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House price bubbles in Nordic countries?

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Abstract

I estimate fundamental house prices for Denmark, Finland, Norway, and Sweden over the past 20 years. My results suggest that house prices were overvalued in all countries in the years preceding the global financial crisis, but that prices quickly returned to equilibrium following the ensuing housing market bust. Results suggest that house prices were undervalued in Denmark and Finland towards the end of 2019, and that they were overvalued in Norway and Sweden. Applying a separate test for bubbles, I only detect signs of a bubble in the Danish housing market in the period before the global financial crisis.

Keywords: Fundamental house prices, housing bubbles, housing markets.

JEL codes: C22, C32, C51, C52, C53, G01, R21.

1 Introduction

House prices have grown substantially in most industrialized countries since the 1990s, with a substantial drop in the aftermath of the 2008 global financial crisis.[1] The Danish, Finnish, Norwegian, and Swedish housing markets are no exceptions. Developments after the global financial crisis have, however, been less synchronized across the Nordic countries. Looking at the past 20 years, real house prices have been growing markedly in Norway and Sweden, with cumulative real growth rates of 109 percent and 147 percent, respectively. House price developments have been more moderate in Finland, where real house prices are up by 27 percent over the same period, while they increased by 49 percent in Denmark between 2000 and 2019.

An important question is whether these price increases can be explained by underlying economic fundamentals, or whether there are signs of imbalances in the Nordic housing markets. A presence of imbalances in the housing market is important to detect, given the large effects a collapse in house prices may have on financial stability and real economic activity. The real economic consequences of a house price bust were clearly shown during the Great Recession (see e.g., Ferreira et al. 2010, Mian et al. 2013, Mian & Sufi 2014, Brown & Matsa 2020, and also Duca et al. 2020 for an excellent review). The literature has documented both consumption wealth effects (Aron et al. 2012, Mian et al. 2013) and self-reinforcing effects between the housing market and the credit market (Hofmann 2003, Fitzpatrick & McQuinn 2007, Gimeno & Martinez-Carrascal 2010, Anundsen & Jansen 2013). In addition, Leamer (2007) and Leamer (2015) have shown that large drops in housing investments are a strong indicator of future recessions in the US economy – a result that has gained international support in a recent study by Aastveit et al. (2019). Against this backdrop, I ask one main question: Have there been signs of systematic overvaluation in Nordic housing markets over the period 2000–2019?

In the first part of my analysis, I test for house price bubbles by applying the methodology of testing for explosivity suggested by Phillips et al. (2015a, 2015b) (PSY). As discussed in Phillips and Shi (2020), this methodology has increasingly been adopted by central banks as a real-time monitoring device (Yiu et al. 2013, Amador et al. 2018, Gomez et al. 2018, Caspi 2016). The PSY-procedure also serves as an early warning device for future financial market meltdowns and crises, as shown in Anundsen et al. (2016) and Phillips and Shi (2019). Using the PSY-approach, I find no evidence of explosive developments in real house prices in Finland, Norway, or Sweden at any point during the past 20 years. For Denmark, the approach suggests that house prices had an explosive development in the years preceding the global financial crisis.

Independent of the presence of bubbles or not, house prices may at times be over- or undervalued. I therefore take another approach to determine whether house prices have evolved in line with the trajectory predicted by developments in underlying economic fundamentals. In particular, I follow Anundsen (2019) and calculate a fundamental house price path for the period 2000–2019 using the system-based

1. Duca (2020) has shown an increased synchronization of global house price developments. House price developments in Denmark, Finland, Norway, and Sweden resemble those in many other countries.

cointegration approach of Johansen (1988). This fundamental path is calculated based on information and parameter estimates that were available in 1999. Having constructed the trajectory of fundamental house prices, I investigate how actual house prices developed relative to model-implied fundamental prices in the period thereafter. As noted in Anundsen (2019), this approach relies on the bubble definition provided by Stiglitz (1990, p.13), which states that a bubble exists if the reason why the price is high today is only that investors believe that the selling price will be high tomorrow when 'fundamental' factors do not seem to justify such a price.

My results indicate an overvaluation of house prices in all countries in the years leading up to the global financial crisis. In 2007, the estimated overvaluation was 57 percent in Denmark, 13 percent in Finland, and 17 percent in Norway. Swedish real house prices were overvalued by 4 percent. The correction in real house prices following the Great Recession brought prices back to equilibrium within two years. After this, the Nordic countries have seen different developments in actual house prices relative to the value implied by economic fundamentals. Danish house prices have fluctuated around the fundamental path, but have remained mostly undervalued. At the end of 2019, my estimates suggest that Danish house prices were undervalued by 9 percent. In Finland, actual prices stagnated and have fluctuated around their equilibrium value. At the end of 2019, my estimates suggest that Finnish house prices were undervalued by 3 percent. In Norway, I find that prices were undervalued until 2016 and overvalued thereafter. At the end of 2019, I find that Norwegian house prices were overvalued by 9 percent. For Sweden, my estimates suggest that house prices have been systematically overvalued since 2014. Towards the end of the period, the gap between actual and fundamental prices was 7 percent in Sweden. The only country were my results point in the direction of a systematic overvaluation is Sweden, but the gap between actual and fundamental prices has remained relatively small.

Although the build-up of national housing market imbalances and bubbles are particularly important to detect from a financial stability point of view, it is well known that there are large regional differences in house price developments (Ferreira & Gyourko, 2012) and that national developments may be driven by certain local markets (Glaeser et al. 2008, Capozza et al. 2004, Malpezzi & Wachter 2005). The Nordic countries are no exceptions in this regard, with a particularly strong house price growth in the capitals. To explore whether there are signs of bubble-like developments in house prices in Copenhagen, Helsinki, Oslo, and Stockholm, I perform separate tests for explosive house price dynamics using the PSY-approach on city-level house price data. My results show that there are no signs of bubbles in the capitals over the period 2010–2019.

As a final contribution, I discuss the main drivers of fundamental house prices at the national level over the past 20 years. In estimating fundamental prices, I estimate semi-elasticities of real after-tax interest rates on house prices, as well as elasticities of house prices with respect to changes in real per capita disposable income and the housing stock per capita. I also discuss what factors may contribute to imbalances in the housing market, and tools that may be used to prevent imbalances from building up. I conclude that favourable income developments have been the main driver of fundamental house prices, and that the Nordic markets are vulnerable to interest

rate hikes. Further, the low supply elasticities in Nordic countries (Caldera & Johansson 2013, Cavalleri et al. 2019) make them sensitive to demand shocks and greater house price volatility over the course of a boom-bust cycle (Huang & Tang 2012, Glaeser et al. 2008, Anundsen & Heebøll 2016).

Other approaches to testing for housing market imbalances and housing bubbles that have been considered in the literature include the regime-switching bubble-tests of Brooks and Katsaris (2005), the user-cost valuation approach of Himmelberg et al. (2005), and tests for cointegration break-down, as in Anundsen (2015). In monitoring the housing market, an eclectic mix of approaches seems useful, since all approaches have their strengths and weaknesses. In this paper, I offer results based on two approaches that have shown to be useful in detecting the US house price bubble in the 2000s at an early stage (see Anundsen 2019).

Several studies have asked whether house price developments in the Nordic countries have been developing along a sustainable trajectory. The European Commission estimated that Finnish house prices were consistently overvalued over the period 2003–2011 and that the overvaluation reached 15 percent in 2006–2008 and 2010–2011 (Marrez & Pontuch 2013). For the case of Norway, Moody's (2017) estimates that Norwegian house prices have been consistently overvalued since 2010. The IMF has warned about developments in house prices in both Norway, Sweden, and Finland over the years. Geng (2018) presents a panel data analysis of 20 countries over the period 1990–2016, in which both Denmark, Finland, Norway, and Sweden are included in the analysis. House prices are estimated to have been overvalued in all four countries in the period preceding the financial crisis. The author concludes that Norwegian and Swedish house prices were overvalued at the end of the sample, whereas Danish and Finnish house prices were undervalued. This is consistent with the findings in this paper. The underlying model developed in Geng (2018) is used by the IMF in monitoring house price developments. Updates in the 2019 Article IV consultations (IMF 2019a, 2019b, 2019c) conclude that Norwegian and Swedish house prices were still overvalued, but far less so. For Finland, there was little evidence of overvaluation.

Another study in which both Denmark, Finland, Norway, and Sweden are analysed is Dermani et al. (2016), who use a panel data approach for the 1995–2015 period. The authors find no evidence of overvaluation in any of the countries once indebtedness is included in the model. When indebtedness is not included, there are signs of overvaluation in Norway and Denmark, but not in Sweden or Finland. The study concludes that this finding may be suggestive of imbalances in the Norwegian and Danish housing markets. My results suggest that these conclusions may be related to the panel-approach adopted in Dermani et al. (2016), which imposes equal effects across countries of changes in fundamentals on house prices. My country-by-country results suggest that both Norway and Denmark are far more sensitive to changes in fundamentals than the other countries.

