

Is there an evident housing bubble in Sweden?

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A discussion has been ongoing for some time on house prices and household indebtedness in Sweden, and whether their current levels are sustainable in the long term. In this article we study this issue for single-family house prices, both in Sweden as a whole and in various municipalities. Our results do not support the notion that Swedish houses are evidently overvalued in the country as a whole, if we assume that their prices are influenced by the relevant economic variables in the same way as in a number of other countries. When we change our perspective and look at how house prices on the municipal level have developed relative to earned income in the same municipalities, we cannot find any strong evidence for abnormal price differences among municipalities. However, the current high valuations of housing is only sustainable in the long term if households' housing costs remain low in relation to their income. Concern over the current developments on the Swedish housing market is therefore justified.

1 Introduction

Many macroeconomic analysts have recently expressed considerable concern regarding how the Swedish housing market is developing, with sharply rising house prices.¹

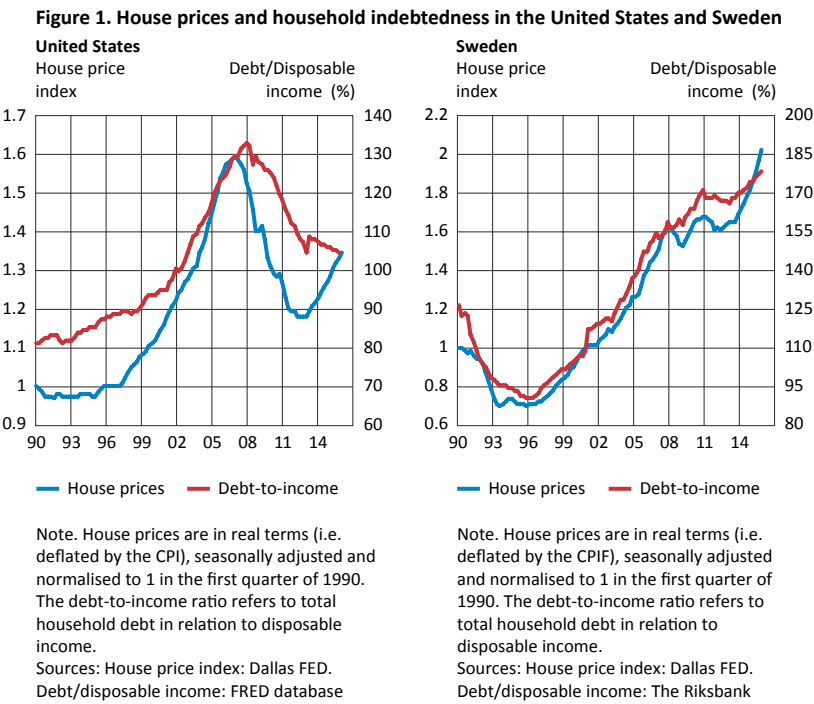
In the wake of rising house prices, the indebtedness of the Swedish households has also increased sharply. As a percentage of disposable income,

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1 See for example European Commission (2016), Giordani et al. (2015), KI (2015) and Birch Sørensen (2013, for the Swedish Fiscal Policy Council), for a discussion of Swedish house prices.

household indebtedness has doubled since 1995 and now stands at about 180 per cent. House prices have also doubled in real terms since 1995. The development of both house prices and indebtedness is documented in detail in Figure 1, for both Sweden and the United States.²

There may be a variety of reasons why analysts are concerned about this development. One of them is that the current situation in Sweden is reminiscent of the development in the United States before house prices crashed there, with record-high and rapidly rising house prices and indebtedness levels. Another is Sweden’s experience from the crisis in the 1990s, when a sharp house price fall coincided with a very deep recession and serious banking crisis.



As can be seen in Figure 1, house prices fell at the beginning of the 1990s by around 35 per cent in real terms, while in the US they fell by about 25 per cent during the most recent financial crisis, i.e. by slightly less than in Sweden. Swedish households also reduced their debt as a percentage of disposable income (debt-

2 The economic issue we discuss in this article concerns house prices in general, i.e. prices of both houses and tenant-owned apartments. In practice, however, we will work exclusively with data for houses (single-family dwellings) as the series are available for longer time periods.

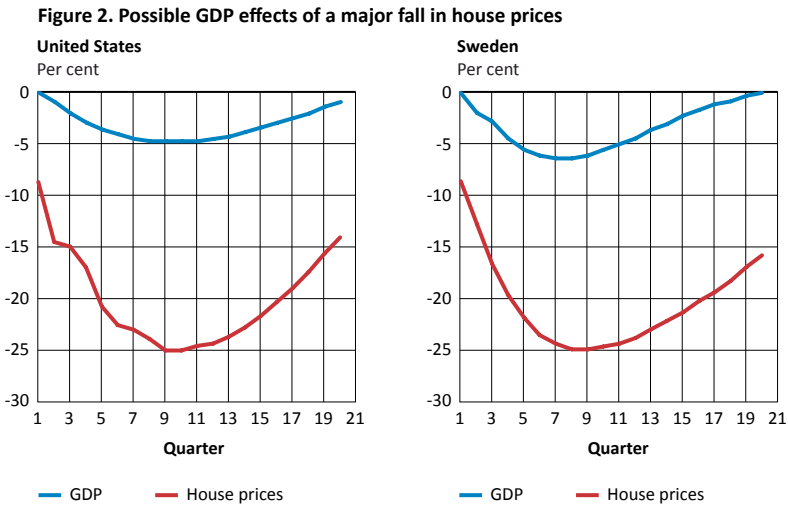
to-income ratio) by just over 30 percentage points by the end of 1995, while the debt-to-income ratio in the US has fallen by around 25 percentage points since 2007 up until the present. There are hence major similarities between Swedish and US developments during both crises.

But how much of the fall in economic activity in the United States and Sweden can be explained by the fall in house prices? We know that that the crisis on the housing market contributed to the worst economic crisis in the United States since the Great Depression of the 1930s. The U.S. crisis in turn led to a global financial crisis in 2007-2009. But how much of the economic downturn that occurred can be reasonably attributed to house prices, and how large would the effects be on the Swedish economy of a major correction in house prices? To investigate this issue we estimate a simple bivariate regression system for GDP and house prices by applying the method of ordinary least squares, and study how large the effects on GDP will be if house prices fall by 25 per cent.³ As we discussed above, this is approximately the same as the overall fall in US house prices in 2007-2009. We estimate the same model for the United States and Sweden to study how consistent the results are for both countries. According to the model, GDP would fall by about a fifth as much as house prices in the United States and by about a fourth as much in Sweden.

The results in Figure 2 imply that a large, unexpected correction in the housing market can result in a major downturn in the economy, and that a significant part of the fall in GDP during the financial crisis in the United States (and also the 1990s crisis in Sweden) was probably driven by the fall in house prices.⁴

3 The so-called “vector autoregressive” (VAR) models we estimate for the United States and Sweden contain real GDP and a real house price index (the one shown in Figure 1). We include a constant and a linear trend, and allow for 4 lags of the endogenous variables in the model. The estimation period runs from the first quarter of 1984 to the final quarter of 2015. GDP is first serialised in the VAR model, and we identify an exogenous shock to house prices with a so-called “Cholesky decomposition” where house prices are not assumed to affect GDP during the current period. This is the reason why the effects on GDP of the fall in house prices in Figure 2 are zero in the first period. This is an assumption which possibly moderates the effects of the house price fall on GDP slightly.

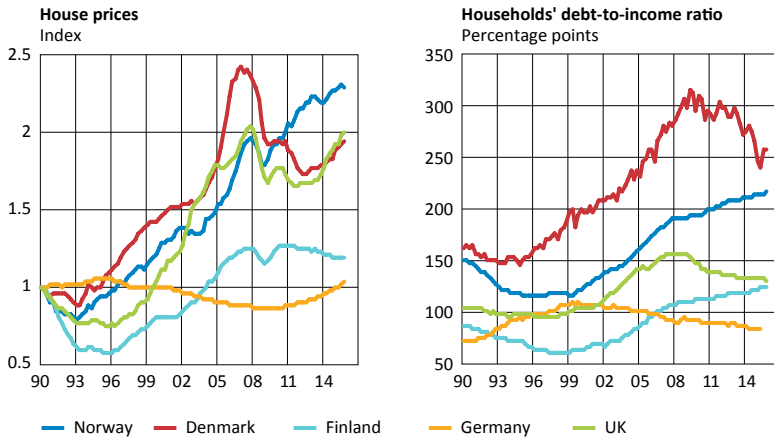
4 It is however important to point out that the results in Figure 2 are based on a simple bivariate regression system. If we include more variables and estimate a larger system (e.g. with international variables included) the influence of house prices on GDP tends to decrease. On the other hand, our assumption that house prices do not affect GDP during the current quarter tends to reduce the influence on GDP. Our overall assessment is, however, that the figures should be seen as an upper limit for how much house prices can affect the macro economy according to linear empirical models.



Note. Own calculations, see description of the VAR model that is estimated in Footnote 4.

As is well-known, the trend in rising house prices and indebtedness is not a phenomenon that is specific to Sweden today or to the United States before the financial crisis. As we see in Figure 3, house prices and household indebtedness have also risen sharply in other European countries, especially in Denmark up until 2009 and in Norway throughout the entire period. Germany is the exception that proves the rule: There, indebtedness and real house prices have basically remained constant since the beginning of the 1990s, apart from in recent years when prices have begun to move upwards.

In light of this, we believe it is important to study the extent to which the sharp rise in house prices since the 1990s crisis in Sweden can be explained by the relevant economic variables, or whether there is an obvious overvaluation which will sooner or later be corrected. We approach this important issue in two different ways.

Figure 3. House prices and household indebtedness in a selection of European countries

Note. House prices are in real terms (i.e. deflated by the CPI), seasonally adjusted and normalised to 1 in the first quarter of 1990.

Sources: House price index: Dallas FED; Debt/disposable income: National statistics offices and central banks

First, we analyse the valuation of Swedish houses from an international perspective. To do this, we have collected data on house prices, indebtedness and a number of key variables that can be assumed to be important for understanding house prices for all the countries shown in Figures 1 and 3 above. We then perform an analysis of the extent to which the development in house prices in these countries can be explained by these variables. Our method assumes that house prices on average are not overvalued for all the countries included in the study during the period studied, 1990-2015. Our method does, however, allow prices to be systematically over- or undervalued for individual countries, even for the period as a whole. Based on this analysis, we can then draw conclusions about the valuation of Swedish house prices from an international perspective.

As the price development has differed considerably among individual regions in Sweden, we also apply a regional perspective where we study the development of house prices on the municipal level. The analysis is important as it supplements the analysis we perform on the national level, and allows us to see whether the development in specific regions is particularly worrying. To perform this analysis, we have collected municipal data on house prices and earned income, which we use to study whether house prices in certain municipalities have increased by an unusual amount in relation to income.

Our study differs method-wise from the articles in the Riksbank's RUTH inquiry (mainly Claussen, Jonsson and Lagerwall 2011, and Englund 2011) in that we

apply a quantitative international perspective when assessing the house price development as a whole in Sweden. The studies in RUTH also use international experiences and comparisons, but not with a coherent quantitative method. Another obvious difference is that we can analyse developments since 2011, which is not insignificant since house prices have increased since then. It is perfectly possible that there were no obvious imbalances in pricing at that time, but that there are now. Further, no analysis was performed on the municipal level in RUTH, although there was a supplementary regional analysis in Englund (2011). A fresh study that takes detailed geographical information into account is Blind, Dahlberg and Engström (2016). Other relevant studies of Swedish house prices and any overvaluation of them are Birch Sørensen (2013), Giordani et al. (2015) and Turk (2015). Flam (2016) summarises a number of studies of Swedish house prices and the presence of a possible bubble.

The structure of the article is as follows: We begin in Section 2 by studying the development of house prices in Sweden as a whole from an international perspective. To do this, we first present the data we have collected and then the results of the analysis. After that, we study house price developments in different municipalities in Section 3. Finally, our conclusions and proposals for further analysis and measures are provided in Section 4.

2 International comparison

In this section, we describe our analysis of the pricing of Swedish houses from an international perspective. We start by presenting the data we use to explain price developments on the housing market in seven countries: Sweden, Norway, Denmark, Finland, the United Kingdom (UK), Germany and the United States (US). We then present our regression model and the results of the regressions in Section 2.2. Finally, we discuss how the results can be interpreted based on simple economic theory.

