Developments in the Market for Owner-Occupied Housing in Recent Years – Can House Prices be Explained?

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1. INTRODUCTION AND SUMMARY

The mid-2000s saw an unusual surge in owner-occupied house prices, followed by a sharp decline towards the end of the decade. The acceleration in house prices during the upswing fuelled a substantial increase in residential construction, which subsequently collapsed in response to the fall in house prices. This article analyses developments in the housing market in recent years, putting Denmark into an international perspective. Importance has been attached to explaining the factors driving the wave of price increases and the subsequent drop in prices.

In section 2, we describe developments in house prices in different parts of Denmark. Greater Copenhagen recorded a particularly strong increase during the upswing of 2004-06 and this area also experienced the most dramatic plunge during the subsequent downturn from the end of 2007 to the spring of 2009. Another significant feature was the speedy propagation of new types of home financing. Adjustable-rate loans caught on in earnest and deferred-amortisation loans, introduced in October 2003, quickly become very popular. By the end of the decade, deferred-amortisation adjustable-rate loans made up a significantly higher proportion of outstanding mortgage loans than traditional fixed-rate loans with amortisation. Residential construction also boomed, accounting for almost 8 per cent of total value added in the middle of the decade and thus vastly exceeding the long-term historical average.

We set up and estimate a new econometric relation in an attempt to explain residential investment. The econometric analysis shows that residential investment is driven to a great extent by house prices, as higher prices of the existing housing stock relative to construction costs trigger new construction. Although the estimated relation goes quite a long way

[1] The authors thank Heino Bohn Nielsen for valuable assistance in preparing the econometric analysis in this article. Any remaining shortcomings are the sole responsibility of the authors.

towards explaining developments in residential construction over an extended period, it has difficulty capturing the unusually large construction boom in the mid-2000s. One reason could be that the surge in house prices during this period seemed to attract a number of new professional property developers to the market in the expectation of harvesting healthy capital gains by constructing and selling new housing.

In section 3, we seek to explain the causes of house-price developments. The premise is that, in the short and medium terms, price developments are determined mainly by housing demand, given that growth in the housing supply in the form of new construction is slow. Housing demand is driven mainly by household disposable income and by short- and long-term interest rates after tax. For households with limited access to credit facilities – or a short-sighted approach – the size of first-year payments on mortgage loans also plays a key part in the house price they are able and willing to pay. Consequently, the size of the required mortgage repayments also impacts on demand. Based on these considerations, we set up and estimate an econometric relation for housing demand to explain the development in house prices from 1972 to 2010. In general, the explanatory power of the relation is good; e.g. it captures the full change in house prices occurring between 2000 and 2010.

The analysis shows that the increases in house prices during the upswing of the 2000s were extensively driven by developments in interest rates and disposable incomes, but the introduction of new loan types also had significant bearing on house prices. From the 4th quarter of 1999 to the 1st quarter of 2007, average real house prices for Denmark as a whole shot up by 71 per cent. Our analysis shows that up to 46 percentage points of this increase can be explained by the popularity of adjustable-rate loans and deferred-amortisation loans, the two loan types playing roughly equal parts. For Denmark as a whole, the freeze on property value tax played a relatively smaller part, explaining up to 14 percentage points of the price increase at the national level. However, the freeze clearly had a greater impact on price developments in large urban areas, particularly Greater Copenhagen, which experienced the steepest rise in house prices and where – in the absence of the freeze – large properties would have been subject to the progressive element of property value taxation. We conduct a more detailed analysis of regional distribution effects of the freeze on property value tax. This analysis shows that, in 2007, an average household in the environs of Copenhagen experienced a reduction in property value tax of approximately kr. 25,000 a year due to the freeze, while the reduction for an average household in Northern Jutland was less than kr. 5,000.

As stated above, our estimated house-price relation is able to explain the full change in house prices occurring between 2000 and 2010. However, the relation captures only part of the exceptionally steep increase in 2004-06. A "house-price bubble" is an appropriate term for developments during this period, in which prices were to a great extent decoupled from underlying economic fundamentals, to be driven instead by expectations of further price rises in the future – with accompanying capital gains. The subsequent price fall in 2008-09 was also steeper than predicted by the house-price relation, probably because overly optimistic expectations of price appreciation were replaced by very pessimistic expectations in the wake of the financial crisis.

Denmark was not the only country to experience rapidly escalating house prices in the early years after the millennium change. In section 4, we describe how the USA, the UK, France, Spain, Norway and Sweden also saw exceptional growth in real house prices in the period up to 2007, after which prices plummeted in most of these countries in the period up to 2009. However, in the Netherlands, prices increased only moderately up to 2008, and Germany stands in stark contrast to most other OECD countries with slightly falling house prices throughout the period. House prices in the individual countries extensively tracked cyclical movements, but generally culminated a couple of quarters before the peak in total output, which occurred in late 2007 and early 2008 in most countries. Thus, the turn in the housing market was one of the key triggers of the economic downturn, which started already before the global financial crisis fed through to the real economy in earnest in the autumn of 2008. In most countries, increases in house prices ahead of the turn were accompanied by a significant rise in the ratio of household debt to disposable income. In Denmark and the Netherlands debt increased more rapidly than in the other countries observed. The rise in debt was driven by falling interest rates in the period up to 2004. In most countries, new loan types and more lenient credit terms made it possible to borrow against increased property values during the upswing. The expanded credit facilities were the result, in part, of the gradual liberalisation of mortgage conditions throughout the 1980s and 1990s, but in some countries – notably the USA – the creditworthiness requirements for home buyers also seem to have been relaxed in the run-up to the financial crisis.