In contrast to Dermani et al. (2016), Bergman and Sørensen (2018) find that there is a high probability that Swedish house prices have been overvalued for quite some time, which is consistent with the findings in this paper. My results also corroborate the findings of Dam et al. (2011), who estimate that Danish house prices were

overvalued in the period before the financial crisis.

The rest of the paper proceeds as follows. In the next section, I present the data that are used throughout the paper, and I discuss house price developments in Denmark, Finland, Norway, and Sweden over the past 30 years. I also look at the capitals Copenhagen, Helsinki, Oslo, and Stockholm. I briefly discuss the methodologies employed throughout the paper in the same section. In Section 3, I start by presenting results from tests for bubbles at the national level. After this, I estimate the degree of over- or undervaluation of house prices over the past 20 years. The section ends by presenting results from tests for bubbles in the capitals. In Section 4, I discuss what the main drivers of fundamental house prices have been. The final section concludes.

2 Data, house price developments, and methodology

2.1 Data

I have collected data at both the national level and for the capitals Copenhagen, Helsinki, Oslo, and Stockholm. This section briefly describes the data.

National data

The aggregate data used in the analysis are collected with a quarterly frequency. House price developments are measured by national indices and deflated by CPI to obtain real house prices. Income is measured by disposable household income, whereas the housing stock is measured by the real housing stock in fixed prices for Denmark and Norway.[2] Due to data availability, the housing stock is measured through the number of dwellings for Finland and Sweden.[3] Both income and the housing stock are divided by the total population to obtain per capita measures.[4]

For Norway, Sweden, and Finland, the interest rate series are weighted nominal mortgage rates across all maturities. This is similar to the data definitions applied for the same countries in the panel study by Dermani et al. (2016). For Denmark, I was not able to access a similar series, and have therefore followed Dam et al. (2011) and weighted the interest rates on 30- and 1-year bonds, controlling for the minimum amortization rate. In all countries, I consider after-tax interest rates by adjusting the nominal rates for tax deductions. Real after-tax interest rates are constructed by subtracting overall CPI-inflation over the past four quarters, which is similar to Dermani et al. (2016) and Geng (2018).[5] Details on data sources are given

2. The total stock of houses is calculated according to the perpetual inventory method.
3. Data on number of dwellings is only available at annual frequency, and have been interpolated to quarterly frequency using linear interpolation.
4. For Denmark and Finland, I was only able to collect population data at annual frequency. Quarterly time series where constructed using linear interpolation.
5. An alternative to using actual inflation for calculating the real interest rate is to use survey data on inflation expectations, or – alternatively – to use an inflation rate consistent with the inflation target in the different countries. However, this is not feasible due to lack of relevant data for the sample period. Survey data on inflation expectations are not available for the whole period for all countries, and the countries adopted

in Table A.1 in the Appendix.

The analysis ends in 2019 for all countries. The sample's starting point is 1990 for Sweden,[6] while Danish, Finnish, and Norwegian data start in 1985.

Data for the capitals

Income and housing stock data are not readily available for the capitals, which prevents me from calculating fundamental prices at this aggregation level. House price data are, however, available at a monthly frequency. I therefore test for bubbles in the capitals using the PSY-procedure. To obtain measures of real house prices, I deflate nominal house price indices by national CPI indices. The sample ends in 2019 for all capitals, and the sample start is set to 2006.[7] Details on data sources for the local house price indices are given in Table A.1 in the Appendix.

2.2 House price developments

National house price developments

Figure 1 shows real house price developments in Denmark, Finland, Norway, and Sweden over the past 30 years, while Table 1 shows cumulative growth rates in real house prices for 5- and 10-year periods, and the cumulative growth over the full sample period, 1990–2019, as well as cumulative growth rates from 2000 to 2019. I have also added the cumulative growth rates from 2000 to the peak in prices before the financial crisis (boom),[8] as well as the drop in prices from peak to trough (bust).[9]

All countries experienced increasing house prices in the period leading up to the 2008 global financial crisis. The cumulative growth rate was highest in Sweden, and lowest in Finland. The drop in house prices during the bust was largest in Denmark, with a drop of 22 percent. In Finland and Norway, real house prices dropped by 9 and 12 percent. In Sweden, house prices dropped by 6 percent. Real house prices exceeded pre-crisis levels already in early 2010 in Finland, Norway, and Sweden. In Denmark, real house prices were still below the previous peak at the end of 2019. After 2010, the countries have followed quite different paths.

In Finland, house prices stagnated, and were 5 percent lower in 2019 than in 2010. In Norway, prices increased by 29 percent over the same period, whereas Sweden had the highest real house price growth with 35 percent cumulative growth between 2010 and 2019. In Denmark, prices were 12 percent higher in 2019 than in 2010.

inflation targets at different points in time, Finland in 1995, Norway in 2001, Sweden in 1993, while Denmark still has a fixed exchange rate regime.

6. I was not able to collect data on the housing stock dating further back.
7. For Oslo, data with a monthly frequency are available from 2003. For Stockholm they start in 2005, while data for Copenhagen start in 2006. For Helsinki, monthly data are only available from 2015, so I have linearly interpolated quarterly data for Helsinki.
8. The peak in real house prices for the different countries are: Denmark (first quarter of 2007), Finland (third quarter of 2007), Norway (second quarter of 2007), and Sweden (third quarter of 2007).
9. The troughs for the different countries are: Denmark (second quarter of 2009), Finland (first quarter of 2009), Norway (fourth quarter of 2008), and Sweden (first quarter of 2009). Note that Danish house prices had a new drop later on, but I use the trough around the financial crisis in calculating the fall in prices during the bust.

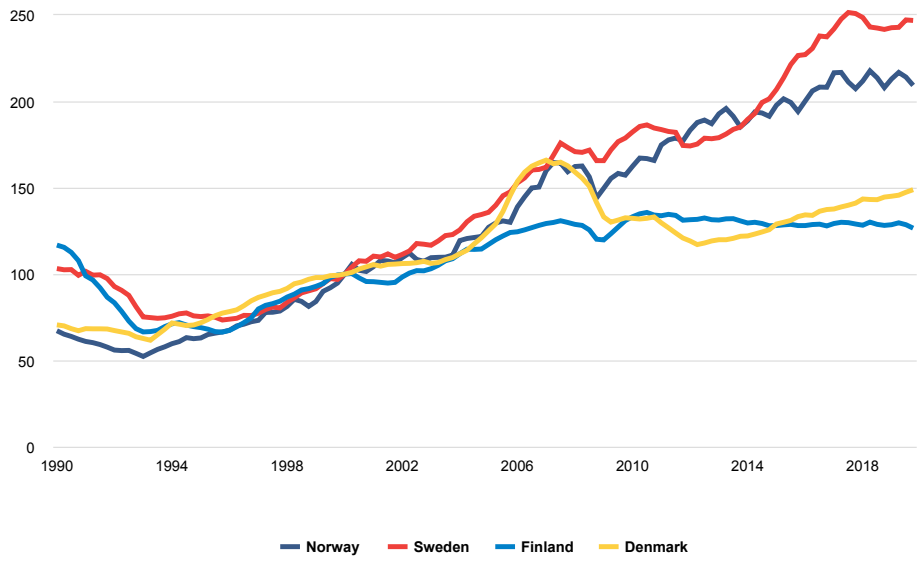
Table 1 Cumulative real house price growth over different periods

Period	Denmark	Finland	Norway	Sweden
5-year cumulative growth				
1990q1–1995q1	1.8	-41.0	-6.3	-27.0
1995q1–2000q1	39.3	45.0	58.8	32.7
2000q1–2005q1	25.1	17.2	27.1	35.8
2005q1–2010q1	5.8	13.7	27.8	34.3
2010q1–2015q1	-2.5	-3.8	21.8	13.5
2015q1–2019q4	15.4	-1.2	5.8	19.3
10-year cumulative growth				
1990q1–2000q1	41.7	-14.4	48.8	-3.1
2000q1–2010q1	32.3	33.2	62.4	82.3
2010q1–2019q4	12.5	-5.0	28.8	35.5
Cumulative growth rates over the boom-bust				
Boom	66.0	30.9	64.6	75.9
Bust	-21.6	-8.5	-12.4	-5.8
Cumulative growth 2000–2019				
	48.9	26.6	109.3	146.9
Cumulative growth 1990–2019				
	110.9	8.4	211.4	139.2

Note: The table shows cumulative real house price growth for 5- and 10-year periods from 2000 for Denmark, Finland, Norway, and Sweden. The boom is defined as the period from 2000 to the peak before the financial crisis, which for the different countries was: Denmark (first quarter of 2007), Finland (third quarter of 2007), Norway (second quarter of 2007), and Sweden (third quarter of 2007). The bust is defined as the period from peak to trough. The troughs for the different countries are: Denmark (second quarter of 2009), Finland (first quarter of 2009), Norway (fourth quarter of 2008), and Sweden (first quarter of 2009). Note that Danish house prices had a new drop later on, but I use the trough around the financial crisis in calculating the fall in prices during the bust. The final two rows show the cumulative growth rates for the period 2000-2019, and for the full sample period, 1990-2019. Real house prices are calculated by deflating national house price indices by the national CPI.