2.1 Data

In Figure 4, we present the data we use to assess the degree to which the development of house prices can be explained by macroeconomic variables. These variables are normally used in econometric analysis in order to explain the development of house prices, see for example Claussen (2013), Englund (2011), Turk (2015) and Bauer (2014). Claussen (2013) used a slightly fewer variables than we do in his previous study of Sweden. In our analysis, we use real variables and allow inflation to affect house prices separately. More specifically, the following explanatory variables are included in our regression:

- real disposable income per capita
- real financial net wealth
- real mortgage rate
- annual CPIF inflation
- annual population growth
- residential investment as a fraction of GDP.⁵

As the dependent variable in the regressions, we use the house price indices shown in Figures 1 and 3 in the introduction. As far as Sweden is concerned, the nominal property price index for houses is used, deflated by the CPIF.⁶ The property price indices for other countries are deflated with the CPI.

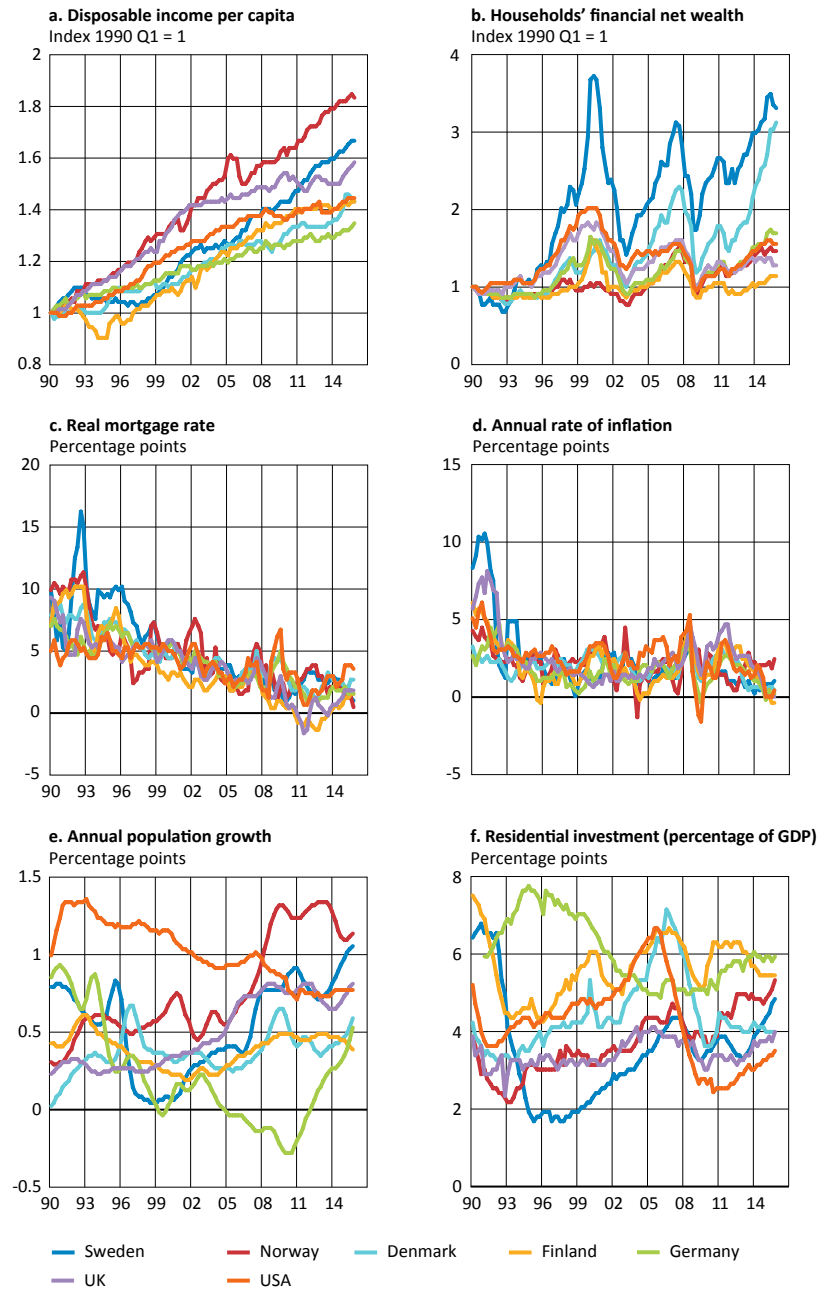
Let us now discuss the various explanatory variables shown in Figure 4. We are mainly interested in long-term, or low-frequency, changes. Please note first of all that mortgage rates have developed in a similar way in all the countries. Roughly speaking, inflation also seems to have the same long-term levels in all the countries studied. If we focus on Sweden, we note that financial net wealth has increased more in Sweden than in all the other countries. As regards disposable income, Sweden is the country in the sample that has the second-highest increase during the period 1990-2015. Population growth in Sweden is close to the average for all the countries during the period as a whole, but high from an international perspective in recent years. Finally, we note that residential investment as a percentage of GDP in Sweden was very low from an international perspective from the housing crisis of the 1990s up until 2006, but that investment in recent years has grown at a rapid rate and now amounts to almost 5 per cent of GDP, which is at the same level as the other countries. It is interesting to note that residential investment in Germany was very high from an international perspective during the 1990s, before falling back slightly in the 2000s. This may have had a restraining effect on German house prices in a way that is not necessarily captured by the development in residential investment in the other countries in our panel.⁷

⁵ For the following variables (i.e. those normalised to 1 in the first quarter), we take the natural logarithm: real house prices, real disposable income per capita and real financial net wealth. This only applies to the regressions, not when we show the variables in Figures, etc.

⁶ The CPIF is a price index for a broad consumption basket where housing costs are calculated with a fixed mortgage rate.

⁷ It is possible that residential investment in Germany has been so high as to keep the supply of houses high enough to satisfy demand, while structural problems (such as limited availability of land where people want to live and various bureaucratic obstacles, see Emanuelsson, 2015) may have led to insufficiently residential investment in other countries in order to provide an adequate supply of houses. In the latter countries, higher residential investment does not necessarily lead to lower price pressure, but only to less of an increase in prices than would otherwise have been the case. In these countries, increased residential investment becomes more of a measure of “surplus demand”, which means that residential investment can easily be given the wrong sign in a regression analysis.

Figure 4. Data for the explanatory variables: 1990 Q1 – 2015 Q4



Note. See Appendix A for detailed information about transformations of raw data.
Sources: See Appendix A

2.2 Regression analysis

We will now discuss the simple econometric approach we use. The basic assumption is that the dynamics in house prices have the same relationship to the fundamental variables in all the countries.⁸ We are aware that this is a restrictive assumption and it should be seen as a starting point for further interpretation and discussion. It is, however, useful for our purpose and puts the valuation of Swedish houses in relation to how houses are valued in other countries. How restrictive this assumption is depends also on the model's capacity to explain the variation in house prices in the various countries. If our approach, which assumes that all variables influence house prices in the same way in all the countries in our study, cannot manage to explain the variation in house prices well, doubts can of course start to arise about this assumption. If we, on the other hand, find that the regression model does explain the house price variation in the various countries well, then it is a reasonable interpretation that our assumption is supported by the data.

To further simplify our analysis, we disregard differences in levels of variables that grow over time by converting the relevant variables into index series that are normalised to 1 for the start period in the empirical analysis (1990 Q1).⁹ In line with this reasoning, we estimate a regression where the coefficients are the same for all countries:

$$(1) \quad p_{i,t}^h = \beta_0 + \beta_y y_{i,t} + \beta_{nw} nw_{i,t} + \beta_{rr} rr_{i,t} + \beta_{\pi} \pi_{i,t} + \beta_{pg} pg_{i,t} + \beta_{ri} ri_{i,t} + \varepsilon_{i,t}.$$

In regression (1), β_0 is the intercept or constant term, β_y the coefficient for disposable income per capita, β_{nw} the coefficient for financial net wealth, β_{rr} the coefficient for the real mortgage rate, β_{π} the coefficient for inflation, β_{pg} the coefficient for population growth and finally, β_{ri} is the coefficient for residential investment as a percentage of GDP. In the previous studies by Claussen (2013), Giordani et al. (2015) and Turk (2015), a similar model approach was estimated exclusively on Swedish data in order to judge whether the sharp rise in house prices could be explained by the economic development since the financial

8 It was Paolo Giordani who suggested to us that it would be interesting to analyse Swedish house prices using an international panel approach.

9 Specifically, this normalisation is done for house prices (Figures 1 and 3), disposable income (Panel A in Figure 4) and financial net wealth (Panel B in Figure 4). Had we not done this, we would have been forced to allow for a country-specific constant term in the model. A country-specific constant had, however, involved an assumption that house prices in each individual country had been correctly valued on average over the estimation period, something which we wish to avoid in advance in our analysis. The normalisation does mean, however, that the average residual for each country contains the deviation in the cointegrating vector between housing prices and the other normalized variables in the first quarter of 1990. Turk (2015) shows that this deviation is small for Sweden. We may therefore interpret our results in terms of over- and undervaluation of prices in levels for Sweden.

crisis in 2008, and largely found support to suggest that this was the case for the outcomes that were available when the studies were published. Since then, prices have continued to rise, but the economic fundamentals have also improved (e.g. real interest rates have fallen). We therefore do not believe that such an approach brings anything new to the debate.

We also estimate a variant of the regression model where we allow household debt as a percentage of disposable income (the debt-to-income ratio) to affect house prices through the coefficient β_{hd} :

$$(2) \quad p_{i,t}^h = \beta_0 + \beta_y y_{i,t} + \beta_{nw} nw_{i,t} + \beta_{rr} rr_{i,t} + \beta_{\pi} \pi_{i,t} + \beta_{pg} pg_{i,t} + \beta_{ri} ri_{i,t} + \beta_{hd} hd_{i,t} + \varepsilon_{i,t}.$$

As can be seen in a comparison of equation (1) and (2), the only difference between them is that the debt-to-income ratio is included in equation (2). If the coefficient β_{hd} is estimated as positive and significantly different from zero, and the model in equation (2) explains a significantly larger proportion of the variation in house prices in total and also in each individual country compared with the model in equation (1), this means that household indebtedness pushes house prices up, beyond the fundamental demand variables we have included in regressions (1) and (2).¹⁰

Some may consider it trivial that house prices are driven by household debt, as nearly all households have to borrow money from the bank when they buy a house. But such a reasoning ignores the fact that those who sell their house often significantly reduce their loan burden, so that total household indebtedness is not necessarily affected to any greater extent. It is therefore reasonable to interpret an estimation result $\beta_{hd} > 0$ in regression (2) as the supply of credit having a direct and quantitatively important significance for house prices, separate from the fundamental factors that govern the demand for houses.

Bearing this in mind, we will now discuss the estimation results of regressions (1) and (2), which are shown in Table 1. We start by commenting the coefficients in the model without the debt-to-income ratio, i.e. regression (1) above, the results of which are shown to the left in the table. Here, we have assumed that house prices in the long term increase as much as disposable income, i.e. the parameter value is 1. We introduce this assumption as a free estimation of this parameter results in a coefficient of 1.61, implying that house prices rise 1.6 times faster than income in the long term, which appears unreasonable given

10 Under the assumption that households' credit demand is explained by the same fundamental variables as in regression (1), the debt ratio should not be significant and add explanatory power in regression (2). A significant coefficient for the household debt ratio in regression (2) which adds to the fit of the model then shows that there is a significant supply effect of credit that is not fully captured by households' demand for loans.

the evidence in Giordani et al. (2015) who documents that real housing prices fall relative to real income per capita between 1875 and 2014.¹¹ We note that the model estimation captures the positive effect from financial net wealth, inflation and population growth as expected. One reason why it is reasonable to assume that inflation affects house prices positively is that it is nominal interest on debts that is tax-deductible in most of the countries. When inflation increases, households' real interest expenditure decreases after tax. The relationship between the real interest rate and house prices is estimated at -1.5, i.e. with an expected negative sign but with a very low value – the vast majority of economic models imply that house prices are significantly more sensitive than that to changes in interest expenditure. However, our estimated coefficient line up well with the IMF's (2005) result (-1 to -2) for eight euro countries. The coefficient for residential investment is positive. But this should not be interpreted as residential investment driving up house prices, but rather as the presence of an underlying unobserved factor that drives up both house prices and residential investment. If we look at the *p*-value in the table (*p*-val), we can see that all coefficients bar one are significant even when using a high significance level. It is only the significance for inflation that is low (only significant on the 10-percent level).

11 It is important to realise that the model's explanatory power for all countries is almost entirely unaffected by this restriction, which means that other variables substitute for the greater importance given to disposable income in an unrestricted model.