In the final section 5, we shift our focus back to Denmark where, despite the price drops in 2008 and the first part of 2009, real house prices are still higher than in the years ahead of the huge wave of price increases from 2004 to 2007. Against this backdrop, we ask the difficult question: "Are Danish house prices still overvalued?" In our attempt to

answer this question, we apply five different quantitative methods. One method is to compare the current house-price-to-rent ratio with the historical average for this ratio. Two other methods assess whether current prices of the existing housing stock appear to be sustainable in the long term when measured against the cost of new construction. The three methods all suggest that real house prices remain somewhat overvalued. However, the three methods share the problem that it is highly difficult to identify a "normal" long-term sustainable level for house prices relative to rents and construction costs. This speaks in favour of placing more emphasis on other methods.

Accordingly, we conduct a more detailed analysis of the housing burden, calculated as the sum of housing taxes and financing costs of a fully leveraged home purchase relative to average household disposable income. We calculate developments in the average housing burden for Denmark as a whole from 1971 until today. The calculations show that the current housing burden is roughly in line with the average level of the last 40 years. With the current level of interest rates, this does not indicate that a further decline in house prices is required. In general, this conclusion does not change when we conduct a more detailed analysis of developments in the housing burden in different parts of Denmark, using different loan types. But the analysis does show that the housing burden in Copenhagen and environs is moderately higher today than in early 2003, so that prices in Greater Copenhagen may be slightly overvalued.

In the final part of section 5, we use the house-price relation estimated in section 2 to assess the current level of house prices. We find that the current price level is lower than would be expected based on the house-price relation, which reflects average historical correlations between house prices, interest rates, incomes, etc. Against this backdrop, we project house prices through 2015 on the basis of expectations of macroeconomic developments over the coming years. To this end, we assume that interest rates will gradually rise from their current very low level to a level equivalent to the long-term historical average. Although interest rates will thus show a notable increase, our house-price relation does not entail any significant change in real house prices in the period up to 2015. Part of the explanation is that some degree of income growth is expected, which will offset the dampening effect of interest-rate rises on house prices. Furthermore, as already mentioned, house prices are currently lower than would be expected based on the estimated house-price relation. This could be due to a certain amount of negative overreaction in house prices, driven by very negative expectations in the wake of the financial crisis. As this overreaction fades away, a basis will

be created for some recovery in house prices, which may counter the effect of the expected interest-rate rise.

Overall, the analyses based on the housing-burden index and the house-price relation do not indicate that house prices in Denmark as a whole are currently overvalued. Nevertheless, real house prices may drop in some parts of the country over the coming years, e.g. in Greater Copenhagen. House-price developments also hinge closely on interest-rate movements. Our analysis thus shows that some decline in real house prices is to be expected if interest rates rise more rapidly and sharply than assumed in our main scenario.

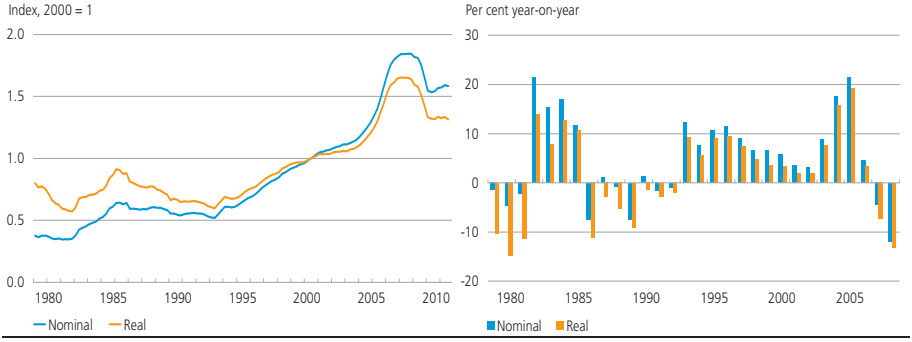
2. THE DANISH HOUSING MARKET IN RECENT YEARS

The economic upswing in 2004-06 fuelled a boom in the housing market. When the average price of a single-family house peaked in 2007, it was 63 per cent higher than the 2003 level, equivalent to an average annual growth rate of 13 per cent, cf. Chart 2.1. Adjusted for general inflation, the increase was 54 per cent or 11 per cent per year.