Source: Own calculations.

Figure 1 Real house price developments



Note: The figure plots real house price developments in Norway, Sweden, Finland and Denmark from 1990 to 2019. Real house prices are constructed by deflating nominal house price indices with national CPI. I have normalized each series so that the real house price index equals 100 in the first quarter of 2000 for all countries.

Source: Own calculations.

House price developments in the capitals

Figure 2 plots developments in real house prices for Copenhagen, Helsinki, Oslo, and Stockholm over the period 2006–2019. In Table 2, I show cumulative growth rates for 5- and 10-year periods. The table also summarizes the cumulative growth in house prices from 2006 to 2019.

Compared to the national house price growth, house prices have grown substantially more in the capitals over the past ten years. In Oslo and Stockholm, real house prices increased by 62 and 56 percent over this period, which is about twice of the national house price growth. In Helsinki, real house prices grew less, with a cumulative growth of about 16 percent. At the national level, prices fell by 5 percent. In Copenhagen, prices increased by 56 percent, whereas the national average was just below 10 percent.

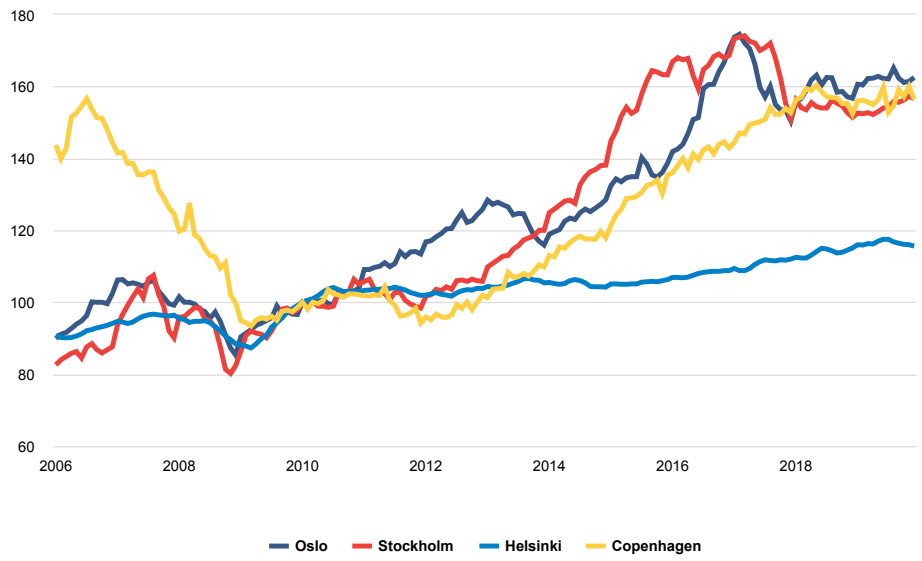
Table 2 Cumulative real house price growth for the capitals over different periods

Period	Copenhagen	Helsinki	Oslo	Stockholm
5-year cumulative growth				
2006m1–2010m1	-30.4	10.0	11.2	21.1
2010m1–2015m1	21.4	5.1	32.4	44.9
2015m1–2019m12	28.7	10.0	22.7	8.1
10-year cumulative growth				
2010m1–2019m12	56.3	15.6	62.5	56.5
Cumulative growth 2006–2019				
Full sample	8.8	27.2	80.7	89.5

Note: The table shows cumulative real house price growth for 5- and 10-year periods from 2006 for Copenhagen, Helsinki, Oslo, and Stockholm. The final row shows the cumulative growth for the full sample period, 2006-2019. Real house prices are obtained by deflating nominal house price indices for the four cities with the national CPI. For Helsinki, monthly data are only available from 2015, so I have linearly interpolated quarterly data for Helsinki.

Source: Own calculations.

Figure 2 Real house price developments in the capitals



Note: The figure shows real house price developments in Oslo, Stockholm, Helsinki and Copenhagen in 2006–2019. Real house prices are obtained by deflating nominal house price indices for the four cities with the national CPI. For Helsinki, monthly data are only available from 2015, so I have linearly interpolated quarterly data for Helsinki. Real house prices are normalized at 100 in January 2010.

Source: Own calculations.

2.3 Methodology

Two different econometric methods are used to test for bubbles and to detect imbalances in the Nordic housing markets over the past 20 years. The first method is that developed by Phillips et al. (2015a, 2015b) to detect explosive developments in a time series. This test is used to test for the presence of bubbles. The second approach is that of Anundsen (2019), which compares developments in actual and fundamental prices. This is not a test for bubbles per se, but rather a way of detecting both short- and long-term imbalances in the housing market, where large and systematic imbalances over a sustained period of time may be interpreted as signalling a bubble (Anundsen 2019). This section briefly describes the two methods.[10]

Testing for explosivity

I apply the framework suggested by Phillips et al. (2015a, 2015b) to explore whether there are signs of explosive developments in real house prices.[11] This procedure investigates whether there are signs of a bubble (explosive developments) in house prices at different points in time.[12] I apply this test to real house prices, both at the national level and for the capitals.

At the national level, I use data from 1990 to 2019 and set the minimum window size to 41 quarters, so that the first test is done for the first quarter of 2000. For the analysis of house prices in the capitals, I use data for the period 2006–2019. I set the minimum window size to 49 months, so that the first test is done for January 2010.[13]

Further details on this econometric approach are provided in Appendix B of a previous version of this paper, see Anundsen (2020).

Estimating fundamental house prices

A commonly used theory for the drivers of house prices is the life-cycle model of housing (see e.g., Meen 1990, 2001, 2002). This theoretical framework takes as a starting point a standard representative-agent model, in which an agent maximizes her lifetime utility with respect to consumption of housing goods and 'other' goods. One can show that this implies an inverted demand equation for housing, which has been used in numerous studies that investigate house price determination (see e.g., Buckley & Ermisch 1983, Hendry 1984, Meen 1990, Holly & Jones 1997, Meen & Andrew

10. Technical details are described in Appendix B of a previous version of this paper, see Anundsen (2020).
11. This approach has a clear link to asset pricing theory, in which the current value of the asset (the house) should be equal to the expected discounted stream of pay-offs in the next period. This framework is similar to a standard present value model (see e.g., Gordon and Shapiro 1956, Blanchard and Watson 1982, and Clayton 1996, who argue that it may equally well be considered for housing).
12. More formally, the procedure uses a recursive algorithm to estimate a Dickey-Fuller (Dickey & Fuller 1979) regression to detect possible explosiveness in a time series over certain periods.
13. A deterministic trend is included in the ADF-regression, both at the national level and when analysing the capitals. I use 4 lags in the ADF-regressions at the national level (quarterly data) and 12 lags when looking at the capitals (monthly data). Critical values depend both on the sample size, nuisance parameters, lag length, and the minimum window size. To calculate the sequence of finite sample critical values, I use the Matlab program accompanying Phillips et al. (2015a), using 5 000 Monte Carlo replications.

1998, Meen 2001, Duca et al. 2011a, 2011b and Anundsen 2015). This inverted demand equation implies that house prices are determined by income, the user cost, and the housing stock.

I start by applying the system-based test for cointegration in Johansen (1988) to analyse the long-run relationship between real house prices, real per capita disposable income, the housing stock per capita, and the real user cost (approximated by real after-tax interest rates).[14] My estimation period is 1985–1999 for Denmark, Norway, and Finland, and 1990–1999 for Sweden.[15] The estimation period ends in 1999 for all countries. The parameters are therefore determined before the evaluation period (2000–2019). To save degrees of freedom, I impose the restriction that the coefficient on income and housing stock is the same, but with opposite signs. This implies an income elasticity of demand equal to one, which is in accordance with what Meen (2001), Duca et al. (2011b), and Anundsen (2015) find for US data, and it is one of the central estimates of Meen (2001).[16] Detailed results from the cointegration analysis are shown in Table A.2 in the Appendix.

Having estimated the parameters in the long-run relationships, I construct the implied fundamental house price path during the period 2000–2019. I assume that house prices were in equilibrium in the first quarter of 2000, and calculate the implied fundamental trajectory of house prices in the ensuing period. Developments in fundamental prices are then compared to actual house prices. Further details on this econometric approach are provided in Appendix B of a previous version of this paper, see Anundsen (2020).

3 Results

I start this section by looking at aggregate results for the Nordic countries. First, I present results from testing for bubbles (explosiveness) before discussing the evolution of house prices relative to what is implied by economic fundamentals. In the second part, I test for bubbles in the capitals.