Table 1. Regression results for panel models of house prices

	Model without debt-to-income ratio			Model with debt-to-income ratio		
Variable	Coeff.	Std. Dev.	p-val	Coeff.	Std. Dev.	p-val
Disposable income	1.00	--	--	1.00	0.04	0.0000
Net wealth	0.23	0.02	0.0000	0.07	0.01	0.0000
Residential investment	2.70	0.55	0.0000	3.38	0.29	0.0000
Real mortgage rate	-1.55	0.31	0.0000	-0.57	0.22	0.0104
Inflation	0.93	0.53	0.0766	1.01	0.29	0.0409
Population growth	23.06	2.08	0.0000	18.18	1.23	0.0000
Debt-to-income ratio	--	--	--	0.33	0.01	0.0000
Models' explanatory power - R^2_{adj}						
	Model without debt-to-income ratio		Model with debt-to-income ratio			
Total	0.74		0.93			
Individual countries						
Denmark	-0.41		0.84			
Finland	0.61		0.89			
Norway	0.91		0.94			
UK	0.74		0.80			
Sweden	0.87		0.94			
Germany	-4.91		-0.68			
US	0.15		0.89			

Notes: The estimated models contain house price index, disposable income and financial net wealth in natural logarithms. A constant is included in both models but not shown in the table. The table reports the estimate coefficients ("Coeff.") for all explanatory variables and standard deviation ("Std. Dev") and p-value ("p-val") for these coefficients. Standard deviation is a measure of how precise the estimation is while the p-value denotes the probability that the coefficient has the stated sign. R^2_{adj} denotes the models' adjusted explanatory power and takes into account that the model with indebtedness contains an extra parameter compared to the model that does not include indebtedness.

The right-hand side of Table 1 shows the results for the model that includes household indebtedness as an extra explanatory variable (equation 2 above). As regards estimated coefficients, the model specification that includes the debt-to-income ratio differs only marginally from the main specification in regression (1) with the difference that we no longer need to add the restriction that the coefficient for disposable income is 1. The estimated coefficient will be estimated

to almost exactly 1 in any case. Another difference is that with equation 2, the coefficients for net wealth and mortgage rate will be lower. One might assume that this is due to a high degree of so-called multicollinearity (covariation) between these variables, i.e. that lower real interest rates drive up net wealth and household indebtedness. In that case, it would be difficult to identify how much influence the various variables actually have. The argument against this is that the standard deviations for both net wealth and the real interest rate fall when indebtedness is introduced. The coefficients for these variables are therefore estimated more precisely. The coefficient for household indebtedness is very precisely estimated and quite clearly helps to improve the model's capacity to explain the variation in house prices. As is evident from the first row in the table under the estimated coefficients, the adjusted explanatory power for all countries in total increases from 0.74 to 0.93 when household indebtedness is included.¹² This is a clear improvement.

We also see in the right-hand column in Table 1 that the coefficient for the debt-to-income ratio is estimated to a third. Given that all the variables in the regression are exogenous in relation to each other in the long term, this means that the increase that has occurred in indebtedness from around 100 to 175 per cent during the 2000s gives a direct contribution to house prices of 25 per cent. By interpreting the results in this way, we derive a simple measure of how much house prices could feasibly be corrected downwards if economic policy measures were implemented to push down indebtedness. At the same time, it is important to remember that we then assume that the economy is not otherwise affected by these measures. At least in the short term, such an assumption is therefore unreasonable, as there is a high degree of covariation among several of the variables in the regressions.¹³

What are the implications of the two models for house prices in the different countries during the estimation period? Let us begin by looking at the regression results graphically in Figure 5. The Figure shows the actual house prices and the fitted (estimated) values from the regression model without the debt-to-income ratio. We can draw four main conclusions from this figure:

1. According to this method, house prices in Sweden at the end of 2015 are well in line with the fundamentals, or are at least not obviously overvalued.

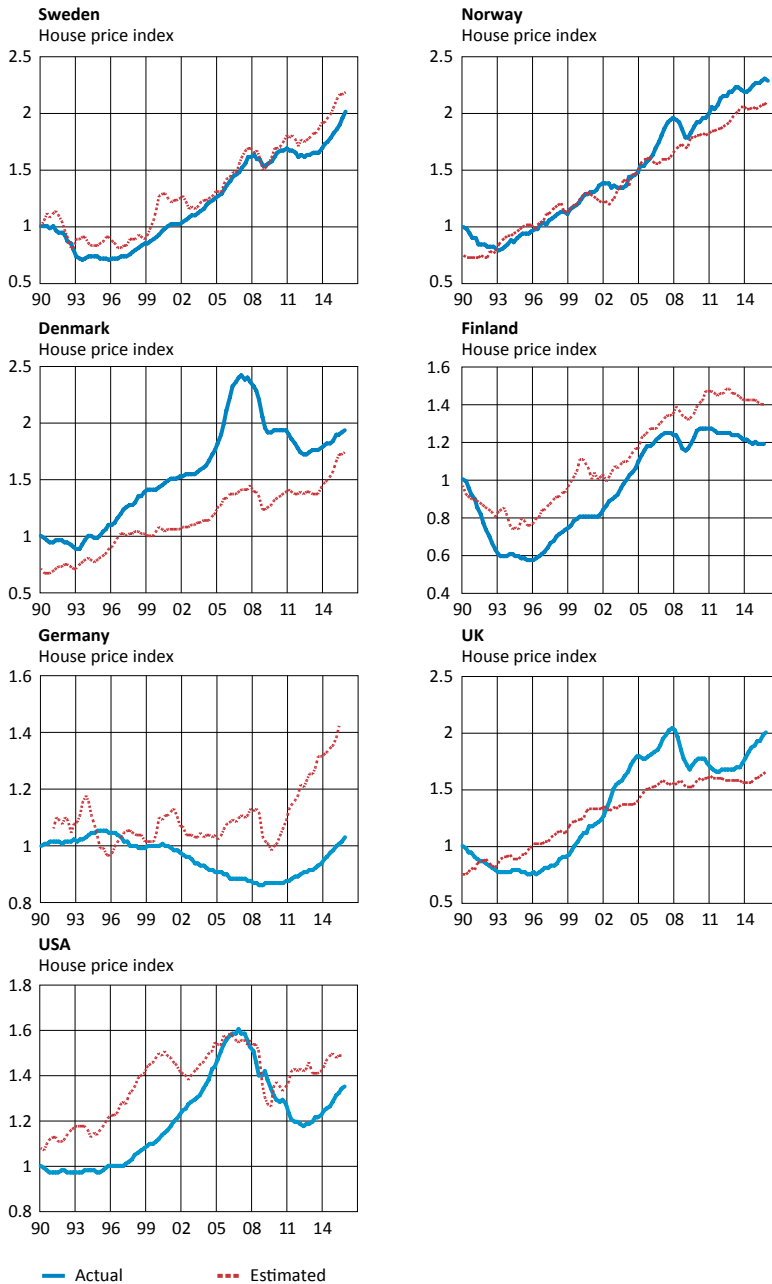
12 The total explanatory power is a weighted average of the model's explanatory power for the various countries in the lower section of the table, where the weight for each individual country is equal to the variance in house prices in the country as a proportion of the sum of the variances for all countries. As Germany has relatively low variation in house prices (as can be seen from Figures 1 and 3), it follows that Germany is given a relatively small weight in the calculation of the total explanatory power, which explains why the total explanatory power is so high in the model without indebtedness, despite Germany having a very negative explanatory power.

13 See, for example, the article by Finocchiaro, Jonsson, Nilsson and Strid (2016).

2. In some cases, estimated and fitted house prices tend to deviate from one another for many years in a row for an individual country. For example, estimated house prices are lower than the actual ones for the entire period in Denmark while the converse is largely true for Finland. A possible interpretation of this is that changes in factors outside the model are also important, and probably country-specific. It may, for example, be a question of changes in differences in institutions, norms or credit supply. As we mentioned previously, another possible explanation is that the variables we include affect house prices in different ways in the various countries.
3. Sharp and rapid rises in house prices tend to not be motivated by fundamentals according to our model. Examples of this include the upturns in Denmark in 2004-2008, in the UK in 2002-2008 and the smaller, temporary upturn in Norway in 2006-2008. The results for the house price boom in the United States is more ambiguous, however. The prices do increase more rapidly than the model implies, but from an undervalued level. Despite this, it is a problem for our approach that it does not identify an overvaluation problem prior to the sharp fall in prices in the United States.¹⁴ Further, gaps between estimated and actual house price series in these cases tend to closed by actual prices falling. We see this as an indication that our model is actually useful – deviations are identified at least *ex post* from long-term prices. Our conclusion is therefore that the difference in dynamics among countries is not particularly large and we therefore deem our approach to be meaningful.

14 In Appendix B, we show that a variant of the model without net wealth included indicates that a substantial overvaluation prevailed in the United States prior to the onset of the sub-prime crisis in August 2007. The results for the United States are therefore not robust for the choice of explanatory variables.

Figure 5. Actual and estimated house prices from the regression model without indebtedness (regression in equation 1)



Note. The estimated prices (dashed red lines) have been calculated using the estimated coefficients reported in the left-hand column in Table 1.

4. House price development in Germany is completely different from the other countries. If prices in Germany had had the same relationship to the fundamentals as in the other countries, they had been 40 per cent higher than they are now. We also see a tendency towards an acceleration in house prices in Germany since 2011 in the figure. As Germany is so different, this result raises the question to what extent the results in Table 1 would have been affected if we had excluded Germany. We will return to this question a little later on, in Section 2.3.

How are the results affected by the fact that we include household indebtedness? The fitted house prices according to the model with indebtedness (model 2) are shown in Figure 6. We note that the difference between actual and fitted prices is much smaller in this model specification. This means that the model has a higher explanatory power than the model without indebtedness. We can also see this from the explanatory power in Table 1. As in the model without indebtedness, price increases that do not have support in the fundamentals tend to be corrected by actual house prices falling. Another similarity with the model without indebtedness is that the current actual house prices in Sweden are close to the house prices predicted by the estimated regression. It is only in the UK that actual house prices are significantly higher than estimated prices at the end of the period in both models. The fact that prices in the UK are higher than predicted also based on household indebtedness may possibly be due to foreign investors having been responsible for a substantial proportion of the purchases.¹⁵ When foreign investors purchase UK houses, the indebtedness of UK households does not rise, but capital inflows increase and sterling tends to rise in value in relation to other currencies.

For several countries, especially Denmark and Norway, the inclusion of indebtedness means that the gap between actual and predicted house prices basically closes. Does this mean that we should view the house price increases in these countries as consistent with the fundamentals? That depends on the perspective we take on indebtedness. If the rising indebtedness is *demand-driven by realistic* expectations of high incomes and permanently low mortgage rates in the future that are not captured by current income and mortgage rates, the prices can reasonably be seen as fundamentally determined. An example of this would be if the real mortgage rate is expected to be more persistently low than historical patterns indicate. In that case, a major downward correction of either house

¹⁵ About 10 per cent of the UK housing stock is owned by foreign citizens and companies (Valentine, 2015), and Badarınza and Ramadorai (2015) find support for the thesis that foreign ownership has driven up prices. Other studies, such as Marsden (2015) and Hilber and Vermeulen (2016) highlight problems on the supply side instead.

prices or indebtedness is not necessary as households' debt-to-income ratio tends to fall gradually over time when their income rises and low interest rates prevail. In this case, household indebtedness can also increase without it necessarily leading to a major correction in prices and indebtedness in the future. But if the increased indebtedness is instead *supply-driven*, and is due to willing borrowers being offered the chance to borrow capital at unusually low rates of interest during a limited period, the situation may be more troublesome.¹⁶ The day when credit supply significantly and unexpectedly declines, the costs of household borrowing will substantially increase. Market rates will then increase, households will be forced to spend more of their income on servicing their debt, which will consequently reduce their scope to consume other goods. To release resources in order to consume other goods, households will want to reduce their debt burden in this situation. All in all, this scenario therefore leads to a sharp fall in household demand for companies' goods and services, resulting in a decline in companies' demand for labour. This leads, in turn, to a fall in households' disposable income and in their financial net wealth due to a lower valuation of companies' future profits and higher discounting of these. Falling disposable income and net wealth combined with higher interest rates create downward pressure on house prices according to our regression model in Table 1, and the downward correction of the debt-to-income ratio may contribute further. In this way, an increase in indebtedness that is not entirely motivated by fundamental factors can be a problem for the economy.