Such developments are not unprecedented in recent Danish economic history; from 1982 to 1986, house prices surged by a total of 84 per cent (16 per cent per year). However, inflation was higher during this period, so that the real increase was 50 per cent (11 per cent per year).

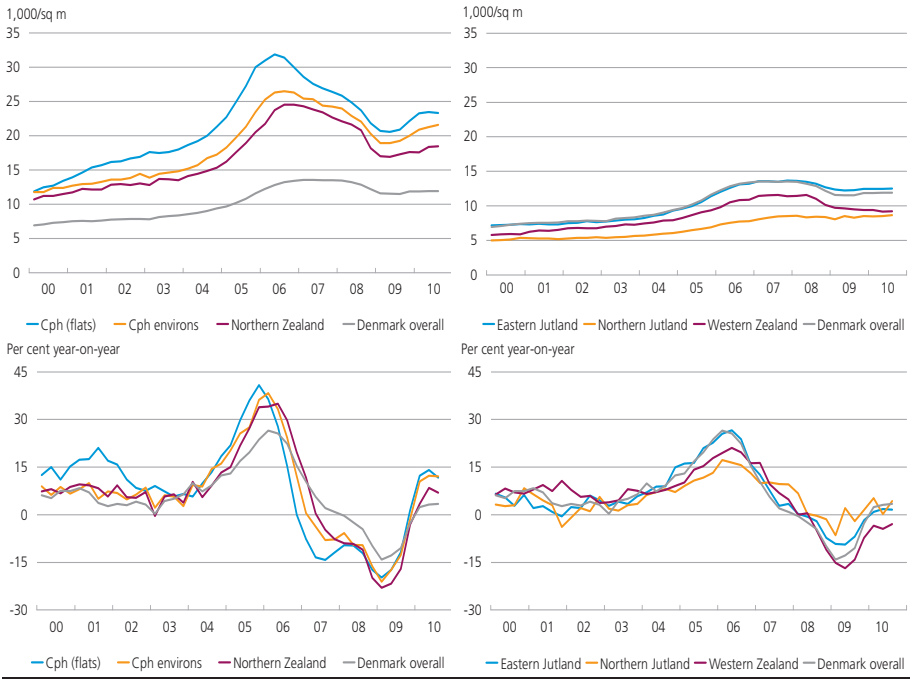
The sharp escalation in prices in the mid-2000s masks significant differences across Denmark. The upswing in the housing market started in Copenhagen, especially in the market for owner-occupied flats, and quickly spread to the environs of Copenhagen and Northern Zealand, cf. Chart 2.2 (left). The high-income municipalities north of Copenhagen thus saw quite a surge in house prices.

HOUSE PRICES, SINGLE-FAMILY HOUSES — Chart 2.1



Note: Seasonally adjusted price index (left-hand Chart). The real house price was obtained by deflating with the national accounts deflator for private consumption.
Source: Statistics Denmark and MONA databank.

REGIONAL DEVELOPMENT IN HOUSE PRICES Chart 2.2



Note: Price per square metre for single-family houses, unless otherwise indicated.
Source: Association of Danish Mortgage Banks (own seasonal adjustment).

Prices peaked towards the end of 2007, by which time turnover in the housing market had dropped to a very low level. A relatively sharp price adjustment followed; from the 4th quarter of 2007 until prices bottomed out in the 2nd quarter of 2009, the average price per square metre for houses dropped by a total of 17 per cent (20 per cent in real terms). House prices stabilised in the 2nd quarter of 2009 and, since then, they have largely tracked the consumer price index.

The largest price increases were recorded in and around Copenhagen and the subsequent fall in prices has also been most pronounced in this part of the country. Hence, the downward price adjustment of recent years has also served to reduce the significant geographical variations in the price per square metre that were observed during the boom, cf. Box 2.1.

The general economic upswing in 2004-06 was reflected in a considerable increase in household disposable income, laying the foundation for higher house prices, cf. Chart 2.4 (left). At the same time, interest rates were generally low during this period, cf. Chart 2.4 (right).

Moreover, financial market liberalisation brought increased flexibility in the composition of home buyer financing, including the option to reduce the first-year payments. Adjustable-rate loans were introduced in

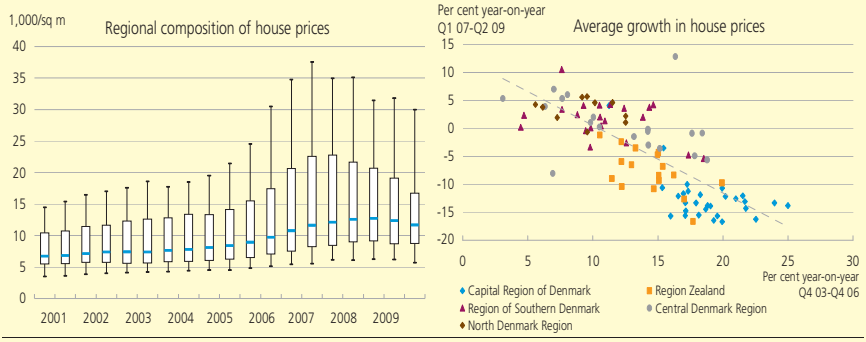
REGIONAL DIFFERENCES IN HOUSE-PRICE DEVELOPMENTS Box 2.1

The acceleration in house prices in 2004-06 was particularly pronounced in and around Copenhagen. Housing in Greater Copenhagen is also characterised by having the highest prices per square metre, causing the spread in house prices across Denmark to increase significantly during this period – the gap between cheap and expensive neighbourhoods widened.