14. While I use the weighted nominal mortgage rate across all maturities as my measure of the relevant interest rate, one could argue that longer horizon interest rates are also important for housing demand. To explore how this affects results, I added the spread between the 10-year bond yields and the mortgage rates to the VAR-models. In all cases, a likelihood ratio test would not reject the restriction that this variable does not enter the cointegration space, with the following p-values: Denmark (0.15), Finland (0.08), Norway (0.42), and Sweden (0.05).
15. For all countries, I consider a VAR(2)-model, which is also supported by the Schwarz information criterion.
16. A similar restriction is used and tested in Anundsen (2019) for Norway, Finland, and the US. To test the validity of this restriction, I estimated a VARX-model for each of the countries, in which I conditioned on the housing stock per capita in the cointegration space. I estimated this model with no constraints on the income and the housing stock coefficients, and under the assumption that the two coefficients are the same, but with opposite signs. I find support for this restriction for Norway, Denmark, and Finland, but that the imposed restriction is more doubtful for Sweden. The p-values from likelihood ratio tests are: Denmark (0.11), Finland (0.06), Norway (0.04), and Sweden (0.01). For Sweden, the (unconstrained) coefficient on the housing stock is estimated very imprecisely, which is probably related to relatively less variation in the housing stock per capita measure in Sweden than in the other countries. I therefore also looked at a model for Sweden in which I excluded the housing stock from the specification. In that case, the coefficient on the user cost and income are quite similar to the baseline specification, and estimated fundamental prices are almost the same. Thus, my conclusions for Sweden are not affected by imposing this restriction.

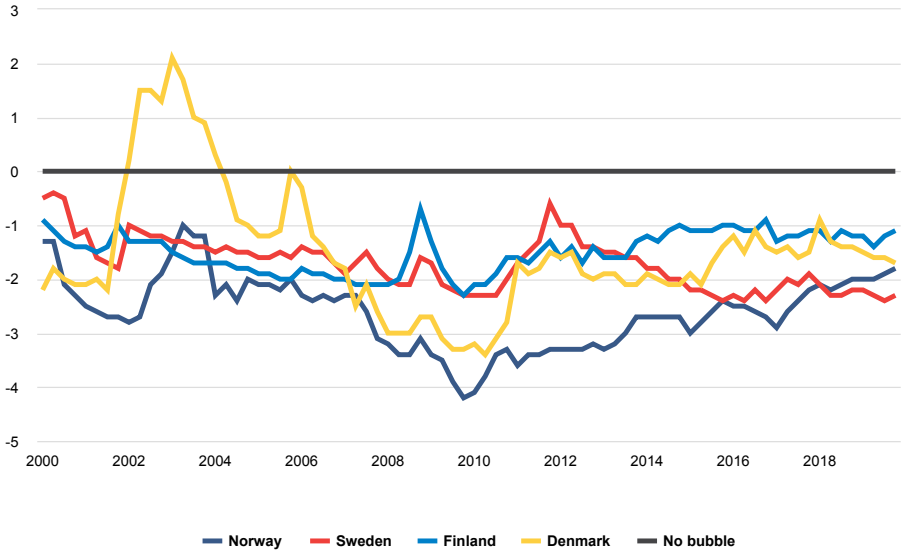
3.1 National results

Testing for bubbles

Figure 3 plots the difference between the test statistics and critical values consistent with a 10 percent significance level, while the 'No bubble'-line is illustrated in black. The interpretation is that whenever this difference is below the black line,[17] there are no signs of a bubble. If it is above the black line, there is evidence of a bubble.[18]

It is evident that there are no points in time in which the test indicates a bubble for Finland, Norway, or Sweden. For Denmark, the test signals a bubble in the period before the sharp price drop starting in the first quarter of 2007.[19] There are no signs of bubble-behaviour in Denmark subsequently.[20]

Figure 3 Test for bubbles



Note: The figure shows the difference between the test statistic and the critical value for a 10 percent significance level for Denmark, Finland, Norway, and Sweden based on the PSY-approach. The tests are performed on real house prices, which are obtained by deflating the national house price indices by the national CPI. The difference between the test statistics and the critical values consistent with a 10 percent significance level is plotted for all countries. The black line is the no-bubble line. The interpretation is that whenever this difference crosses the black line, there are signs of exuberance. If it remains below the black line, there are no signs of exuberance. The evaluation sample covers the period 2000–2019 for all countries. The estimation sample starts in the first quarter of 1990. I use a minimum window size of 41 quarters, and include 4 lags and a

17. Non-rejection of the null of no explosivity.
18. Rejection of the null of no explosivity in favour of the alternative hypothesis of an explosive root.
19. Results are not materially affected by using a 5 percent significance level.
20. While my analysis concentrates on the past 20 years, there have been previous episodes of strong house price growth in Nordic housing markets. Analysing this would require historical data series dating far back. While such an analysis is outside the scope of this paper, Anundsen and Eitrheim (2016) offers an analysis on historical data over the period 1890-2015 for Norway. They use house price indices and a CPI from the Norges Bank Historical Monetary Statistics (HMS) database. Their results indicate bubble-behaviour in Norwegian house prices in 1895-1899 and 1985-1988. For later periods, there are no signs of bubble-behaviour.

deterministic linear trend in the ADF-regressions. The critical values are simulated using 5 000 Monte Carlo replications. Details on the econometric approach are provided in Appendix B of a previous version of this paper, see Anundsen (2020).

Source: Own calculations.

House prices and fundamentals

I use the country-specific estimates from the cointegration analysis to construct implied fundamental prices (see Table A.2 in the Appendix for detailed estimation results). This series are plotted in Figure 4 a–d.[21]

Comparing actual and fundamental prices, it is evident that my results suggest that house prices were overvalued in all four countries in the years leading up to the 2008 global financial crisis. The overvaluation was particularly prominent in Denmark, which also saw the largest drop in actual house prices from peak to trough. This finding is consistent with the results from testing for explosiveness, which indicated a bubble in the Danish housing market in the years preceding the global financial crisis. The correction in house prices around 2008 brought house prices back to the value implied by fundamentals in all countries by 2010.

After 2010, Norwegian house prices remained undervalued until 2016, when the model suggests that Norwegian house prices became overvalued. They were overvalued by 9 percent at the end of 2019.[22] For Sweden, the estimates suggest that house prices have been overvalued – although relatively modestly – since 2014. At the end of 2019, the model suggests that Swedish house prices were overvalued by 7 percent.

In Finland, house prices have stayed flat since 2010, and they have more or less been at equilibrium. At the end of 2019, my results suggest that Finnish house prices were undervalued by a mere 3 percent. Following the drop in house prices in the aftermath of the global financial crisis, Danish house prices have remained mostly undervalued, and towards the end of the sample, I find that Danish house prices were undervalued by 9 percent.

Based on these results, I conclude that Danish and Finnish house prices were undervalued at the end of 2019, whereas Norwegian and Swedish house prices were overvalued. The only country where there are signs of systematic overvaluation is Sweden, where prices have been above equilibrium since 2014.

One should note that there is some volatility in my estimated fundamental prices. This is due to volatility in the fundamental drivers. Part of the volatility is related to movements in the real after-tax interest rate. The volatility of fundamental prices suggest that one should be careful in drawing conclusions about overvaluation based only on one or two quarters of data. Still, the trend over a few quarters gives useful information on whether house prices are systematically over- or undervalued.

21. Adopting a panel-approach, thereby abstracting from heterogeneity across countries in the response to changes in fundamentals, I get results that are more similar to Dermani et al. (2016), see Figure A.1 in the Appendix.
22. At Housing Lab - National center for housing market research, we update this indicator for Norway on a quarterly basis. The most recent estimates can be found on our website.