We can also exclude Sweden from our regressions to answer the following question even more literally: "If house prices in Sweden had developed according to the same pattern as in other countries, what would they then have been?" But this exclusion has only negligible effects on estimated house prices – the four conclusions above still hold up. However, the estimated values of the coefficients sometimes change noticeably. This is particularly true for the model without the debt-to-income ratio and suggests that some of the coefficients are less robust.¹⁷

Finally, we note that the four conclusions, including the absence of an obvious overvaluation of Swedish house prices at the end of 2015, hold up even if we exclude net wealth from the regression. This is an important robustness exercise as it is plausible that the overvaluation of housing coincides time-wise with the

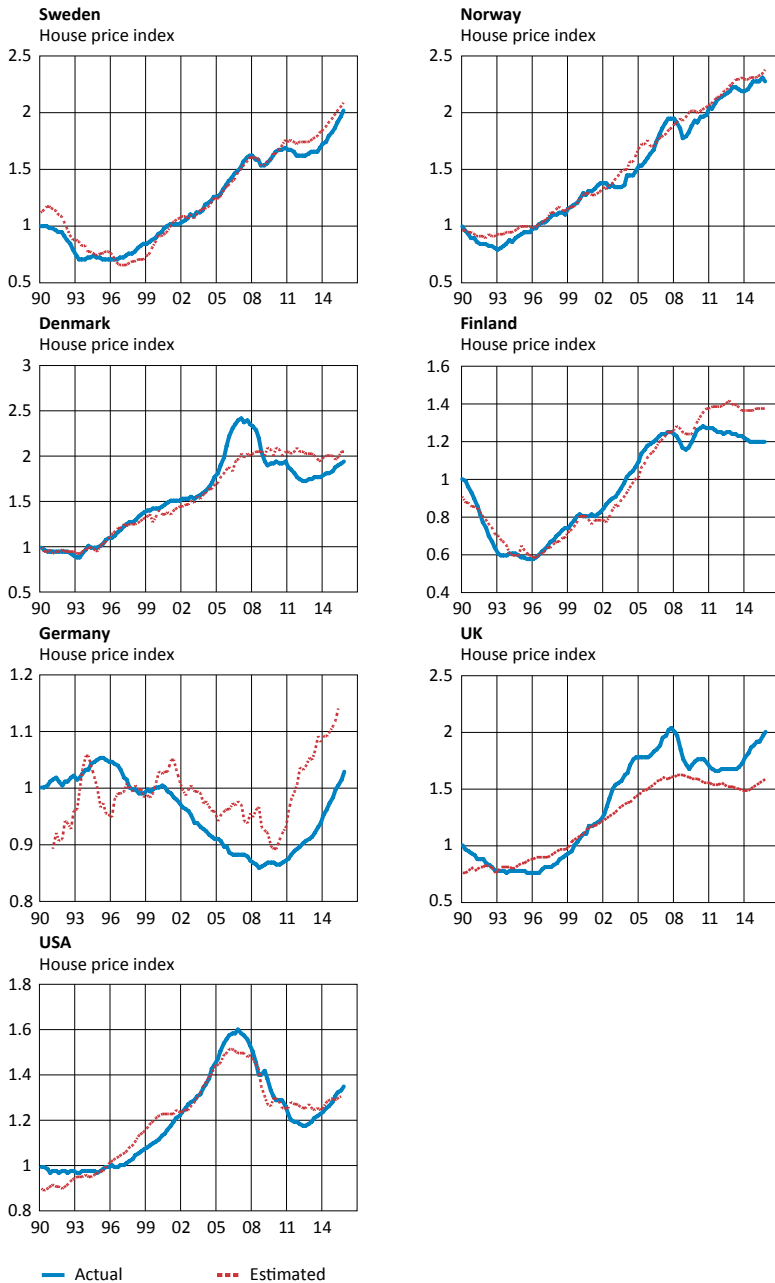
16 Unrealistic expectations of future income and interest rate levels have, in all likelihood, qualitatively similar effects to a temporary increase in capital supply that pushes down interest rates and contributes to greater economic activity in the near term.

17 While the coefficient for the debt-to-income ratio is still highly significant and virtually unchanged (0.33), the coefficient for the real interest rate becomes positive and non-significant when Sweden is excluded from the panel in the model with the debt-to-income ratio. In the next section, we discuss the interplay between real house prices and the real interest rate in more detail, and look at why the uncertainty regarding its impact is so substantial in our models in Table 1.

overvaluation of other financial assets. In fact, dropping net financial wealth as an explanatory variable improves the fit of the models for Sweden, because of our constructed Swedish net financial wealth series is so volatile (see panel b in Figure 4). We present the results for this simplified variant of the regressions in equations (1) and (2) in Appendix B.

In conclusion, there is no obvious overvaluation of the Swedish housing stock as a whole, since even the model that does not include indebtedness indicates that the valuation of Swedish houses is in line with fundamental variables. But since the model that includes indebtedness fits the data better, both internationally and for Sweden, there is nevertheless a risk that prices and the high level of indebtedness are not sustainable in the long term if the supply of capital decreases and interest rates rise rapidly. Further, it is important to note that these results only apply to the country as a whole, and do not say anything about valuation in individual municipalities. We will discuss pricing in individual municipalities in Section 3. But before we do, we will discuss the interpretation of the regression results in a little more detail based on existing economic theory.

Figure 6. Actual and estimated house prices from the regression model with indebtedness (regression in equation 2)



Note. The estimated prices (dashed red lines) have been calculated using the estimated coefficients reported in the right-hand column in Table 1.

2.3 How can the regression results be interpreted?

In this section, we present what economic theory says about the share of household expenses that go to housing and what that means for house prices in the long term. An important concept in this context is “user cost”, that is the cost of owning and using a home as a share of its price. The user cost for housing (uc) includes a financial cost comprising the real interest rate for the mortgage (or the return on another investment with a risk similar to housing) and other components, such as property tax, tax relief on interest expenditure and expected house price increases, as well as costs for operation and maintenance.¹⁸

Economic theory and empirical data support the idea that households will in the long term choose to spend a fixed proportion of their income on housing.¹⁹ We can then calculate what these housing costs signify for house prices. We do that both with a macroeconomic model, Walentin 2014, and in the simplest possible way.

Let us begin with the simple method. We can express the housing expenditure share in the long term, HES , as

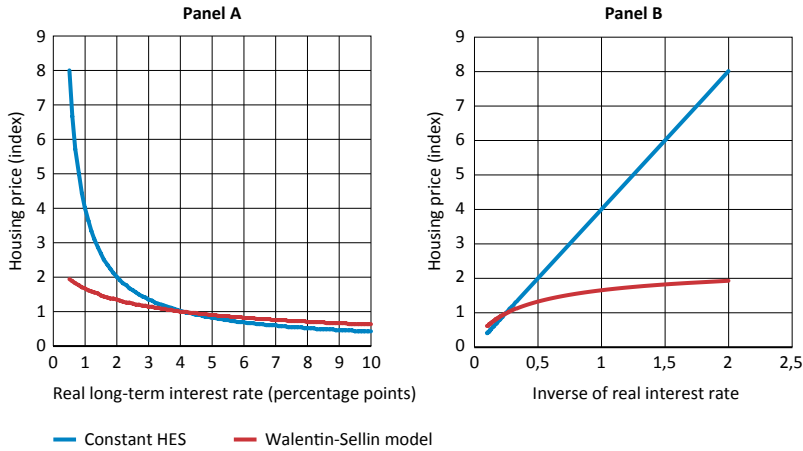
$$(3) \quad HES = \frac{r^* p^h \bar{h}}{y},$$

Where r^* is the real interest rate in the long term, p^h is the real house price, \bar{h} the housing stock and y the real disposable income per capita. We assume that \bar{h} is constant in this reasoning. The relationship in equation (3) is of course a stylised picture of the real housing cost in that we use the real interest rate instead of the user cost for housing. In other words, we disregard property tax, tax relief on interest expenditure and expected house price increases as well as the costs for operation and maintenance, as they are difficult to measure over time in many countries. We discuss the interplay between r^* and uc below, but assume for the time being that variations in r^* are the most important source of variations in uc in the long term. This is often a reasonable assumption possibly with the exception of property tax changes.

An important insight from equation (3) is that the relationship between the real interest rate and house prices is non-linear. A change in the real interest rate from 6 to 5 percentage points is not a big issue, but a fall from 2 to 1 per cent provides major leverage on house prices if HES is assumed to be constant. The interplay between the real interest rate and house prices is illustrated in Figure 7.

¹⁸ See Englund (2011) for a detailed discussion of the user cost for housing.

¹⁹ Cobb-Douglas preferences for consumption over housing services and consumption of other goods and services imply that households spend a constant share of their income on housing in the long term. For example, the influential article by Iacoviello (2005) makes this assumption.

Figure 7. Relationship between user costs and house prices

The blue line in Panel A in the figure (“Constant HES”) indicates the value of p^h which, according to equation (3), implies a given housing expenditure share, HES, when we vary the real interest rate, r^* , along the x-axis. The red line in the same figure (“Walentin-Sellin”) indicates the long-term house price that the model from Walentin (2014) implies.²⁰ The main differences compared to equation (3) is that the Walentin-Sellin model takes into account the fact that

- i. the housing stock is adjusted upwards when house prices rise over the long term (h in equation (3) increases)
- ii. user costs include not only interest but also operation and maintenance costs for the house of 4 percentage points annually.

Both these aspects moderate the change in the house price that an interest rate change implies and is quantitatively of about the same importance. A long-term reduction in the annual real interest rate from 4 to 1 percentage point leads to, according to this model, an increase in the housing stock of 54 per cent, which is a substantial increase. If such an increase in the stock cannot materialise, the price pressure will be higher in the model. Despite the large increase in the stock, such a long-term reduction in the real interest rate will lead to the price of housing rising by 65 per cent, according to Walentin-Sellin.

Panel B in Figure 7 instead indicates the relationship between the inverse of the real interest rate ($1/\text{the real interest rate}$) and the house price. A fixed housing expenditure share, “Constant HES”, implies a linear relationship between these

²⁰ The house price is normalised to 1 when the real interest rate is 4 per cent in both models.

variables, while Walentin-Sellin implies that the house price is a concave function of the inverse of the interest rate, because the supply of housing increases when the real interest rate persistently falls and the user cost includes not just the interest rate, as we have discussed previously.

What do these relationships look like in actual data? The regressions in Table 1 indicated quite a low coefficient for the real interest rate, but the regressions were done for a predominant proportion of high outcomes for the real interest rate (see Panel C in Figure 4), which implies that the estimated coefficient should be limited according to the reasoning concerning equation (3) above. We therefore now perform a more direct test of the theoretical, long-term relationship between the inverse of the real interest rate and house prices by studying the actual relationship between these variables for each country in Figure 8. A value of 1 on the x-axis in Figure 8 therefore means that the real interest rate is 1 per cent, and a value of 0.5 that the real interest rate is 2 per cent. Most of the values on the x-axis are below 1 as real interest rates have fallen over time from quite high levels.²¹ This can be seen, for example, in Panel C in Figure 4. Apart from data, the panels also contain the concave relationship implied by the Walentin-Sellin model and the linear pricing relationship implied by a constant housing expenditure share for a fixed housing stock (HES in equation 3).²² We note that an overwhelming proportion of the observations tend to be between these two lines. The simple linear regression is not suitable for Germany in particular, but also for the United States. As far as Germany is concerned, we see, surprisingly enough, a negative relationship between the inverse of the real interest rate and house prices, which is in strong contrast to economic theory.²³

If we disregard Germany, the overall impression from the figure is that, although prices have not risen as much as a constant housing expenditure share

21 We should also bear in mind that the theoretical relationship is between long-term levels of the real interest rate, while the data is for real mortgage rates with interest-rate fixation periods that vary from one country to the next. Internationally speaking, Sweden and the UK, for example, have a low average interest-rate fixation period of about 2 years. Despite this, the linear relationship is suitable for both these countries. Surprisingly enough, the relationship is less suitable for the US, which is a country with long interest-rate fixation periods, i.e. the current interest rate is a long-term interest rate.

