

In our empirical application we measure household expectations using consumer confidence indicators. In particular, we use the composite consumer confidence index and reported households expectations about the economy one year ahead. A more optimistic outlook would raise the demand for housing and might thereby increase the house price gap. The timing is, however, uncertain and therefore we will allow for lagged effects.

There is a current debate among economists as to whether central banks should also focus on financial stability (including the housing market) when designing monetary policy. One issue in this debate is whether there is a direct and strong effect from monetary policy to house

prices. The debate is particularly lively in Sweden. A majority of the deputy governors of the Riksbank are arguing that the repo rate should be kept relatively high in order to limit credit growth and therefore also households' high indebtedness. This argument has been challenged recently by a former deputy governor, Lars E.O. Svensson, who argues that a temporary change in the repo rate will have only minor effects on house prices whereas a permanent change will have a substantial effect. Given this controversy, it is interesting to evaluate empirically if there is an effect from interest rates on the house price gap. We therefore include an interest rate in our regressions, CIBOR for the regressions with Danish data and STIBOR when estimating the Swedish model.

Almost all models of financial crises suggest that rising household indebtedness plays a crucial role when explaining soaring asset prices, including house prices. We include a measure of credit growth in our regressions to capture this effect. We would expect that higher credit growth would tend to increase the house price gap since previous research suggests a positive effect on actual house prices.

In the regression above all variables must be stationary. We already know from Bergman and Sørensen (2013) that the estimated gaps for both Danish and Swedish data are stationary regardless of assumptions concerning the two elasticities, ε_Y and ε_R . Prior to running the regression above, we test whether the variables contain unit roots using standard ADF-tests.⁷ If we cannot reject the null hypothesis that the variable contains a unit root, we use the difference instead of the level. The results suggest that both the CIBOR and the STIBOR interest rates are non-stationary and therefore we include first differences of these variables in our regressions. The Danish unemployment rate is found to be non-stationary (and is included in first differences) whereas the Swedish unemployment rate is stationary (and included in levels). The consumer confidence indicators for both countries are clearly stationary, they measure the fraction of households having a positive outlook on the economy. Output growth is stationary as well. Total credit in the economy, however, shows a clear trending behaviour and is assumed to be non-stationary and therefore we use the growth rate of credit in our regressions. We measure credit growth in Denmark using bank credit to the non-financial sector whereas for Sweden we use bank lending to households.

⁷ The test results are not shown here for brevity but are available from the authors upon request.

We have used a general-to-specific estimation procedure starting off with three lags of every variable. Then we remove parameters with the highest p-value, one at a time, until only significant parameters remain in the regression (using the 10 percent level as a cut-off). However, we always report the point estimates of the most significant lag for each variable in the tables below. The estimated gaps between the actual and estimated fundamental house prices are autocorrelated, indicating that there is autocorrelation in the residuals. We therefore include the lagged gap as an explanatory variable.

Tables 1 and 2 report the estimates of the gaps shown in Figures 8 and 9 using the explanatory variables discussed above and the general-to-specific approach. Consider first the results for Denmark reported in Table 1. We see that point estimates on all variables have the expected signs except for GDP growth, which is not significant. The results do not seem to be much affected by the choice of income and price elasticities. Looking at the case with unit elasticities, an increase in credit growth by 1 percentage point increases the house price gap by 0.27 percentage points, and an increase in the CIBOR rate by 1 percentage point reduces the gap in the following quarter by about 0.5 percentage points. The gap also responds positively to the consumer indicator. Unemployment turns out insignificant (but with the expected negative coefficient).