This divergence in house prices is illustrated by a sequence of box plots in Chart 2.3 (left). Each box plot sums up the distribution of prices per square metre across municipalities in Denmark during the six-month period in question. The box plot comprises a white box spanning the lower and upper quartiles. The blue line indicates the median, while the thin "arms" span the lowest and highest observations during the given six-month period.

It is seen that while the price increases in 2004-06 affected expensive as well as cheap municipalities, the increases started in expensive municipalities in the course of 2004, while, in cheap municipalities, prices did not start rising until 2005. During the 2005-06 price boom, increases – also in relative terms – were higher in expensive municipalities, while the subsequent correction masks that prices in expensive municipalities fell, while they stagnated in cheap municipalities. The price gaps across Denmark have thus been reduced in step with the downward correction.

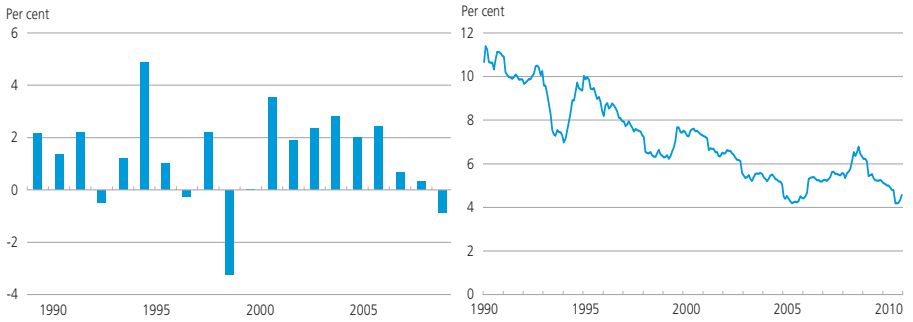
HOUSE-PRICE DEVELOPMENTS, BROKEN DOWN BY MUNICIPALITIES Chart 2.3



Note: The box plot in the left-hand Chart is based on semi-annual average prices per square metre for individual municipalities, depicting the lowest observation, lower quartile, median, upper quartile and highest observation for each six-month period. The right-hand Chart depicts average annual growth rates for the periods shown on the axes for each municipality in Denmark.
Source: Association of Danish Mortgage Banks and own calculations.

Chart 2.3 (right) shows price developments broken down by municipalities during the upswing from the 4th quarter of 2003 to the 4th quarter of 2006 compared with developments from the peak in the 1st quarter of 2007 to the trough in the 2nd quarter of 2009. Again, it is seen that the municipalities with high price increases during the upswing were also the ones to experience steep drops during the subsequent price adjustment. The Chart also documents that the greatest increases and subsequent falls were in Greater Copenhagen, while developments west of the Great Belt were generally much more moderate.

HOUSEHOLD DISPOSABLE INCOME AND 30-YEAR BOND YIELD — Chart 2.4



Note: Household disposable income has been deflated by the implicit deflator for private consumption.
Source: Statistics Denmark and Danmarks Nationalbank.

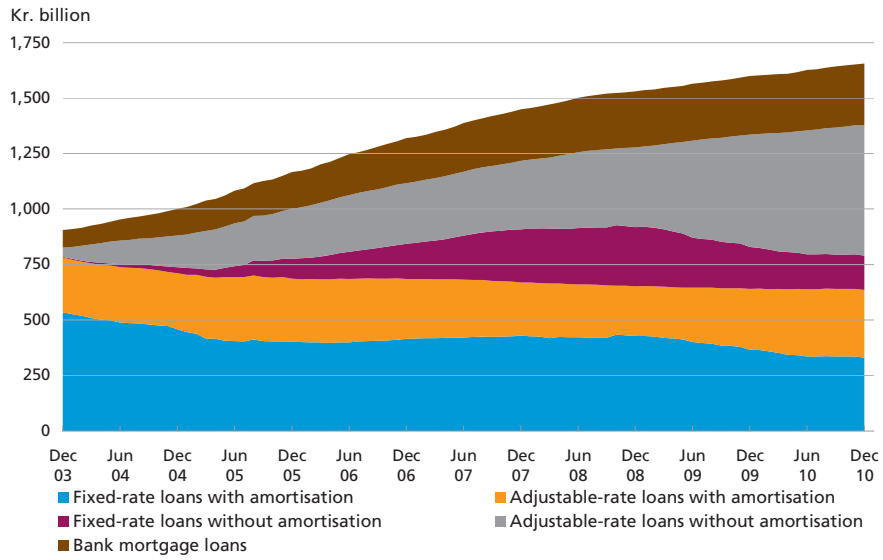
1996 and rapidly gained ground in the years just after the millennium change. October 2003 saw the launch of deferred-amortisation loans, which have also become popular in recent years, cf. Chart 2.5.