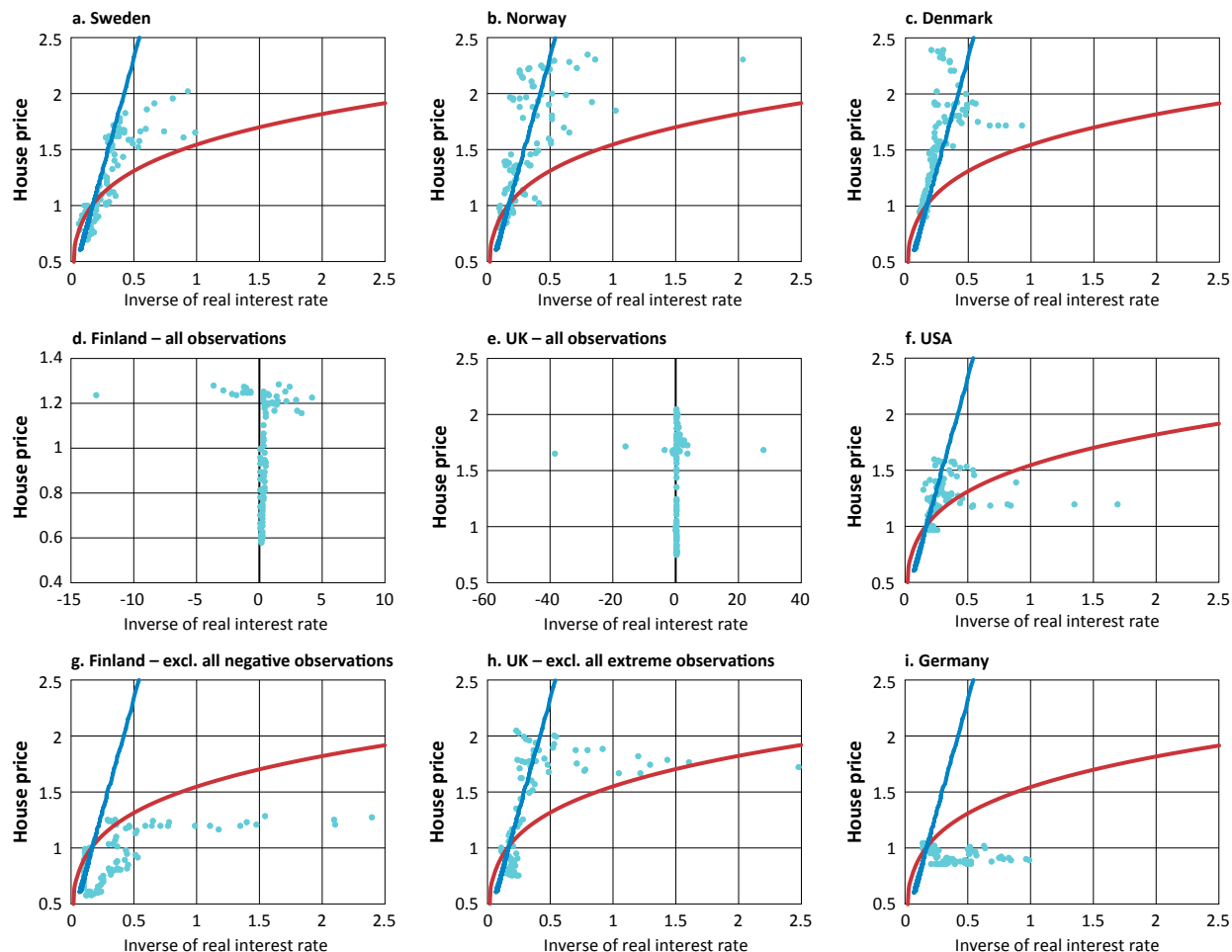
22 To be able to compare the results for Finland and the UK with the other countries in a better way, we exclude in Panels G and H all observations that have a negative real interest rate along with an observation for the UK that has a very low real interest rate (0.036 percentage points, which implies an inverse of 28). Panels D and E show the results for all observations included (but without the models).

23 The fact that Germany has such a divergent relationship between house prices and the real interest rate, and that there are a couple of large “outliers” in the real interest rate for Finland and the UK (which is indicated by Panels D and E in Figure 8) means that the coefficient for the real interest rate is pushed down in our estimated regression models in Table 1. If we re-estimate the models and exclude Germany and these observations for Finland and the UK, the coefficients for the real interest rates increase sharply, but household indebtedness is still strongly significant. Our earlier conclusions are not therefore affected. In future work, it would be desirable to compute real rates as the nominal rate minus long-term inflation expectations rather than subtracting the yearly change in the CPI as we did.

with a fixed supply of housing would imply, prices have in general risen more than what is implied by the Walentin-Sellin model with an endogenous (increased) supply of housing. This is probably explained by the fact that several countries find it difficult to increase the effective housing stock; it is often said that countries such as Denmark, Norway, the UK and Sweden have structural difficulties to increase the supply of housing in locations where people want to live.²⁴ This analysis therefore also indicates that although Swedish houses are currently very highly valued, it is difficult to claim that they are obviously overvalued. The prices can nevertheless be corrected downwards if the supply increases sharply, but we know that this is politically difficult to achieve.²⁵

24 See Hilber and Vermeulen (2016) for a discussion on supply problems in the UK. The IMF (2016) discusses supply problems on the Danish housing market and Emanuelsson (2015) the supply problems in Sweden.

25 See Emanuelsson (2015) for a detailed discussion of various political obstacles to increasing the supply of housing in Sweden.

Figure 8. Long-term relationship between the inverse of the real interest rate and house prices

Note. The blue line describes the relationship between house prices and the inverse of the real interest rate according to a constant housing expenditure share (equation 3). The red line is the theoretical relationship according to the Walentin-Selling model. Both lines are taken from Panel B in Chart 7. House price data for Finland and the UK (SB) is reported twice – first the complete dataset (Panels D and E) and then with the same scale as for all the other countries (Panels G and H) where all negative observations have been excluded. Additionally, for both Finland and the UK, extreme values (>2.5) of the inverse real rate have been excluded. Both lines have been normalised so that they intersect at the point at which house prices are 1 and the inverse of the real interest rate is 0.167 as this is the case in the start period for our sample (1 follows from the normalisation of house prices we did in the first quarter of 1990, see notes on Charts 1 and 2).

3 Analysis on the municipal level

We now study how house prices have developed in individual municipalities in Sweden, and whether we can draw the conclusion that the price development in individual municipalities is justified by the income development and the fall in real interest rates, or if prices in certain municipalities have risen much more.

We start by describing the data that we have at our disposal, and then present the results from our simple regression analysis.

3.1 Data

On the municipal level, there is annual data on median earned income available from Statistics Sweden.²⁶ Furthermore, there is data on the mean value for house prices per municipality available per year.²⁷ Please note that the data here concerns the price of a house in that municipality, $\tilde{p}_{j,t}^h$, not the quality-adjusted price per square metre, $p_{j,t}^h$. If we assume that households pay the same interest and property tax, we can calculate from the house price and disposable income the share of income that households in each municipality j spend on their housing in year t according to the following formula:

$$(5) \quad HES_{j,t} = \frac{uc_t \tilde{p}_{j,t}^h}{y_{j,t}}.$$

In equation (5), $HES_{j,t}$ represents the share of income, $y_{j,t}$, that homeowners in municipality j *implicitly* spend on their housing. We write *implicitly* because this is a calculation based on a so-called “user cost”, i.e. a calculation where the cost is calculated as if the household constantly borrows the entire current price of the home from a bank and pays property tax. As mentioned above, we assume here that this user cost, uc_t , is the same in all municipalities. We approximate uc_t with a nominal mortgage rate adjusted by actual inflation, tax relief on interest expenditure and property tax according to the following formula:

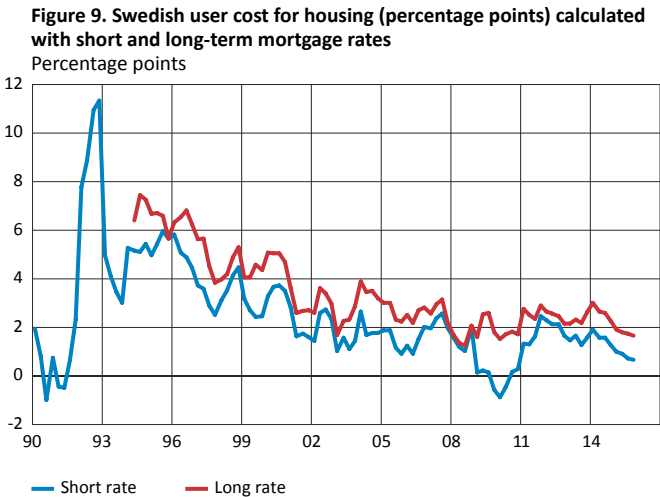
$$(6) \quad uc_t = i_t^{loan} (1 - \tau_t) - \pi_t^e + fs_t.$$

In equation (6), i_t^{loan} represents the nominal mortgage rate, τ_t the share of interest expenditure the household can deduct from income tax, π_t^e expected inflation (measured as the previous year’s inflation) and fs_t the effective property tax rate (in per cent). We disregard operational and maintenance costs, which are reasonable if they are approximately constant. Figure 9 shows the time series for

²⁶ Statistics Sweden. Purchase price for houses.

²⁷ Statistics Sweden. Aggregate earned income per municipality, per individual over the age of 20.

uc_t for two different measures of the mortgage rate; a rate with a short (3-month) fixation period and one with a long (8 year) fixation period. The average interest-rate duration for Swedish mortgages has fallen considerably since the housing crisis of the 1990s, and in that regard, the user cost series based on the short-term mortgage rate in Figure 9 is a more accurate measure of what the household has actually paid over the last decade.²⁸ Nevertheless, the user cost series based on the long mortgage rate is relevant as it measures what households should expect to pay over a longer period in the future if we assume that the long-term mortgage rate is approximately equal to an average of expected short-term interest rates.²⁹



Note. Short interest rate refers to 3-months maturity, whereas the long interest rate refers to 8-years maturity.

Another property of the user cost measure in equation (6) is that it implicitly assumes that real house prices are expected to be constant. If the household expects a rise in house prices by a certain percentage, the effective housing cost would need to be reduced by an equivalent percentage (adjusted for the capital gains tax rate), as an expected increase leads to ownership of the home

28 The proportion of variable rate mortgages in the stock of mortgages has gone from below 20 per cent to above 60 per cent from 1998 to 2015 according to the 2016 Financial Stability Report.

29 The expectation hypothesis implies that the long-term interest rates is equal to an average of present and future short interest rates plus a risk and liquidity premium. The long-term interest rate we use to calculate the user cost series in Figure 9 still contains a risk premium, and therefore gives a certain overestimation of the expected future housing cost when the household borrows with a short fixation period. As long as the risk premium is constant, we catch the variation in future expected interest expenditure well. Historically, however, there is considerable time variation in this risk premium.

being worth more in the next period. On good grounds, we can question this simplified assumption as Figure 1 shows that the real house prices for the country as a whole have increased at a quite steady rate since the housing crisis at the beginning of the 1990s. But it is important to differentiate between actual and expected increase. If everyone had expected a steady increase in real house prices for a number of years in the future already in 1995, prices should have reached current levels as early as at the end of the 1990s. It therefore seems reasonable to assume that market participants did not expect an increase in real house prices of the scale that has actually been recorded.

Still, it may be reasonable to make a certain adjustment to the user cost for an expected house price increase, especially bearing in mind that the trend in productivity growth in the construction sector is below the rest of the economy otherwise, which tends to drive up real house prices in the long term. But as we neither have access to any good measures of real house price expectations nor to productivity differences between the housing sector and other sectors, we do not make any adjustment for this effect. As a result, there is a clear tendency for both user cost series in Figure 9 to overestimate the effective housing cost. On the other hand and as mentioned above, we disregard operational and maintenance costs when we calculate the user cost. This gives a tendency in the opposite direction, towards underestimation of the user cost.

Bearing in mind this discussion of the effective user cost for housing, we use uc_t based on the long-term mortgage rate to calculate households' housing expenditure share for ($HES_{j,t}$ in equation 5 above) in Table 3 for a number of selected municipalities and the country as a whole.³⁰ Since we don't have data on income for the house-buyers in the various municipalities, we also implicitly assume that the house-buyers have the same income as other residents in the municipality. This assumption can be misleading in the municipalities where house prices have increased the most. In these municipalities, it seems reasonable to assume that the income of house-buyers exceeds the median income of the existing residents. Further, the assumption is problematic for municipalities where the median earned income is very different for house-owners compared to other local residents, such as those who rent their home.

In addition, there is a debatable assumption that affects the expenditure shares in table 3, namely that the income data we use is for earned income. The theory applies instead to housing costs as a share of total income. As a consequence, municipalities with a large share of other income, mainly income from capital, will be incorrectly seen as municipalities with a high housing

30 Even though we have annual data at our disposal, we only show the results for every 5th year starting in 1995.

expenditure share. It is possible that this income from capital partly explains the high expenditure share for housing in, for example, Danderyd in Table 3 below.

Table 3. Households' expenditure share for housing in selected municipalities and in the country

Municipality	1995	2000	2005	2010	2013	2014
Båstad	0.44	0.41	0.27	0.23	0.27	0.39
Danderyd	0.91	0.90	0.49	0.37	0.61	0.72
Göteborg	0.53	0.51	0.36	0.28	0.38	0.45
Lidingö	0.78	0.88	0.49	0.40	0.62	0.75
Linköping	0.37	0.34	0.25	0.18	0.25	0.29
Malmö	0.51	0.55	0.41	0.32	0.39	0.45
Nacka	0.63	0.70	0.42	0.33	0.48	0.56
Norrköping	0.34	0.29	0.21	0.16	0.22	0.25
Solna	0.65	0.92	0.56	0.41	0.55	0.72
Stockholm	0.54	0.63	0.40	0.30	0.44	0.52
Sundbyberg	0.62	0.82	0.45	0.39	0.51	0.58
Umeå	0.36	0.32	0.21	0.16	0.21	0.26
Uppsala	0.42	0.40	0.27	0.21	0.30	0.35
Västerås	0.38	0.32	0.25	0.17	0.22	0.27
Örebro	0.33	0.31	0.20	0.15	0.21	0.26
Country – mean	0.25	0.20	0.13	0.10	0.13	0.16
Country - median	0.22	0.17	0.10	0.08	0.11	0.13

We can also see in Table 3 that there is a substantial variation in the expenditure share for housing. Unsurprisingly, the share is lower in rural areas and in smaller towns than in the metropolitan municipalities listed in Table 3. Therefore, it will also be lower in the country on average. As regards to changes over time, we note that the share in 2014 is not unusually high from a historical perspective. This is due to the fact that the user cost has fallen more since 2000 than house prices have risen, at the same time as income growth has been good. The expenditure share has, however, risen sharply since 2010, especially in metropolitan municipalities, reflecting that prices have risen much more than income and that uc_t have been almost unchanged during this period (see Figure 9).