Figure 4a Actual versus fundamental house prices, Norway

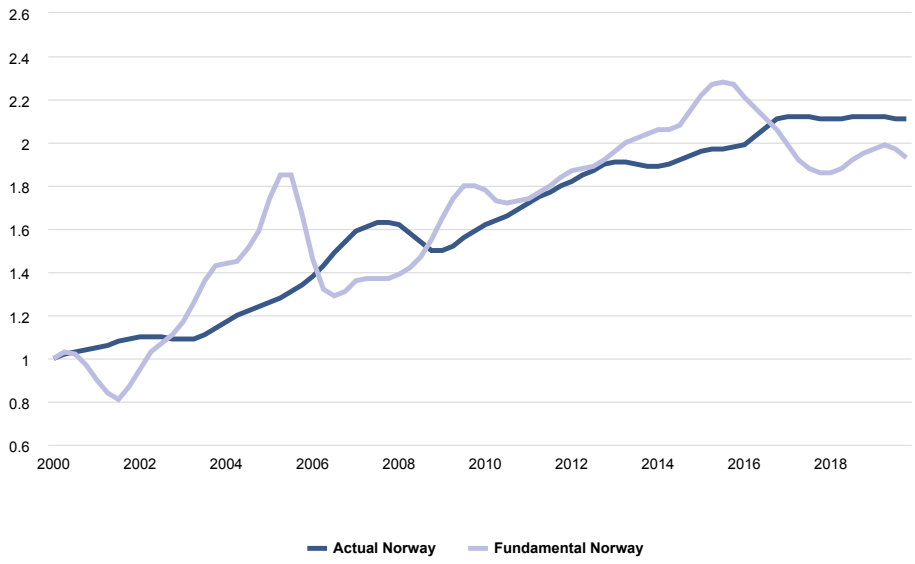


Figure 4b Actual versus fundamental house prices, Sweden

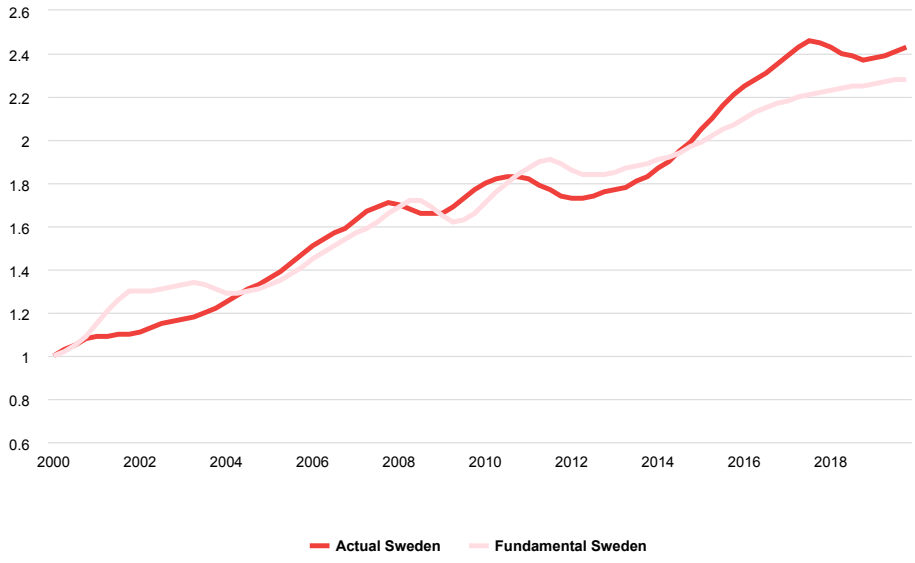


Figure 4c Actual versus fundamental house prices, Finland

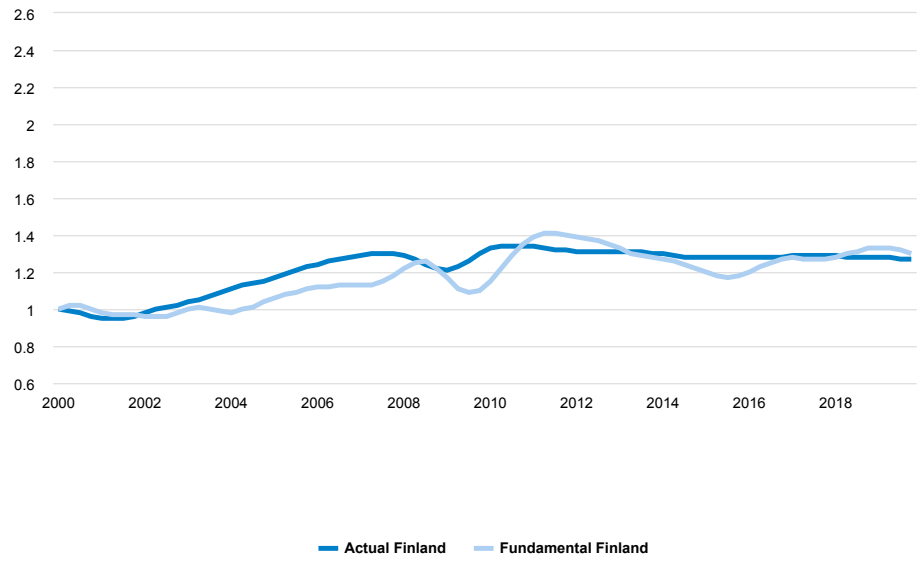
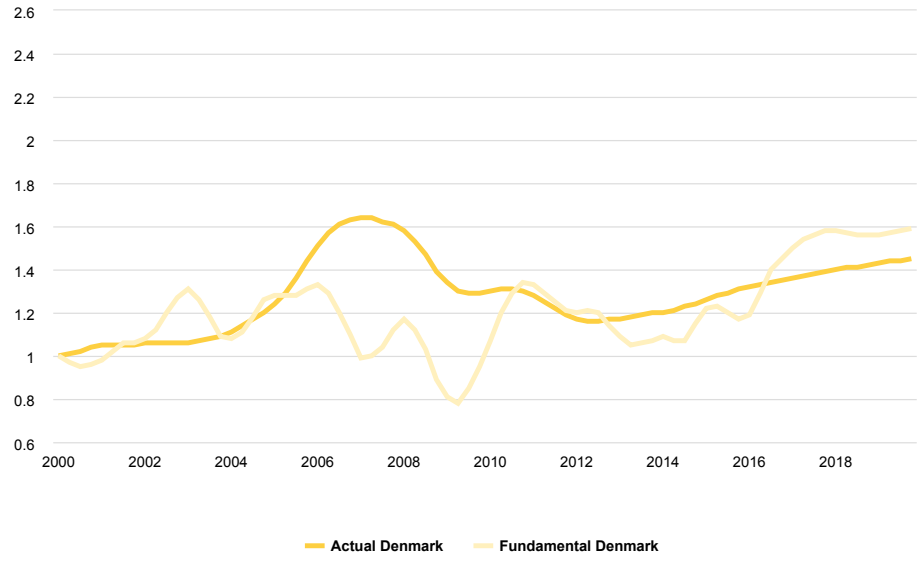


Figure 4d Actual versus fundamental house prices, Denmark



Note: The figures shows fundamental house prices and actual house prices over the period 2000–2019 for Denmark, Finland, Norway, and Sweden. Fundamental prices are determined by income per capita, the housing stock per capita, and real after-tax interest rates. Both fundamental and actual prices are normalized to one in the first quarter of 2000. Detailed results on estimated coefficients are given in Table A.2 in the Appendix.

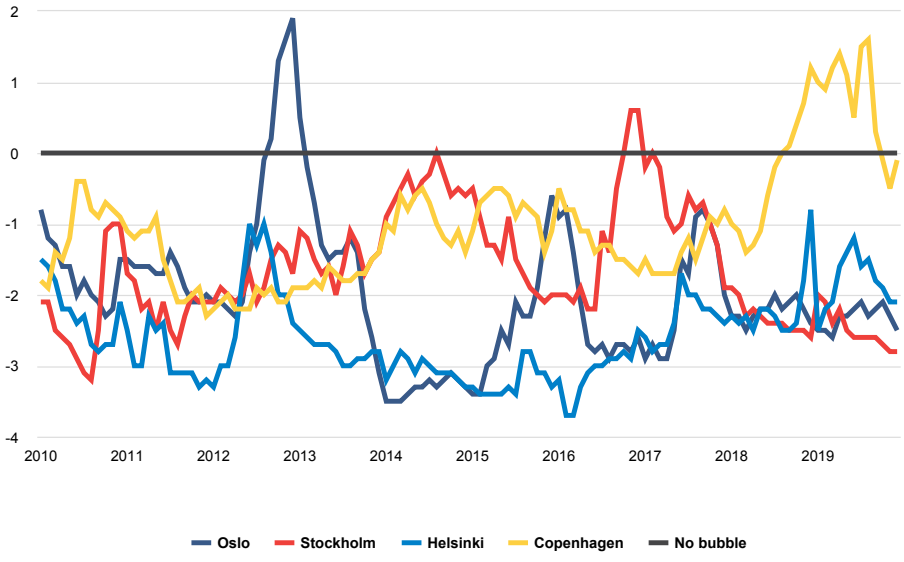
Source: Own calculations.

3.2 Results for the capitals

Figure 5 plots the difference between the test statistics and the critical values consistent with a 10 percent significance level from the PSY-approach for Copenhagen, Helsinki, Oslo, and Stockholm. The black line is the 'No bubble'-line. The interpretation is that whenever this difference crosses the black line, there are signs of a bubble. If it remains below the black line, there are no signs of a bubble.