Below, we seek to illustrate the impact of the various factors on house-price developments.

Residential construction and economic developments

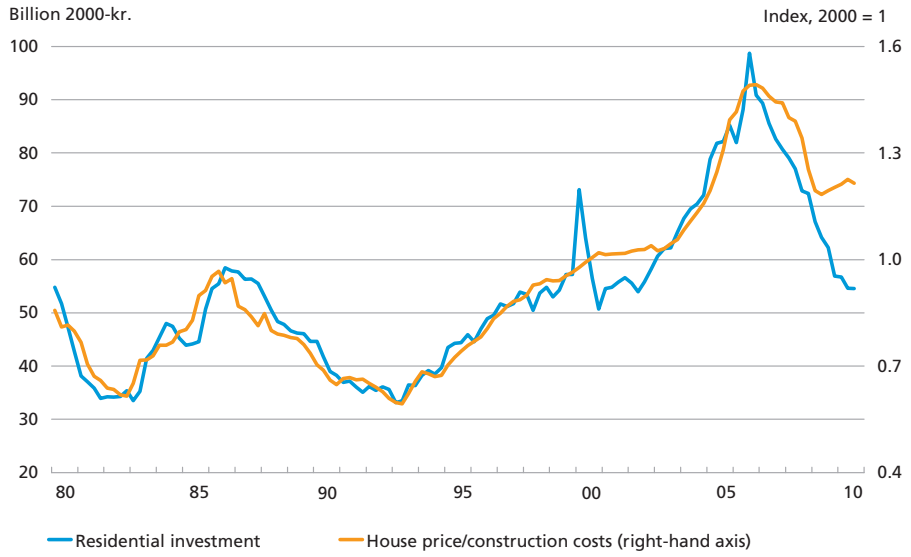
Rising house prices triggered a boom in residential construction. Historically, there has been close correlation between residential investment and the ratio of traded house prices to the price of new construction

COMPOSITION OF HOME BUYER FINANCING — Chart 2.5



Source: Danmarks Nationalbank.

HOUSE PRICES, CONSTRUCTION COSTS AND RESIDENTIAL INVESTMENT Chart 2.6



Note: Annualised seasonally adjusted quarterly figures for residential investment. The national accounts deflator for construction investment is used as construction costs. The extraordinary and temporary increase in the 1st quarter of 2000 is the result of the December 1999 hurricane.
Source: Statistics Denmark and Danmarks Nationalbank.

(*Tobin's Q*), cf. Box 2.2. During the upswing, the response did not fail to show itself when the price of the existing housing stock increased relative to new construction, cf. Chart 2.6. In 2006, residential investment was thus 61 per cent higher than in 2002.

DEVELOPMENTS IN RESIDENTIAL INVESTMENT Box 2.2

Chart 2.6 shows close correlation between residential investment, on the one hand, and the ratio of owner-occupied house prices to the price of new construction, on the other. As discussed in section 5, this correlation reflects that new construction becomes attractive when the price of existing housing tends to be higher than the price of new construction, and vice versa.

This correlation forms the basis for the determination of residential investment in MONA as well as a number of other macroeconometric models, such as ADAM. For our model-based analyses in the following sections, we have updated the MONA residential-investment relation in light of developments in recent years.

The selected formulation of the relation is estimated for the period from the 1st quarter of 1980 up to the 4th quarter of 2007. We thus choose to disregard the 1970s, during which decade the housing market was characterised by significant regulation and extensive subsidised construction. The estimated equation has the following form:

$$I^h/K^h_{-1} = 0.86 \cdot \left(I^h/K^h_{-1}\right)_{-1} + 0.003 \cdot \log\left(P^h_{-1}/P^i_{-1}\right) + 0.014\,\mathrm{Dlog}\left(P^h/P^i\right) + dummy + 0.002,$$