In summary, there is strong upward price pressure in the country as a whole and in metropolitan municipalities in particular. But thanks to the low user cost, households' expenditure share have remained normal or even lower than normal from a historical perspective, at least until the end of 2014.³¹ In the next section, we perform a slightly more rigorous analysis which results in the same conclusion.

3.2 Regression analysis

In light of the descriptive analysis in the previous section, we now perform a simple regression analysis. The aim of this is to investigate whether housing costs as a share of income in *individual municipalities* have developed in an unusual way more recently. To perform this analysis, we estimate the following simple regression where we assume that the housing expenditure share in municipality j , $HES_{j,t}$, depends on the earned income in the municipality relative to the average earned income in other municipalities in period t :

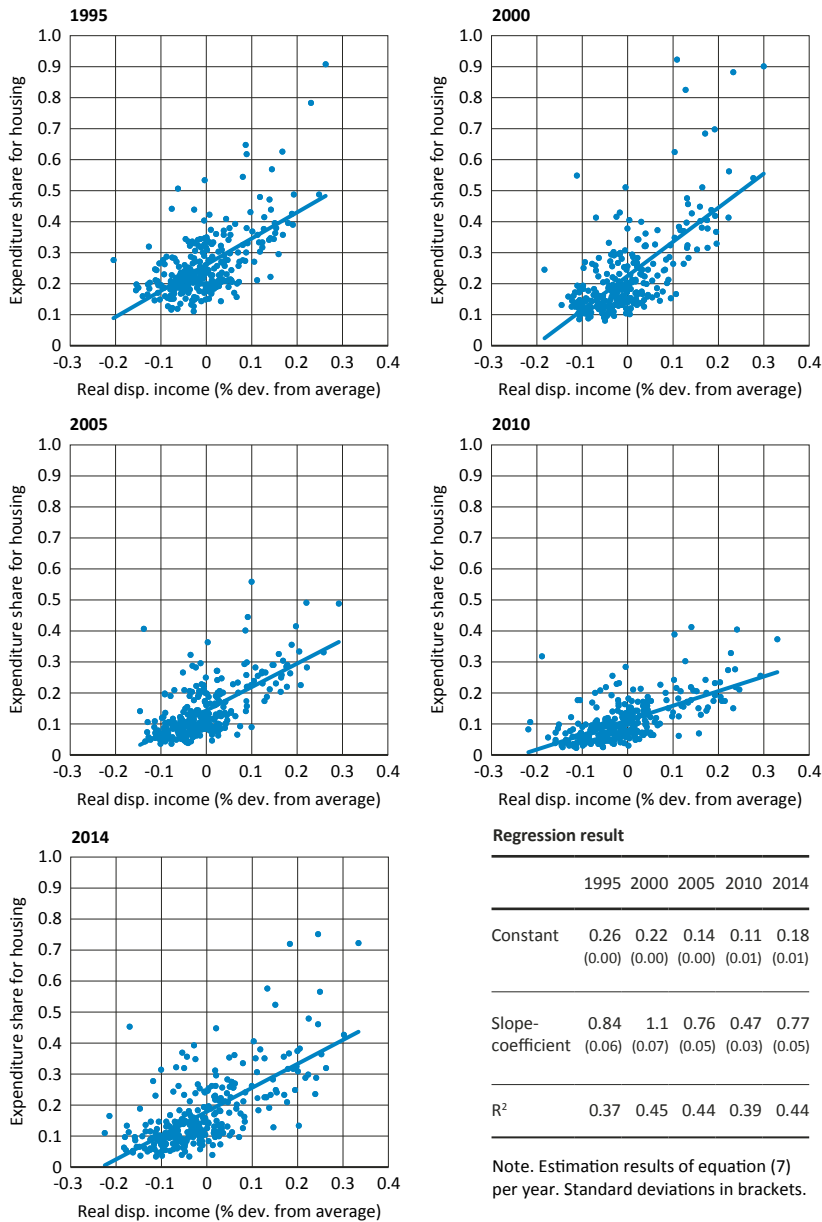
$$(7) \quad HES_{j,t} = \beta_{0,t} + \beta_{1,t} (\ln y_{j,t} - \ln \bar{y}_t) + \varepsilon_{j,t}.$$

There is no underlying theory behind the regression specification in equation (7), but Table 3 supports our assumption that households in municipalities with a high level of income spend a greater share of their income on housing. It is, however, important to remember that by allowing for this in the analysis, we purge a systematic income effect when we study whether the expenditure share has risen by an unusual amount in individual municipalities more recently.

We estimate the regression in equation (7) every 5th year for all $n=290$ municipalities. We are interested in three aspects of the regression. Firstly, we want to know whether $\beta_{1,t}$ has increased over time, i.e. whether the expenditure share has become more income-sensitive more recently. This would signify that households in municipalities with higher incomes have increased their expenditure share for housing. Secondly, the regression in equation (7) gives us a direct estimate of the residual, $\varepsilon_{j,t}$, for each municipality j , and, based on the estimate for 2014, we can study whether the residuals are unusually high in a historical perspective. We do this by selecting the municipalities that have the 10 largest residuals in 2014, and then reporting these municipalities' residuals for earlier years (1995, 2000, etc.) as well. Thirdly, we are interested in the regression's explanatory power. A falling explanatory power would indicate that there is a more unexplained dispersion of expenditure shares between the municipalities.

31 We know prices continued to rise sharply in 2015, but the distribution among municipalities and the extent to which this was compensated for by a falling user cost and rising incomes is currently unclear.

Figure 10. Regression results on the municipal level per year



Note. Own calculations as described in the main text around equation (7).
Sources: Aggregate earned income per municipality and purchase price for houses (mean value in SEK thousands by region and type of property per year), Statistics Sweden; User cost, the Riksbank

Figure 10 gives a graphical representation of the observations for each year together with the regression line from equation (7). As we see from the various panels in the figure, relative income differences among the municipalities explain the differences in housing costs relatively well. This can be seen formally from the lower right-hand panel, which reports the regression results. From these results, we see that income differences explain almost half of the dispersion in the expenditure shares. We also see that the explained share is stable; there is no tendency for it to decrease over time.

It is also clear from the regression results and the figures that the housing expenditure share, *HES*, is strongly dependent on the income in the municipality. Apart from a dip in 2010, this elasticity tends to be around 0.8. Strictly interpreted, this means that households in a municipality with 30-per cent higher earned income compared to the average municipality spend almost 24 percentage points more of their income on housing. Even so, the income elasticity is probably overestimated for reasons discussed previously. This is due partly to the fact that we don't base our income series on those who have actually bought a house in the various municipalities, and partly to the fact that earned income excludes income from capital. Irrespective of this, the most interesting aspect is that the sensitivity in relation to earned income has not increased over time. There is therefore no support for the idea that *HES* has systematically become more income-sensitive recently. This means that the tendency towards greater dispersion in the expenditure share since 2010 – and hence in house prices as well – as we see in Figure 10, is largely explained by the slight increase in the income spread among municipalities.

Of course, this does not preclude the possibility that the expenditure share has increased by an unusually large amount in certain high-income metropolitan municipalities in recent years. To study this, we select the 10 municipalities with the largest positive residuals, i.e. the deviations from the straight line which we derive from the regression in equation (7) for 2014. Once we have selected the municipalities with the 10 largest deviations in 2014, we then study their deviations for all the previous years. This allows us to place the deviations for 2014 in a historical perspective, and to analyse whether the deviation in 2014 is unusually large from a historical perspective. Table 4 shows the results of this exercise. Panel A reports unexplained housing costs as a share of income for each year, i.e. $\varepsilon_{j,t}$ in equation (7), while Panel B reports the results in Swedish kronor (SEK), i.e. $\varepsilon_{j,t} \times y_{j,t}$.

Table 4. Municipalities with the most positive unexplained housing expenditure share in 2014 according to regression (7)

Panel A: Unexplained housing costs as a share of earned income

Municipality	2014*	2013	2010	2005	2000	1995
Malmö	0.41	0.36	0.30	0.37	0.45	0.30
Solna	0.40	0.29	0.24	0.34	0.58	0.31
Lidingö	0.38	0.31	0.18	0.18	0.40	0.33
Sundbyberg	0.30	0.28	0.23	0.23	0.46	0.28
Danderyd	0.29	0.24	0.11	0.12	0.35	0.42
Göteborg	0.25	0.22	0.18	0.22	0.29	0.27
Båstad	0.24	0.14	0.13	0.16	0.26	0.24
Botkyrka	0.23	0.20	0.13	0.16	0.18	0.11
Stockholm	0.23	0.19	0.13	0.19	0.29	0.22
Strömstad	0.21	0.17	0.12	0.10	0.13	0.10

Panel B: Unexplained housing costs in SEK (real)

Municipality	2014*	2013	2010	2005	2000	1995
Malmö	83,445	72,877	56,454	70,764	80,749	48,125
Solna	117,712	81,828	62,920	82,865	130,065	58,356
Lidingö	119,996	94,261	53,133	49,468	102,162	70,817
Sundbyberg	82,673	76,021	59,057	56,380	105,367	52,749
Danderyd	97,624	80,006	34,544	36,663	94,296	94,562
Göteborg	63,309	52,846	40,335	48,396	58,410	46,924
Båstad	56,132	32,579	29,365	34,094	49,788	38,848
Botkyrka	53,540	44,678	28,804	33,602	35,739	19,698
Stockholm	64,875	52,590	34,325	46,331	64,218	39,974
Strömstad	47,002	37,543	26,485	21,393	23,323	15,502

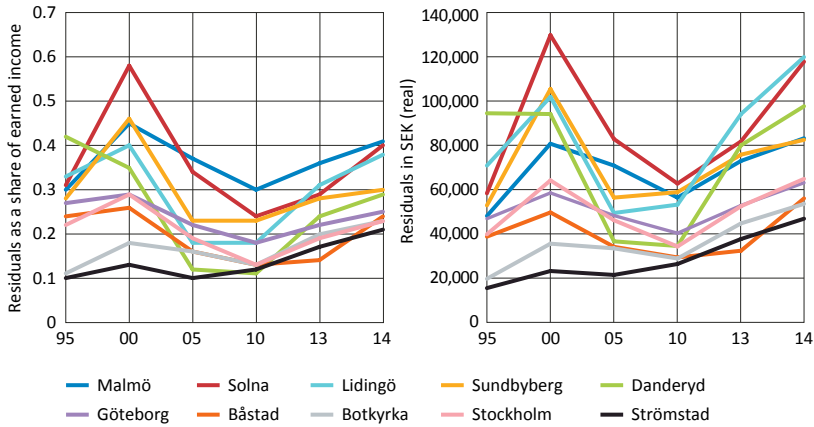
Note. * indicates that we have selected municipalities with the largest positive unexplained expenditure share in 2014, i.e. $\epsilon_{j,2014}$. For the other years, we report the unexplained variation in the expenditure shares for the same municipalities. In Panel B, we multiply the unexplained share by the real earned income, to obtain the unexplained variation in user cost in SEK (in real terms).

As is clear from the results in Table 4, all the municipalities with the largest share of unexplained HES are metropolitan municipalities, with the exception of Båstad and Strömstad, two very attractive holiday resorts on Sweden's west coast. Malmö is the municipality with the largest unexplained share of HES. In Table 3 we could see that households in Malmö spend 45 per cent of their earned income on housing, while the average for the country as a whole is 16 per cent. This is a difference of 29 percentage points. How is it then that we report a residual of 41 percentage points for Malmö in Table 4? Well, households in Malmö have 17 per cent lower earned income than the average household in the country as a whole (SEK 205,788 compared to SEK 243,829). Our regression then implies, according to the table in Figure 10, that households in Malmö should spend $0.18 + 0.77 = 0.04$, i.e. only 4 percentage points of their earned income on housing. In reality, however, they spend 45 percentage points, i.e. 41 percentage points more than they should according to normal patterns for all municipalities for our linear regression specification. Correspondingly for Danderyd, the municipality with the second largest HES of 72 percentage points, the residual is only 29 per cent since household earned income there is 34 per cent higher than in the country as a whole. We can use similar reasoning to explain the figures for the other municipalities in Table 4.