My results suggest no signs of a bubble in Helsinki over the sample period. There are some signs of explosiveness in Stockholm and Oslo, but very short-lived, so it is hard to conclude that there have been bubble-like dynamics in these cities. For Copenhagen, I find some signs of explosiveness in 2018 and 2019, but this seems more related to a relatively sharp drop in prices and does therefore not suggest a bubble.[23]

Figure 5 Test for bubbles in the capitals



Note: The figure shows the difference between the test statistic and the critical value for a 10 percent significance level for Copenhagen, Helsinki, Oslo, and Stockholm based on the PSY-approach. The tests are done on real house prices, which are obtained by deflating the city-level house price indices by the national CPI. The difference between the test statistics and the critical values consistent with a 10 percent significance level is plotted for each of the countries. The black line is the no-bubble line. The interpretation is that whenever this difference crosses the black line, there are signs of exuberance. If it remains below the black line, there are no signs of exuberance. The evaluation sample covers the period 2010–2019 for all cities. The estimation sample starts in January 2006. I use a minimum window size of 49 months, and include 12 lags and a deterministic linear trend in the ADF-regressions. The critical values are simulated using 5 000 Monte Carlo replications. Details on the econometric approach are provided in Appendix B of a previous version of this paper, see Anundsen (2020).

Source: Own calculations.

23. Results are not materially affected by using a 5 percent significance level.

4 What factors drive fundamental prices?

An important finding from the cointegration analysis is that house prices are highly sensitive to interest rate changes in all countries (see Table A.2 in the Appendix for detailed estimation results). This is particularly so in Denmark and Norway. The estimates for Norway resemble those in Anundsen (2019), the estimates for Denmark are close to Dam et al. (2011), and the estimates for Sweden are similar to Claussen (2013), in which similar type of models are estimated. These estimates may be considered semi-elasticities of interest rates on (equilibrium) house prices, and may have additional usage elsewhere for policy makers. They are estimated to be -12.55 in Denmark, -7.90 in Finland, -11.00 in Norway, and -5.84 in Sweden. My results also suggest considerable cross-country variation in income and housing stock elasticities.[24]

Recent estimates suggest that the average housing supply elasticity for the countries I consider are: 1.41 for Denmark, 1.00 for Finland, 1.20 for Norway, and 2.01 for Sweden (Cavalleri et al. 2019). For comparison, they find that the housing supply elasticity for the US is 2.82.[25] Note that Cavalleri et al. (2019) estimate that the housing supply elasticity for Sweden is almost twice that of Norway and Denmark. My estimates suggest that Swedish house prices are also less sensitive to changes in income and interest rates than Danish and Norwegian house prices are. This is consistent with the idea that a more flexible supply in Sweden than in Denmark and Norway makes house prices less responsive to changes in fundamentals.

Heterogeneity in coefficients also makes a panel approach more challenging, since it would impose equal effects of changes in fundamentals on house prices in all countries. To shed some light on this, I estimated the long-run parameters using a panel approach. These estimates are also reported in Table A.2, and confirm that the panel approach masks underlying heterogeneities.

To look more into the drivers of fundamental prices in the four countries, I estimated quasi-counterfactual developments for fundamental prices, by holding a) real per capita disposable income fixed and b) the real after-tax interest rate fixed. This is not a fully-fledged counterfactual analysis, however, since that would require a model taking general equilibrium effects into account. The main motivation is simply to illustrate the importance of developments in income and the real after-tax interest rate for the evolution of fundamental house prices.

In Figure 6a–d, I plot actual house prices, fundamental house prices, fundamental house prices when holding real per capita disposable income constant, and fundamental house prices when holding the real after-tax interest rate constant. It is evident that the most important driver of house prices in all countries are income developments, as would be expected. It is also evident that the real after-tax interest rate matters a great deal for the evolution of fundamental prices.

24. The housing stock elasticities for Denmark and Norway are not directly comparable to those for Finland and Sweden, since they are measured somewhat differently due to data availability.
25. A previous study looking at housing supply elasticities in Europe is Caldera and Johansson (2013).

That interest rate developments are important for house price dynamics finds support in the literature, see e.g., Williams (2015) for an excellent summary of some international studies. For US metro areas, Aastveit and Anundsen (2017) show that monetary policy shocks exercise a great impact on house price developments. They also show that whether expansionary or contractionary shocks have the greatest impact on house prices depends on the elasticity of housing supply. In particular, they show that expansionary shocks have a greater impact on house prices in areas with low housing supply elasticities, whereas the opposite is true for areas with high housing supply elasticities. At the median, they find that expansionary shocks hit harder than contractionary shocks.

The estimated housing supply elasticities in Cavalleri et al. (2019) for the Nordic countries are lower than the corresponding estimate for the US. To the extent that the results in Aastveit and Anundsen (2017) are generalizable outside the US, contractionary monetary policy may have a relatively weaker impact in slowing down house price increases than expansionary shocks have in fuelling price increases. Low supply elasticities have also been shown to increase house price volatility in booms and busts (see e.g., Huang & Tang 2012, Glaeser et al. 2008, Anundsen & Heebøll 2016).

Figure 6a Fundamental house prices, actual house prices, and fundamental house prices without interest rate changes for Norway, 2000–2019

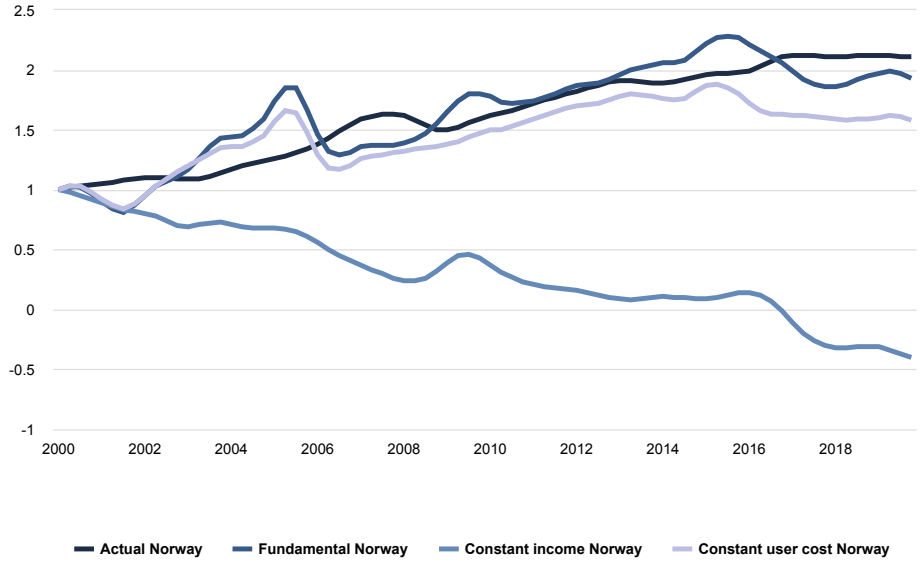


Figure 6b Fundamental house prices, actual house prices, and fundamental house prices without interest rate changes for Sweden, 2000–2019

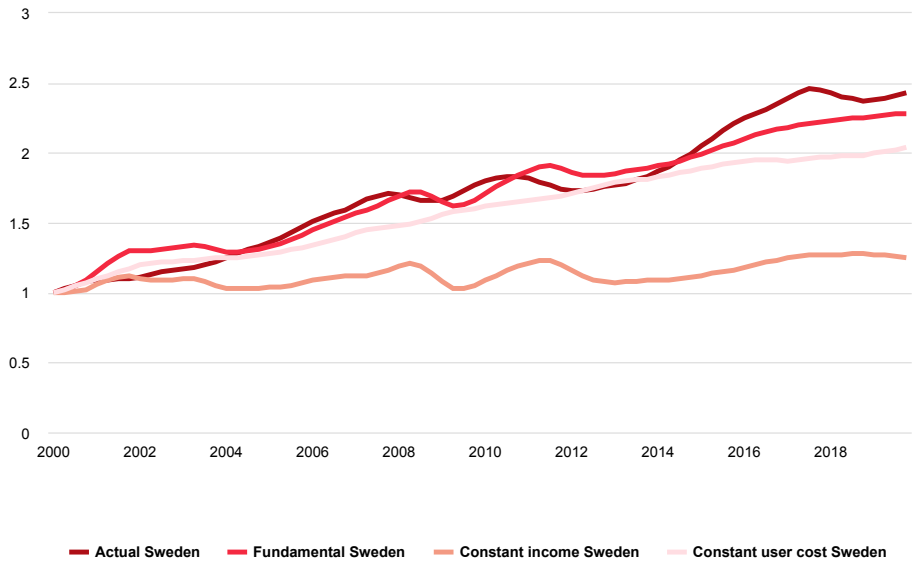


Figure 6c Fundamental house prices, actual house prices, and fundamental house prices without interest rate changes for Finland, 2000–2019