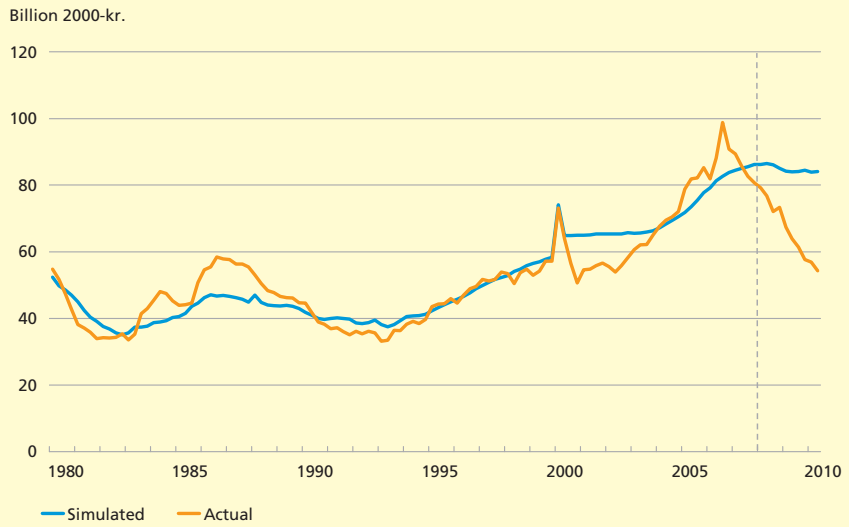
CONTINUED Box 2.2

where I^h is net residential investment, K^h is housing stock, P^h is house price and P^i is investment cost. The estimated relation contains a dummy to capture the outliers in the 1st half of 2000, when residential investment was extraordinarily high due to the December 1999 hurricane. The relation entails that, in the long term, house prices are determined by the investment cost in accordance with the theory of Tobin's Q, cf. section 5. The relation also entails a considerable degree of persistence – the response to changes in the relative price of owner-occupied housing is reflected only gradually in the level of investment.

Chart 2.7 shows actual residential investment, along with the investment predicted by the relation. It is seen that, in general, the relation explains the level of investment relatively well, while it has difficulty capturing the boom from 2004 and especially the steep fall.

The estimated residential-investment relation is described in detail in Appendix A.

ACTUAL AND PREDICTED RESIDENTIAL INVESTMENT Chart 2.7

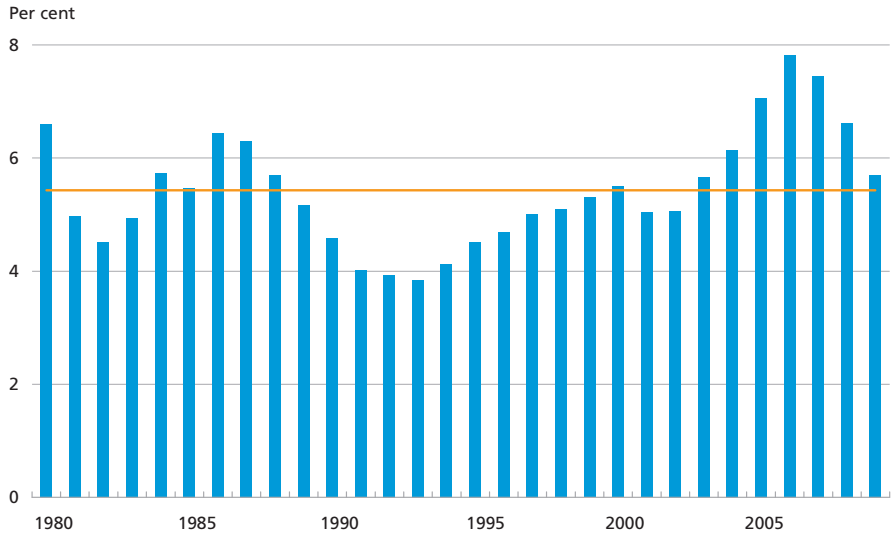


Note: Annualised chained values. Simulated values are based on dynamic simulation of residential investment as from the 1st quarter of 1980.
Source: Statistics Denmark and own calculations.

Since the housing market ran out of steam in 2007, residential construction has fallen back to the 2002 level. Remarkably, residential investment continued to fall throughout 2009 and 2010, while house prices stabilised; accordingly, the historical covariation between residential construction and relative house prices has been broken in recent years.[1]

[1] Danish Economic Councils (2010, p. 123) put forward the hypothesis that the unusually low residential investment level during the past few years may be explained by continued overvaluation of the prices of building plots.

RATIO OF RESIDENTIAL INVESTMENT TO TOTAL GVA — Chart 2.8

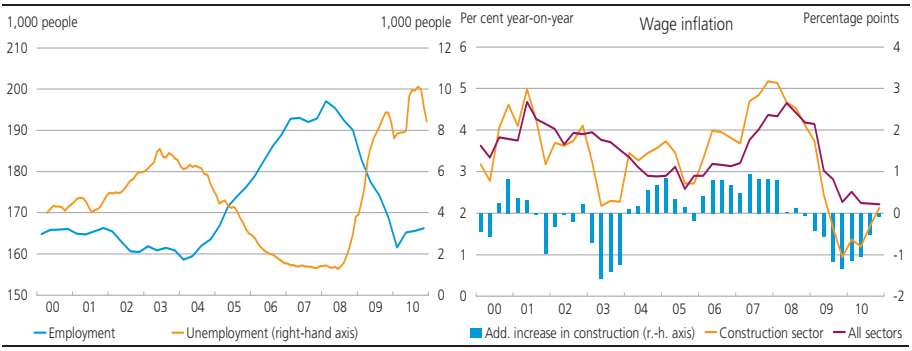


Note: Current prices. The average for the period 1980-2009 is 5.4 per cent, indicated by the horizontal orange line.
Source: Statistics Denmark.