It is reasonable to think that omitted factors like urbanisation and problems in increasing the supply of housing to meet the increase demand are the underlying causes of the high proportion of unexplained variation in these municipalities. Even so, it is worth noting that our analysis indicates that the unexplained variation in HES at the end of 2014 is not unusual from a historical perspective in these municipalities. As is evident from Table 4, the proportion of unexplained variation was just as large as during the second half of the 1990s. If anything, it seems possible to make a case that the house valuations in several of these municipalities were unusually low in 2005-2010 given the fall in the user cost, and that prices have now caught up with the falling user cost.

Figure 11 documents the development over time of the residuals from Table 4. The figure confirms that the increase in residuals from 2010 to 2014 (and also 2013-2014) is substantial for several municipalities. But in terms of levels, the residuals for the studied municipalities are close to what they were in 2000. A tentative interpretation of this is that omitted variables and measurement issues cause municipalities to differ in the long term in a way that makes the housing costs deviate from equation (7). As mentioned above, there are many possible reasons why the simple linear regression in equation (7) does not perfectly capture the relationship between housing costs and earned income.

Figure 11. Development over time of the unexplained housing expenditure share in the top-10 municipalities in 2014



The figure also shows the substantial covariation among the municipalities. This is due to the fact that the user cost, uc_t , is common for all municipalities. This should actually be captured by our regression model in equation (7), but this does not happen in our simple linear approach. In this context, it is worth noting that a linear-quadratic model fits the data better than our linear approach.³² This reflects that HES in high-income municipalities generally seems to be more income-sensitive than in low-income municipalities, and this increased income sensitivity is captured better in a linear-quadratic model than in our linear model. It is important to realise, however, that although the data fit is significantly better with a linear-quadratic model, it does not affect the conclusion that the residuals tend to be greatest in metropolitan areas. Nor does it affect the conclusion that the residuals have not increased noticeably since the end of the 1990s.³³

32 In a linear-quadratic approach, the model's explanatory power increases to as much as 0.46, 0.52, 0.47 and 0.43 and 0.49 for 1995, 2000, 2005, 2010 and 2014. These are significantly higher coefficients of determination compared to the linear model, whose coefficients of determination are reported in Figure 10. Another advantage of the linear-quadratic approach is that low-income municipalities, such as Malmö in the example above, are not given such a low predicted expenditure share. An alternative to a more advanced econometric specification in order to increase the explanatory power is to include more explanatory variables, e.g. number of people moving into the area, new construction and associated costs, see the IMF's (2016) study of regional house price differences in Denmark.

33 These is one exception, however, and that is Danderyd: Households in Danderyd have a much higher earned income than households in other municipalities in 2014 (34 per cent higher), which, according to a linear-quadratic approach results in a much higher expenditure share and knocks Danderyd off the top-10 list.

4 Conclusions

In this article, we have studied the development of house prices in Sweden since 1990 and related it to international developments. Taken together, fundamental factors seem to be able to explain the high valuation for the country as a whole.³⁴ Compared with the other countries in the study, we note that Sweden has seen a strong increase in disposable income and financial net wealth along with a low level of housing investment. Together with substantial population growth and low real interest rates in recent years, these factors have contributed to the sharp increase in house prices during the period 1995-2015 in Sweden. But for several other countries, such as Denmark, Norway and the UK, the recent upturn in house prices can only be fully explained if we include increased household indebtedness. This indicates that imbalances may have accumulated on the housing markets of these countries.³⁵ The exception is Germany, where our results indicate that house prices may be considerably undervalued.

We have also studied the price development on the municipal level in Sweden to see if obvious imbalances have built up locally. We have focused particularly on municipalities that, compared with others, had unusually high housing costs in relation to earned income in 2014.³⁶ Unsurprisingly, we found that most of these are metropolitan municipalities. Even so, by calculating the housing expenditure shares for the municipalities back to 1995, we found that this relationship was not new – these municipalities have had a higher housing expenditure share compared with the average municipality for a long time.

It is important to note that we have only studied the pricing of houses (single-family dwellings), and therefore cannot say anything about the pricing of tenant-owned apartments. According to Valueguard's price index, which is only available from 2005 and onwards, prices of apartments have increased twice as fast as house prices in the country between January 2005 and 2015, an increase of 138 per cent compared with 71 per cent in nominal terms.³⁷ As house prices according to our study have risen well in line with fundamental factors, it can be reasonably assumed that prices of apartments in Sweden have increased more than historical patterns. In all likelihood, this reflects even greater limitations in the supply of apartments in the metropolitan areas and an increased preference for living in

34 Thus, we reach a somewhat different conclusion than some earlier studies, for instance the European Commission (2016). The main reason is that our methodology allows for more economic explanatory variables in addition to income (notably, the real interest rate) to affect the "fundamental" value of houses.

35 The UK stands out in this context. This might be explained by the fact that several international investors have invested in properties in the UK in general, and in London in particular, see Valentine (2015).

36 Data for 2015 and 2016 are not yet available.

37 Please note also that this discrepancy is not driven by geography: even if we only look at the Stockholm region, the increase in the prices of tenant-owned homes has been twice as high as for houses.

large cities among households. More studies are needed here. It would also be of interest to increase the number of countries in our panel (e.g. Australia, Belgium, Canada, France, Ireland, Italy, The Netherlands and Spain) to see whether our findings are robust when a larger number of countries is included.

According to the methods we have used, there is no evident overvaluation of houses in Sweden, either in the country as a whole or in the municipalities for which we have data. Perhaps surprisingly, it seems possible to explain the increase that has occurred by common macroeconomic variables. It is of key importance, however, to realise that the high valuation of Swedish houses is only sustainable in the long term if real interest rates remain low for the foreseeable future. If the economy experienced an unexpected, sharp and permanent increase in the real interest rate, for example as the result of an international banking crisis with significant contagion effects on Swedish banks, there is a risk of a rapid downward correction in house prices. The risk of this correction being large and difficult to handle from a stabilisation policy point of view increases if households expect real interest rates to remain low for the foreseeable future and therefore tend to take out large mortgages to finance their expensive housing purchases. There may therefore be reason to be concerned about developments on the Swedish housing market, and, as we see it, also good reason to limit further increases in household indebtedness until the effects of the global financial crisis subside and we can observe whether interest rates remain permanently low.

Most of today's housing policy debate in Sweden concerns reducing household demand for housing by limiting their ability to take out a mortgage, introducing amortisation requirements, and making house purchases more expensive by reducing the tax relief on interest expenditure and increasing the property tax. We believe that such measures, properly sized to take initial conditions of high debt levels and constraints on monetary policy accommodation into account, can be important in the near term. Even so, more beneficial effects on the economy as a whole can be achieved in the longer term if prices can be held back by satisfying the demand for houses by an increase in the effective supply, something which the International Monetary Fund emphasised in its Article IV Report for Sweden 2015 (see IMF, 2015). It is therefore of grave importance that the responsible politicians roll up their sleeves and sit down at the table to work on resolving the fundamental housing supply problems highlighted by Emanuelsson (2015) in his article.

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APPENDIX A – Data sources and transformations

Below we describe data sources and the transformations we have performed on the data used in Section 2. We present the data per country in alphabetical order.

Denmark

Variable	Source	Description
House prices	Dallas FED	Seasonally adjusted real house price index (RHPI), normalised to 1 1990Q1.
Disposable income	Dallas FED	Seasonally adjusted real disposable income index (RPDI), normalised to 1 1990Q1.
Residential investment	Danmarks Nationalbank	Nominal residential investment (N.111) divided by nominal GDP (B.1*g). In percentage points.
Inflation	The Riksbank (DORIS)	Annual inflation in percentage points, i.e. 100 multiplied by the logarithm of the fourth differential for the seasonally adjusted CPI.
Real mortgage rate	Danmarks Nationalbank	Nominal mortgage rate (30 years) minus inflation (calculated as above).
Population growth	EUROSTAT	Based on annual data on the population level, we estimate a quarterly series via a cubic spline. The population growth is then calculated as the logarithm of the fourth differential for the quarterly series. Percentage points.
Debt-to-income ratio	Danmarks Nationalbank	Household indebtedness (nominal) as a share of nominal disposable income. Percentage points.
Net wealth	OMXC20; OECD	Total household wealth minus their debt (nominally) divided by the CPI, normalised to 1 1990Q1. Since the OECD only has annual data for 1995-2015, quarterly data is generated by splining out the series with the OMXC20 stockmarket price index (ultimo) which is available at a quarterly frequency 1990-2015.

Finland

Variable	Source	Description
House prices	Dallas FED	Seasonally adjusted real house price index (RHPI), normalised to 1 1990Q1.
Disposable income	Dallas FED	Seasonally adjusted real disposable income index (RPDI), normalised to 1 1990Q1.
Residential investment	Statistics Finland	Nominal residential investment (P51/ N1111+N1112) divided by nominal GDP (B1GMHT). In percentage points.
Inflation	The Riksbank (DORIS)	Annual inflation in percentage points, i.e. 100 multiplied by the logarithm of the fourth differential for the seasonally adjusted CPI.
Real mortgage rate	Bank of Finland; Statistics Finland	Weighted nominal mortgage rate (all maturities) minus inflation (calculated as above).
Population growth	EUROSTAT	Based on annual data on the population level, we estimate a quarterly series via a cubic spline. The population growth is then calculated as the logarithm of the fourth differential for the quarterly series. Percentage points.
Debt-to-income ratio	Bank of Finland; Statistics Finland	Household indebtedness (nominal) as a share of nominal disposable income. Percentage points.
Net wealth	OMXH25; OECD	Total household wealth minus their debt (nominally) divided by the CPI, normalised to 1 1990Q1. Since the OECD only has annual data for 1995-2015, quarterly data is generated by splining out the series with the OMXH25 stockmarket price index (ultimo) which is available at a quarterly frequency 1990-2015.

Norway

Variable	Source	Description
House prices	Dallas FED	Seasonally adjusted real house price index (RHPI), normalised to 1 1990Q1.
Disposable income	Dallas FED	Seasonally adjusted real disposable income index (RPDI), normalised to 1 1990Q1.
Residential investment	SSB	Nominal residential investment divided by nominal GDP (whole economy). In percentage points.
Inflation	The Riksbank (DORIS)	Annual inflation in percentage points, i.e. 100 multiplied by the logarithm of the fourth differential for the seasonally adjusted CPI.
Real mortgage rate	SSB	Weighted nominal mortgage rate (applies to banks up until 2007, banks and credit companies thereafter) minus inflation (calculated as above).
Population growth	EUROSTAT	Based on annual data on the population level, we estimate a quarterly series via a cubic spline. The population growth is then calculated as the logarithm of the fourth differential for the quarterly series. Percentage points.
Debt-to-income ratio	SSB; Norges Bank	Household indebtedness (nominal) as a share of nominal disposable income. Percentage points.
Net wealth	Oslo Børs; OECD	Total household wealth minus their debt (nominally) divided by the CPI, normalised to 1 1990Q1. Since the OECD only has annual data for 1995-2015, quarterly data is generated by splining out the series with the OMXO20 stockmarket price index (ultimo) which is available at a quarterly frequency 1990-2015.

UK

Variable	Source	Description
House prices	Dallas FED	Seasonally adjusted real house price index (RHPI), normalised to 1 1990Q1.
Disposable income	Dallas FED	Seasonally adjusted real disposable income index (RPDI), normalised to 1 1990Q1.
Residential investment	Bank of England	Nominal residential investment (Sector S.1, Asset AN.111) divided by nominal GDP. In percentage points.
Inflation	The Riksbank (DORIS)	Annual inflation in percentage points, i.e. 100 multiplied by the logarithm of the fourth differential for the seasonally adjusted CPI.
Real mortgage rate	Bank of England	Nominal mortgage rate (2 years, 75% LTV fixed interest) minus inflation (calculated as above).
Population growth	EUROSTAT	Based on annual data on the population level, we estimate a quarterly series via a cubic spline. The population growth is then calculated as the logarithm of the fourth differential for the quarterly series. Percentage points.
Debt-to-income ratio	Office for National Statistics, Bank of England	Household indebtedness (nominal) as a share of nominal disposable income. Percentage points.
Net wealth	Google Finance; OECD	Total household wealth minus their debt (nominally) divided by the CPI, normalised to 1 1990Q1. Since the OECD only has annual data for 1995-2015, quarterly data is generated by splining out the series with the FTSE100 stockmarket price index (ultimo) which is available at a quarterly frequency 1990-2015.