Table 1: The effects of macroeconomic variables on the gap between actual and fundamental house prices in Denmark 1976:1-2012:2.

	gap_t ($\varepsilon_Y = \varepsilon_R = 1$)	gap_t ($\varepsilon_Y = 1, \varepsilon_R = 0.5$)	gap_t ($\varepsilon_Y = 0.5, \varepsilon_R = 1$)	gap_t ($\varepsilon_Y = \varepsilon_R = 0.5$)
Δ Unemployment rate	-2.162 (1.604)	-2.302 (1.608)	-2.149 (1.753)	-2.297 (1.647)
Consumer confidence	0.00005 (0.0004)	0.0007* (0.0004)	0.0004 (0.0004)	0.0007** (0.0004)
GDP growth	-0.0651 (0.266)	0.058 (0.265)	-0.245 (0.294)	-0.0131 (0.274)
Credit growth	0.274*** (0.085)	0.244*** (0.084)	0.354*** (0.095)	0.282*** (0.088)
Δ Cibor (-1)	-0.497*** (0.157)	-0.458*** (0.156)	-0.560*** (0.175)	-0.487*** (0.162)
Gap (-1)	1.111*** (0.053)	1.105*** (0.053)	1.094*** (0.053)	1.104*** (0.053)
Gap (-3)	-0.150*** (0.051)	-0.136*** (0.051)	-0.144*** (0.052)	-0.135*** (0.050)
R^2	0.17	0.16	0.18	0.17
AR(5)	0.457	0.340	0.621	0.404
ARCH(4)	0.137	0.059	0.174	0.196
Normality	0.846	0.676	0.479	0.599

Note: Consumer confidence is measured as the fraction of Danish households having a positive view on their own financial situation over the next 12 months. Credit growth is measured as the change in bank credit to non-financial sector. R^2 is the coefficient of determination excluding lags of the dependent variable and the constant term. AR(5) is the Ljung-Box test for autocorrelation using 5 lags, ARCH(4) is the LM test for ARCH using 4 lags and normality is a test whether the residuals are normally distributed. Only p-values are reported for these tests. Robust standard errors are reported within parentheses below each estimate. *** denotes significance at the 1 percent level, ** at the 5 percent level and * at the 10 percent level.

For Sweden we see that the point estimates have the expected signs as well, except for GDP growth, which is insignificant. The same variables turn out significant as in the Danish case, although the STIBOR rate is only borderline significant depending on the elasticities chosen. Looking at the calculations with unit elasticities and comparing to the Danish outcome, credit growth (now lagged one quarter) seems to have a bigger influence on the gap on the Swedish housing market, whereas the money market rate has a smaller influence compared to Denmark. An increase in the unemployment rate by 1 percentage point causes the house price gap to drop by 0.19 percentage points with a lag of two quarters.

Table 2: Estimating the effects of macroeconomic variables on the gap between actual and fundamental house prices in Sweden 1992:2-2012:1.

	gap_t ($\varepsilon_Y = \varepsilon_R = 1$)	gap_t ($\varepsilon_Y = 1, \varepsilon_R = 0.5$)	gap_t ($\varepsilon_Y = 0.5, \varepsilon_R = 1$)	gap_t ($\varepsilon_Y = \varepsilon_R = 0.5$)
Unemployment rate (-2)	-0.191*** (0.064)	-0.186*** (0.067)	-0.151** (0.060)	-0.160*** (0.063)
Consumer confidence	0.001*** (0.000)	0.002*** (0.000)	0.001** (0.000)	0.001*** (0.000)
GDP growth	-0.221 (0.423)	-0.185 (0.437)	-0.190 (0.401)	-0.142 (0.417)
Credit growth (-1)	0.491** (0.191)	0.530*** (0.197)	0.391** (0.182)	0.472*** (0.189)
Δ Stibor (-2)	-0.360* (0.199)	-0.463** (0.205)	-0.175 (0.190)	-0.377*** (0.196)
Dependent variable (-1)	0.905*** (0.022)	0.929*** (0.018)	0.883*** (0.028)	0.937*** (0.018)
R2	0.36	0.40	0.22	0.24
AR(5)	0.233	0.301	0.180	0.261
ARCH(4)	0.246	0.247	0.314	0.256
Normality	0.852	0.831	0.950	0.968