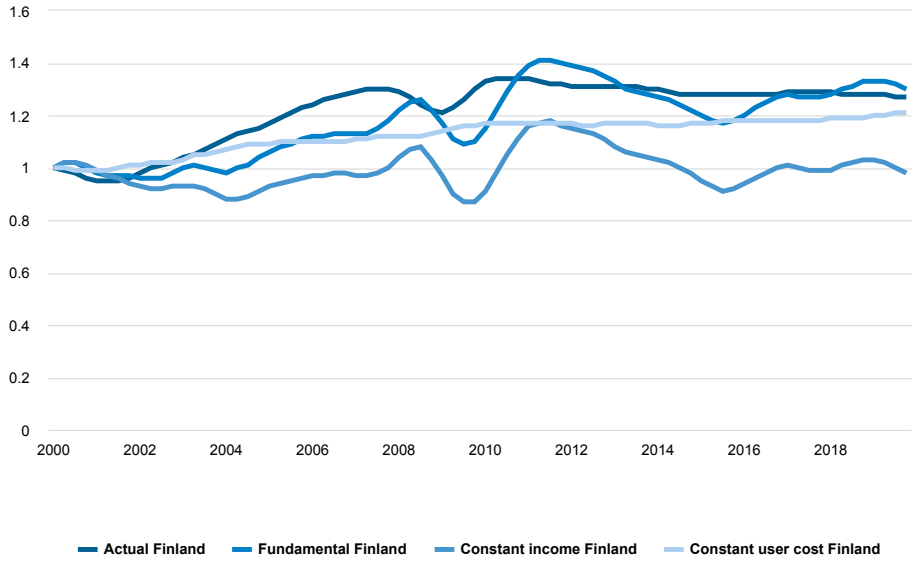
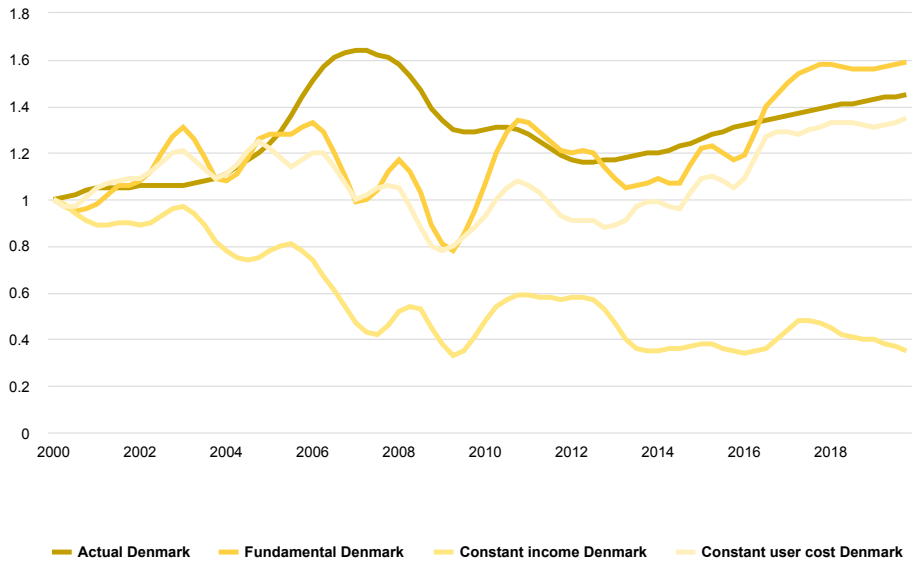


Figure 6d Fundamental house prices, actual house prices, and fundamental house prices without interest rate changes for Denmark, 2000–2019



Note: The figure shows fundamental house prices, actual house prices, fundamental house prices when holding real per capita disposable income constant from the first quarter of 2000, and fundamental prices when the real after-tax interest rate is kept unchanged from the first quarter of 2000 for Norway (6a), Sweden (6b), Finland (6c), and Denmark (6d). The sample covers the period 2000–2019. Fundamental prices are determined by real disposable income per capita, the housing stock per capita, and the real after-tax interest rate. All series are normalized to one in the first quarter of 2000. Detailed results on estimated coefficients are given in Table A.2 in the Appendix.

Source: Own calculations.

5 Conclusion

In this paper, I have investigated whether there are signs of bubbles or imbalances in the Danish, Finnish, Norwegian, and Swedish housing markets. First, I tested for explosive developments in real house prices. My results suggest that there was a bubble in the Danish housing market in the years preceding the global financial crisis. There is no evidence of bubbles for the other Nordic countries.

Using another methodological approach, I also estimated the trajectory of fundamental house prices for the period 2000–2019, as implied by developments in per capita income, the housing stock per capita, and the real after-tax interest rate. My results show that there were signs of overvaluation in all countries before the global financial crisis. I find that Norwegian and Swedish house prices were somewhat overvalued, while Danish and Finnish house prices were undervalued at the end of 2019.

My estimation results imply that the Nordic housing markets are highly sensitive to

interest rate changes, and that the secular decline in real after-tax interest rates over the past 20 years has been an important contributor to developments in fundamental house prices. I argue that the high sensitivity of house prices with respect to interest rate changes in Denmark, Finland, Norway, and Sweden must be seen in conjunction with the low housing supply elasticities that have been estimated for the Nordic countries. The low housing supply elasticities contribute to increased house price volatility over the course of a boom-bust cycle, and low supply elasticities implies a stronger effect of demand shocks on house prices.

From a policy point of view, fewer restrictions on construction activity would make builders more responsive to house price increases (increasing the housing supply elasticity), thereby dampening the effects of demand shocks and lowering house price volatility over the course of a boom-bust cycle. Policy actions that could reduce the bureaucratic hurdle in the building process could therefore lower house price volatility. If there is a supply side problem, it is easier to solve it on the supply side, not by manipulation of the demand side.

Several papers have also shown that relaxation of lending standards matters to regional house price developments in the US (e.g., Mian & Sufi 2009, Favara & Imbs 2015 and Anundsen & Heebøll 2016), and a strand of the literature attributes the bubble-like dynamics in the US housing market in the 2000s to the subprime explosion (see Duca et al. 2011a, 2011b, Pavlov & Wachter 2011 and Anundsen 2015). In this context, it may be tempting for authorities to impose limits to credit expansion through macroprudential policies. As a policy to cool down credit growth and to lower the risk of financial imbalances, this may be a sound tool, but it is not necessarily the best way to deal with housing market developments. If the reason why prices are increasing is that not enough houses are built in high-demand areas, it is a supply-side problem that requires supply-side policies. Tightening of credit standards can lower credit growth and thereby lower demand for housing. This pushes house prices down, but at the same time results in less construction activity – thus magnifying the initial structural deficiency. Given the low elasticities that are estimated for the Nordic countries, together with the high interest rate sensitivity of house prices, it seems to be of acute importance that one commissions a thorough investigation of political hurdles in the building process, which also studies housing needs in different part of the countries, and in particular whether new construction activity meets the actual needs in terms of type of housing, size, and not least location. Removing bureaucratic hurdles in the building process can lower house prices in the long run, make them less sensitive to demand shocks, and reduce house price volatility.

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Appendix

Data definitions

Table A.1 Variable definitions and data sources

Series	Description	Denmark	Finland	Norway	Sweden
PH	House price index	DS/DN	SF/BoF	SSB/NB/EV	SS/RB/VG
P	Consumer Price Index	DS	SF/BoF	SSB/NB	SS/RB
H	Housing stock	DS/DN	SF/BoF	SSB/NB	SS/RB
Y	Households' disposable income	DS/DN	SF/BoF	SSB/NB	SS/RB
i	Mortgage interest rate	RKR/DN/Dam et al. (2011)	BoF	NB	RB
τ_y	Capital gains tax rate	DS	BoF	SSB/NB	RB
POP	Population	DS/DN	SF/BoF	SSB/NB	SS/RB

Note: This table reports data descriptions and sources for the analyses of this paper. The data period runs from 1985 to 2019 for Denmark, Finland, and Norway. For Sweden, the sample covers the period 1909–2019. The abbreviations are the following: SD = Danmarks Statistikk, DN = Danmarks Nationalbank, RKR = Realkredittrådet, SF = Statistics Finland, BoF = Bank of Finland, SSB = Statistisk Sentralbyrå, NB = Norges Bank, EV = Eiendomsverdi, SCB = Statistiska Centralbyrån, RB = Riksbanken, and VG = Valueguard. For Denmark, I follow Dam et al. (2011) and construct the real after-tax interest rate using a combination of the interest rate on 30-year bonds and 1-year bonds, controlling for the minimum amortization rate and property taxes.

Detailed results from estimating fundamental house prices

Table A.2 summarizes the estimated long-run coefficients and adjustment parameters for each of the countries.