The housing boom of 2005-07 led to an increase in residential construction as a ratio of total economic activity (measured as gross value added, GVA), cf. Chart 2.8. During the subsequent marked slowdown in construction, the ratio of residential investment to GVA declined again, but in 2009 it was still slightly higher than the average of the last 30 years.

The boom in residential construction was accompanied by an upsurge in employment in the construction sector, cf. Chart 2.9 (left). From 2004

EMPLOYMENT, UNEMPLOYMENT AND WAGE INFLATION IN THE CONSTRUCTION SECTOR — Chart 2.9



Note: Employment (seasonally adjusted) in the construction sector according to the national accounts. Unemployed workers from five selected unemployment insurance funds.
Source: Statistics Denmark (own seasonal adjustment of unemployment figures).

to 2007, employment rose by just over 30,000, which was reflected in very low unemployment in construction-related sectors; moreover, labour from other sectors migrated to construction – in line with developments during previous upswings with extensive construction activity.

The shortage of labour in construction during the upswing was reflected in substantial wage pressure; in 2004-07, annual wage inflation was 0.5 percentage point higher than in the Danish economy as a whole, cf. Chart 2.9 (right). After the slowdown, wage inflation in the construction sector quickly fell to quite a modest level. It is a well-known phenomenon that the construction sector is more cyclical in terms of both the level of activity and wage developments than the economy in general.

3. FACTORS BEHIND HOUSE-PRICE DEVELOPMENTS

Short-term house-price developments are predominantly determined by demand, the reason being that supply in the form of new construction is slow to respond to demand. Hence our analysis of house-price developments over recent years is based on an estimated relation of housing demand, the development in the overall housing stock being taken as a given.

What determines housing demand?

In general, demand for owner-occupied housing is assumed to be determined by household income and the user cost of investing in housing. The user cost consists of real interest rates (after tax) and housing-related taxes. The user cost should also include expected real capital gains on housing, but as these are notoriously difficult to estimate, they are often left out in practice. We attempt to capture the effect of expected capital gains through a process in which households form expectations of future price developments based on developments in recent years. In principle, depreciation should also be included, but in the following we have chosen to disregard depreciation.[1]

The econometric relations used until now to describe price developments in the Danish housing market all had difficulty explaining the steep price increases of the mid-2000s. This led to a sharper focus on the possible effect of first-year payments as an alternative or supplement to the significance of the user cost.

[1] In MONA, depreciation on the housing stock has, in practice, also been disregarded so far. This seems to be empirically reasonable in view of the very stable development of depreciation in the national accounts.

In a situation where consumers are fully rational and not subject to binding credit restrictions, demand should be determined solely by the economic user cost. Accordingly, the possibility of opting for deferred-amortisation periods should not impact housing demand, and thus house prices, as repayments on loans constitute savings for the home-owner rather than actual costs.

To the extent that households also consider their cash flow position, or are subject to binding credit restrictions – or simply find it difficult to comprehend the economic calculation on which the user cost is based (including the role of inflation as repayment on the real debt) – factors such as repayment profile and the possibility of opting for adjustable-rate loans will, however, have an impact on housing demand, cf. Box 3.1. We allow for this possibility in the estimation by including the lowest possible first-year payments in addition to the user cost. While the user cost is based on a 30-year fixed-rate bond loan, the immediate savings by choosing 1-year adjustable-rate loans[1] and the possibility of opting for deferred amortisation from the 4th quarter of 2003 are fully reflected in the first-year payments.

Explanation of the increase in house prices during the 2000s

Based on these considerations, we estimate a demand relation for owner-occupied housing where real demand is proportional to household disposable income and otherwise dependent on the user cost (expected house-price increases being handled separately) and the first-year payments. According to the estimation, the relative impacts on housing demand of first-year payments and user cost are 60 per cent and 40 per cent, respectively.

We now rewrite the demand relation to determine the real house price as a function of a number of key economic variables that are included in the demand factors described. The relation is written in error-correction form, meaning, roughly speaking, that the price only gradually adjusts to changes in the underlying demand as a result of changes in interest rates, income, repayment rates, etc. The estimated relation is described in Box 3.2.

Based on this price relation, developments in real house prices may now be broken down into contributions from individual variables. To this should be added other model effects which cannot be distributed unequivocally on the underlying specific economic variables, and residuals in the form of price changes that cannot be explained by the model.

[1] Adjustable-rate loans were formally (re)introduced in 1996, but this loan type did not come into widespread use until after the millennium change. Consequently, we have decided that short-term interest rates will be reflected in the first-year payments from the 1st quarter of 2000.