Note: Consumer confidence is measured as the fraction of Swedish households having a positive view on the general economic situation over the next 12 months. Credit growth is measured as the change in bank lending to households. R^2 is the coefficient of determination excluding lags of dependent variable and the constant term. AR(4) is the Ljung-Box test for autocorrelation using 4 lags, ARCH(4) is the LM test for ARCH using 4 lags and normality is a test whether the residuals are normally distributed. Only p-values are reported for these tests. Robust standard errors are reported within parentheses below each estimate. *** denotes significance at the 1 percent level, ** at the 5 percent level and * at the 10 percent level.

The regression results clearly show that credit growth is essential when analysing the housing market. Slower credit growth has a negative impact on the gap between actual and fundamental house prices but higher interest rates also seem to reduce the gap. This suggests a potential for monetary policy to stabilize the housing market.

6. Conclusions and policy implications

In this paper we have analysed the housing markets in Denmark and Sweden. The experience of these countries is interesting since they have both gone through two “bubble-like” episodes with soaring house prices in recent decades. They have also experienced two major financial crises and have managed to turn unsustainable fiscal situations around, enabling them to stimulate the economy during the recent international crisis. Both countries saw a peak in house prices in 2007, but while Danish house prices have fallen significantly since then, Swedish prices have remained at a historically high level.

We presented estimates of the fundamental house price, defined as the price level that can be justified by the current and rationally expected future values of fundamental economic variables such as interest rates, disposable incomes, housing supply and property taxes. These estimates allowed us to evaluate whether house prices in Denmark and Sweden have been and still are significantly out of line with fundamentals. We found that there have indeed been periods when house prices were substantially overvalued or undervalued. For Denmark house prices were undervalued in the early 1980s and overvalued since the late 1990s. For Sweden we found that house prices were overvalued before and during the Swedish banking crisis in the early 1990s (which was triggered by a sharp downturn in the real estate market) and since around 2005.

As of 2012, it appeared that house prices in both countries were above their fundamental level, particularly so in Sweden. However, on the popular assumption of a unit income elasticity of housing demand, actual house prices in both countries fell within the 90 percent confidence bands for the estimated fundamental house prices. This statistical uncertainty is testimony to the difficulties of identifying an asset price bubble *ex ante*.

We also investigated whether macroeconomic variables can explain the behaviour of the gap between actual and fundamental house prices. We found that variables such as the short-term interest rate, unemployment, credit growth and consumer confidence have the expected impact on the house price gap. Higher interest rates tend to reduce actual house prices relative to their fundamental level in both Denmark and Sweden. This effect is statistically significant in both countries but seems particularly strong in Denmark. Household expectations about the future economic situation also play a role in both countries. It seems as if households consider their own economic situation as well as the general economic development when deciding to invest in housing. Finally, we find that credit growth has a significant positive effect on the house price gap in both countries. This effect is especially strong in Sweden.

Our findings suggest that the monetary authorities have some scope for reducing destabilizing deviations of actual from fundamental house prices, partly through their interest rate policy, and partly via their potential influence on credit growth. If the cycle in the housing market is tightly synchronized with the general business cycle, there is no conflict between the goal of stabilizing the house price gap and that of stabilizing the overall economy. However, our analysis suggests that large deviations of actual from fundamental house prices can persist for a long time, so the goal of closing the house price gap may not always be consistent with the

goal of adjusting monetary and financial policy to the current state of the general business cycle.

In summary, our analysis suggests that the potential dilemma for monetary policymakers between pricking an asset bubble and stabilizing inflation is indeed a real one. We also saw that house prices in many European countries have behaved much like those in Denmark and Sweden, so most likely policymakers in these countries face the same dilemma. The recent Spanish and Irish experience sadly illustrates the utmost importance of pursuing a policy that prevents bubbles in the housing market.

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