Sweden

Variable	Source	Description
House prices	Dallas FED	Seasonally adjusted real house price index (RHPI), normalised to 1 1990Q1.
Disposable income	Dallas FED	Seasonally adjusted real disposable income index (RPDI), normalised to 1 1990Q1.
Residential investment	Statistics Sweden, the Riksbank; OECD	Real residential investment divided by real GDP (NR0103CE) up to 1992. The remaining data is from the OECD in nominal terms. In percentage points.
Inflation	The Riksbank (DORIS)	Annual inflation in percentage points, i.e. 100 multiplied by the logarithm of the fourth differential for the seasonally adjusted CPIF.
Real mortgage rate	Statistics Sweden, the Riksbank	Weighted nominal mortgage rate (all maturities) minus inflation (calculated as above).
Population growth	EUROSTAT	Based on annual data on the population level, we estimate a quarterly series via a cubic spline. The population growth is then calculated as the logarithm of the fourth differential for the quarterly series. Percentage points.
Debt-to-income ratio	Statistics Sweden, the Riksbank	Household indebtedness (nominal) as a share of nominal disposable income. Percentage points.
Net wealth	OMX30; OECD	Total household wealth minus their debt (nominally) divided by the CPIF, normalised to 1 1990Q1. Since the OECD only has annual data for 1995-2015, quarterly data is generated by splining out the series with the OMX30 stockmarket price index (ultimo) which is available at a quarterly frequency 1990-2015.

Germany

Variable	Source	Description
House prices	Dallas FED	Seasonally adjusted real house price index (RHPI), normalised to 1 1990Q1.
Disposable income	Dallas FED	Seasonally adjusted real disposable income index (RPDI), normalised to 1 1990Q1.
Residential investment	OECD	Nominal residential investment divided by nominal GDP. In percentage points.
Inflation	The Riksbank (DORIS)	Annual inflation in percentage points, i.e. 100 multiplied by the logarithm of the fourth differential for the seasonally adjusted CPI.
Real mortgage rate	Deutsche Bundesbank	Weighted nominal mortgage rate minus inflation (calculated as above).
Population growth	EUROSTAT	Based on annual data on the population level, we estimate a quarterly series via a cubic spline. The population growth is then calculated as the logarithm of the fourth differential for the quarterly series. Percentage points.
Debt-to-income ratio	BIS; The Riksbank (DORIS); Bundesbank	Household indebtedness as a percentage of GDP (BIS total credit statistics, Q:DE:H:A:M:770:A) multiplied by nominal GDP and then divided by nominal disposable income from Bundesbank. Percentage points.
Net wealth	Google Finance; OECD	Total household wealth minus their debt (nominally) divided by the CPI, normalised to 1 1990Q1. Since the OECD only has annual data for 1995-2015, quarterly data is generated by splining out the series with the DAX stockmarket price index (ultimo) which is available at a quarterly frequency 1990-2015.

US

Variable	Source	Description
House prices	Dallas FED	Seasonally adjusted real house price index (RHPI), normalised to 1 1990Q1.
Disposable income	Dallas FED	Seasonally adjusted real disposable income index (RPDI), normalised to 1 1990Q1.
Residential investment	FRED database; OECD	Nominal residential investment divided by nominal GDP. Data from 1990Q1 up to and including 1994Q4 comes from a cubic spline of annual data from FRED (A011RE1A156NBEA). The rest is from the OECD. In percentage points.
Inflation	The Riksbank (DORIS)	Annual inflation in percentage points, i.e. 100 multiplied by the logarithm of the fourth differential for the seasonally adjusted CPI.
Real mortgage rate	FRED database	Nominal mortgage rate (30 years, MORTGAGE30US) minus inflation (calculated as above).
Population growth	FRED database	Based on quarterly data on the population level, population growth is calculated as the logarithm of the fourth differential. Percentage points.
Debt-to-income ratio	FRED database	Household indebtedness (CMDEBT) as a share of nominal disposable income (DPI). Percentage points.
Net wealth	Google Finance; OECD	Total household wealth minus their debt (nominally) divided by the CPI, normalised to 1 1990Q1. Since the OECD only has annual data for 1995-2015, quarterly data is generated by splining out the series with the S&P 500 stockmarket price index (ultimo) which is available at a quarterly frequency 1990-2015.

APPENDIX B – Model without net wealth

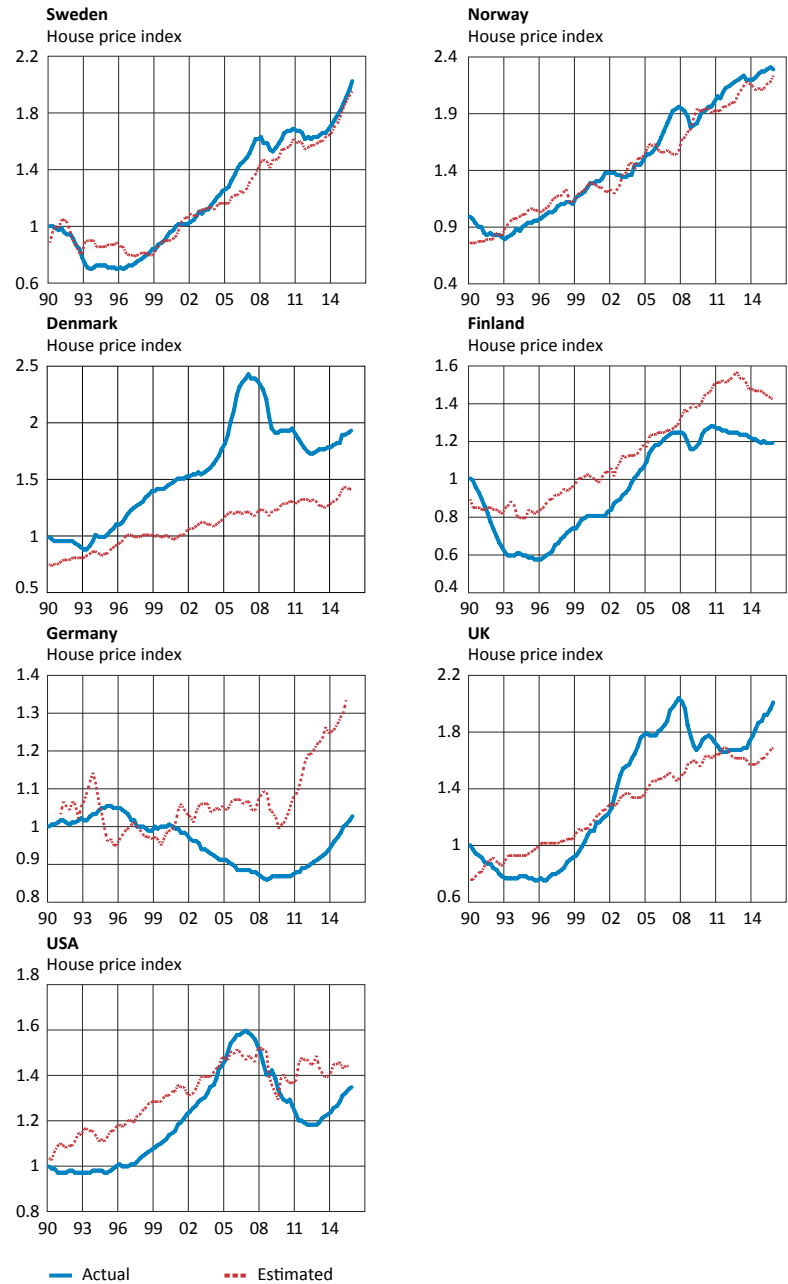
This appendix presents estimation results for the model without net wealth. Table B.1 presents the estimation results; the left-hand column excludes household indebtedness as an explanatory variable, while the right-hand column presents results when indebtedness is included as an explanatory variable. Compared with Table 1, the results in terms of parameter estimates are relatively stable. The coefficient for the debt-to-income ratio is virtually unchanged. We also see that the regression that includes household indebtedness as a dependent variable explains the variation in the data, both in total and for individual countries, much better.

Figures B.1 and B.2 show the actual and predicted house prices according to the models in Table B.1. We see that the actual prices, as far as Sweden is concerned at the end of 2015, are well in line with what the estimated models predict, which means that even if net wealth is excluded as an explanatory variable, there is no obvious overvaluation of house prices for the country as a whole.

Table B.1. Regression results for panel models of house prices, without net wealth

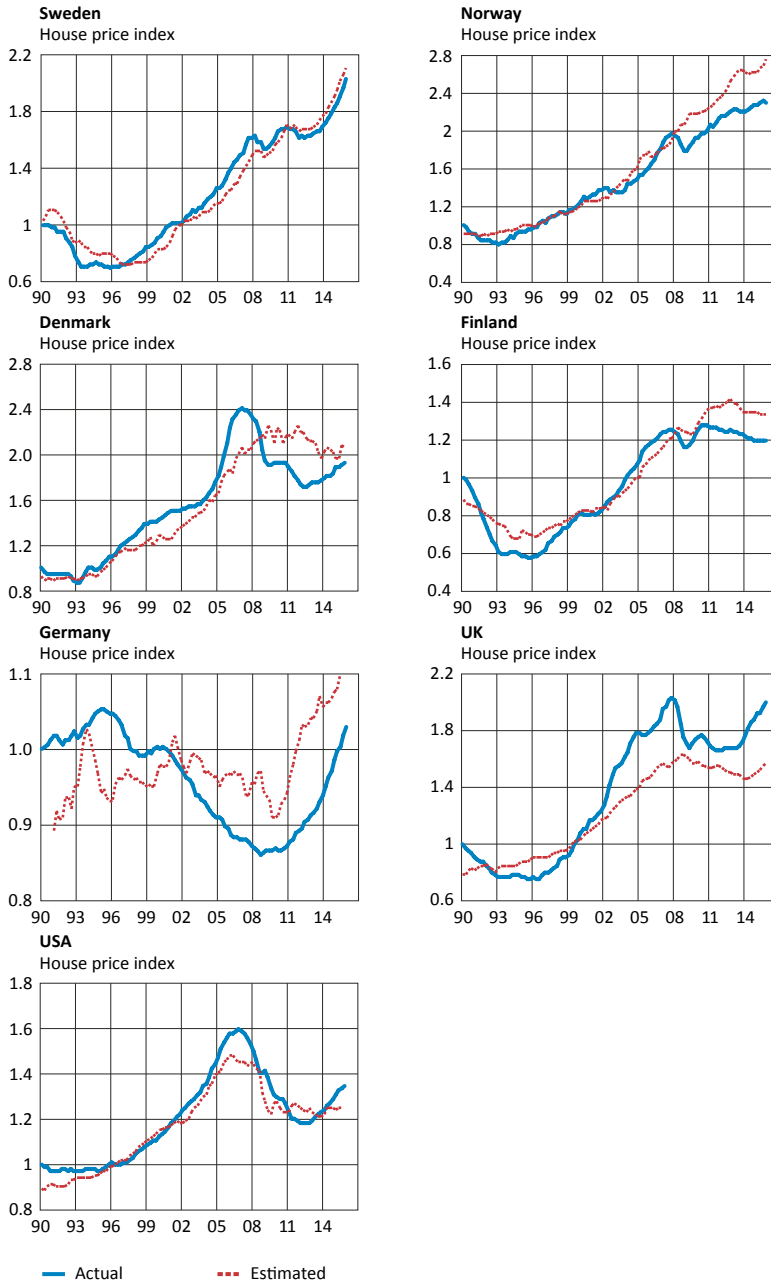
	Model without debt-to-income ratio			Model with debt-to-income ratio		
Variable	Coeff.	Std. Dev.	p-val	Coeff.	Std. Dev.	p-val
Disposable income	1.00	--	--	1.02	0.04	0.0000
Residential investment	1.58	0.57	0.0058	3.09	0.29	0.0000
Real mortgage rate	-2.54	0.31	0.0000	-0.78	0.22	0.0005
Inflation	-0.32	0.54	0.5603	0.68	0.29	0.0206
Population growth	23.77	2.20	0.0000	18.05	1.25	0.0000
Debt-to-income ratio	--	--	--	0.34	0.01	0.0000
Models' explanatory power - R^2_{adj}						
	Model without debt-to-income ratio			Model with debt-to-income ratio		
Total	0.63			0.91		
Individual countries						
Denmark	-0.65			0.84		
Finland	0.36			0.86		
Norway	0.92			0.92		
UK	0.76			0.82		
Sweden	0.91			0.93		
Germany	-5.02			-0.59		
US	0.33			0.90		

Figure B.1. Actual and estimated house prices from the regression model without net wealth and indebtedness



Note. The estimated prices (dashed red lines) have been calculated using the estimated coefficients reported in the left-hand column in Table B.1.

Figure B.2. Actual and estimated house prices from the regression model without net wealth but with indebtedness included



Note. The estimated prices (dashed red lines) have been calculated using the estimated coefficients reported in the right-hand column in Table B.1.