Table A.2 Results from cointegration analysis

Variable	Denmark	Finland	Norway	Sweden	Panel
Real interest rate	-12,55	-7,90	-11,00	-5,84	-6,88
	(6.39)	(0.99)	(5.11)	(1.50)	(0.84)
Disp. income	4,78	0,96	5,36	2,15	3,76
	(1.67)	(0.48)	(1.33)	(1.36)	(0.35)
Housing stock	-4,78	-0,96	-5,36	-2,15	-3,76
	(-)	(-)	(-)	(-)	(-)
Adjustment parameter	-0,05	-0,19	-0,03*	-0,15	
	(0.02)	(0.06)	(0.01)	(0.04)	

Note: This table reports a summary of the main results when the system-based approach of Johansen (1988) is implemented. The estimation period runs from 1985 to 1999 for Denmark, Finland, and Norway. For Sweden, it covers the period 1990–1999. The final column reports long-run coefficients when the countries are pooled into a panel. The dependent variable is real house prices, while the independent variables are real per capita disposable income, the housing stock per capita, and the real after-tax interest rate. The VAR models are of order two. * -0.029 before rounding.

Source: Own calculations.

It is evident that there is a substantial interest rate effect in all countries, and that the income effect is larger in Norway and Denmark than in Sweden and Finland. There is also evidence suggesting that equilibrium deviations are restored more slowly in Norway and Denmark than in the other two countries.

Having determined the parameters in the long-run relationship, I construct the fundamental house price path using the following specification:

$$ph_t^* = ph_{t-1}^* + \hat{\beta}_y^{1999q4} \Delta y_t + \hat{\beta}_h^{1999q4} \Delta h_t + \hat{\beta}_r^{1999q4} \Delta r_t, \quad t > 1999q4$$

Figure A.1a Actual versus fundamental house prices: country-by-country analysis versus panel approach, Norway

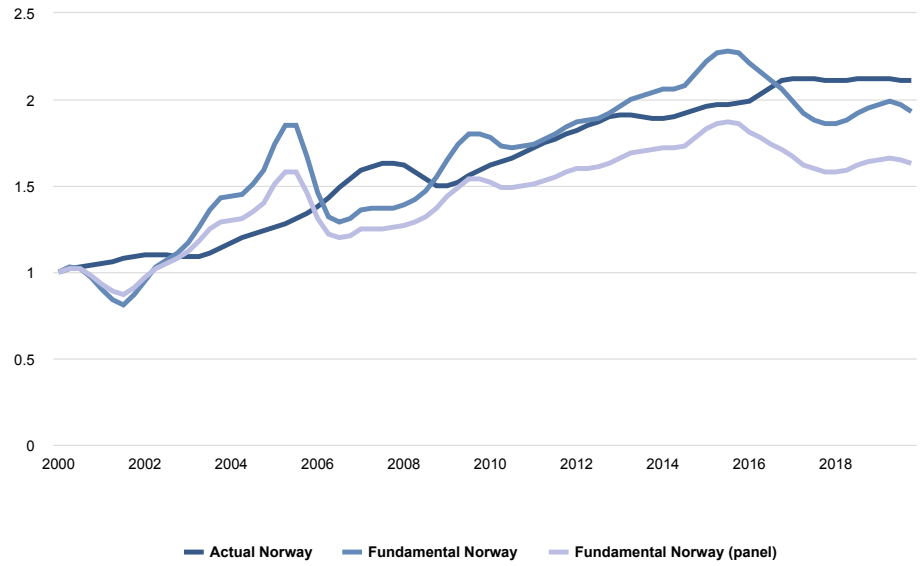


Figure A.1b Actual versus fundamental house prices: country-by-country analysis versus panel approach, Sweden

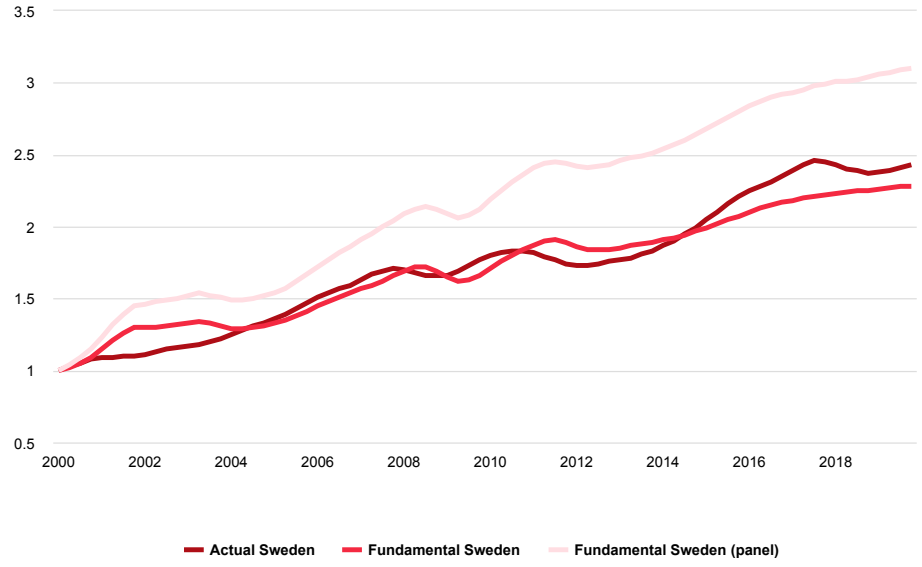


Figure A.1c Actual versus fundamental house prices: country-by-country analysis versus panel approach, Finland

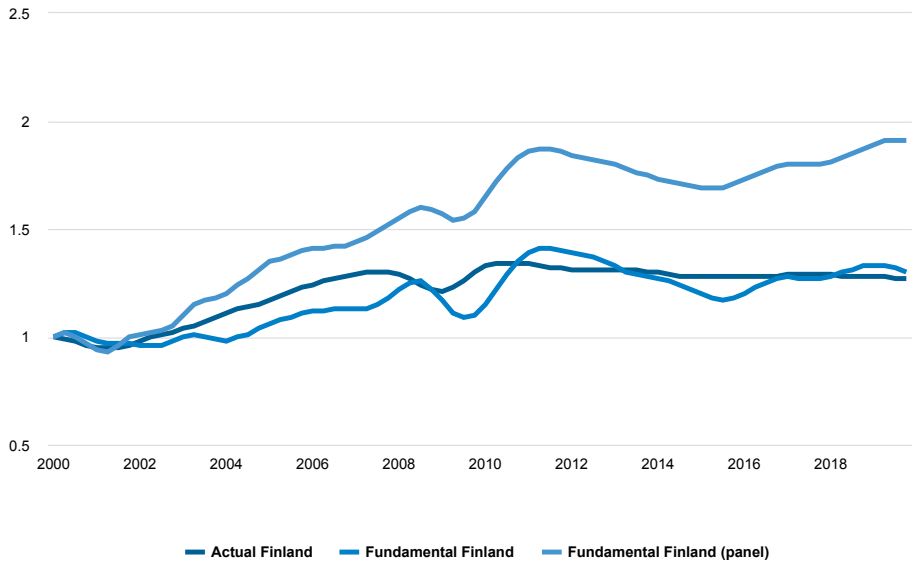
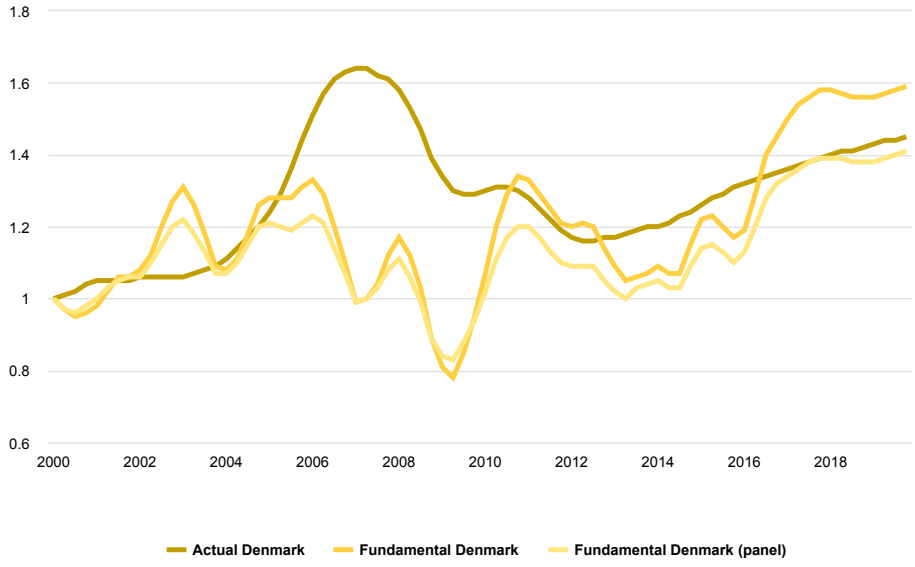


Figure A.1d Actual versus fundamental house prices: country-by-country analysis versus panel approach, Denmark



Note: The figures shows fundamental house prices when using country-specific estimates, fundamental house prices when using panel estimates, and actual house prices over the period 2000–2019. Fundamental prices are determined by income per capita, the housing stock per capita, and real after-tax interest rates. Both fundamental and actual prices are normalized to one in the first quarter of 2000. Detailed results on estimated coefficients are given in Table A.2.

Source: Own calculations.