DEFERRED-AMORTISATION LOANS AND THEIR IMPACT ON HOUSING DEMAND Box 3.1

Deferred-amortisation loans were introduced in the autumn of 2003. They quickly became popular and now account for more than half of total lending to homeowners. These loans do not affect the user cost of owner-occupied housing – only the repayment profile – and thus it could be argued that the option to defer amortisation should not impact house prices. Still, these loans may have had an impact through the following channels:

- *Liquidity-constrained consumers*. Consumers who are subject to credit rationing cannot achieve the desired consumption smoothing over their lifetimes. It is rarely possible to borrow against future income, entailing that consumption – including housing consumption – may be lower than desired. With deferred-amortisation loans, home buyers are no longer forced to accumulate home equity, i.e. they can borrow a larger amount without having to pay more, thus increasing their housing consumption. A number of consumers must be assumed to be liquidity constrained. However, the lending policies of the mortgage banks will put a damper on the impact of deferred amortisation. In principle, they should grant deferred-amortisation loans only to consumers who can afford a fixed-rate loan with amortisation.
- *Short-sighted and irrational behaviour.* Many home buyers focus on the first-year payments when buying a home. Deferred amortisation, in combination with adjustable-rate loans, currently the most widely used loan type, has reduced these payments significantly. The low payments may have tempted many people to over-extend themselves, thus contributing to driving up housing demand. Unless the loan is refinanced, the payment increases when the deferred-amortisation period expires. Others may hope to find a solution at some point in the future, e.g. in the form of higher income, increasing house prices or political intervention. Again, the lending policies of the mortgage banks will be key for the impact.
- *Flexible repayment profile*. Some home buyers will probably choose a more demanding repayment profile than they would otherwise have done, knowing that they may opt for a deferred-amortisation period, should they suffer a period of lower income. Deferred amortisation may thus be seen as an option. However, e.g. supplementary loans have always been an option.
- *Reduced supply*. Deferred-amortisation loans may reduce the housing supply by enabling more people to stay in their homes in situations in which they would otherwise have sold. Examples could be divorce, unemployment or death. Pensioners will also be able to stay in their homes longer. The reduced supply pushes up prices. The housing supply fell immediately after the introduction of deferred-amortisation loans and up to early 2006. Since then, it has increased significantly, making it difficult to attach much quantitative weight to this explanation. Furthermore, previously homeowners were also able to obtain supplementary loans or dissaving loans if they needed extra liquidity.
- *Settlement of more expensive debt*. Homeowners with deferred-amortisation loans may settle other, more expensive debt more quickly, obtaining savings that may be used to take out a larger mortgage loan.

RELATION FOR OWNER-OCCUPIED HOUSING DEMAND Box 3.2

We let underlying (long-run) demand for owner-occupied housing be determined by real household disposable income and a free combination of user cost and the lowest possible first-year payments, where the real house price is separated out. In other words, we assume that

$$K^D = F\left(Y, u, y, p^h\right),$$

where K^D is the households' desired housing stock, Y is their real disposable income, u is an expression of elements of the user cost (see below), y is the lowest possible first-year payments and p^h is the real house price.

Theoretically, user cost is defined as

$$usercost = \left(\underbrace{\left[(1-t)r^{30} - \pi\right] + s + d}_{u} - \pi^h \right) p^h,$$

where the square brackets are real interest rates after tax on 30-year bonds, s is housing-related taxes (currently land tax and property value tax), d is depreciation and maintenance and π^h is the expected (real) capital gain in the form of higher house prices (over and above ordinary price increases). Inflationary expectations π and expected capital gains, π^h, are each approximated by adaptive algorithms of the AR(1) form. In the estimation, user cost is divided into the actual real house price p^h, the rate of user cost u (excluding expected capital gains) and expected capital gains π^h.

The first-year payments are defined as

$$payment = \underbrace{\left((1-t)r^{\min} + s + repay\right)}_{y} p^h,$$

where interest rates r^{min} as from the 1st quarter of 2000 change from the 30-year bond yield to a short-term bond yield (weighted for mortgage bonds with a maturity of 1 and 2 years) and *repay* is the repayment rate for a fully leveraged house with full utilisation of adjustable-rate loans as from the 1st quarter of 2000 and deferred amortisation as from the 4th quarter of 2003. As was the case with the user cost, the first-year payments are divided into the real house price and a rate for the first-year payments, y, in the estimation.

The relation is transformed into log-linear form and estimated over the period from the 1st quarter of 1972 to the 2nd quarter of 2010 as an error-correction model for the house price, and a few significant short-term elements are added. The underlying estimated price relation (the long-run relation) is then

$$\log p^h = -15.5 \cdot \left(0.4 \cdot u + 0.6 \cdot y\right) + 2.0 \cdot \pi^h + 1.5 \cdot \left(\log Y - \log K^h\right).$$

The price relation implies that, in the absence of a supply response, a general drop in interest rates of 1 percentage point will lead to a 15 per cent increase in the real house price, equivalent to a 9 per cent rise in the desired housing stock. If only short-term interest rates fall by 1 percentage point, the price response will be a 9 per cent increase, equivalent to a 5 per cent rise in the housing stock demand. If real household disposable income grows by 1 per cent, the real house price will go up by 1.5 per cent for an unchanged housing stock.

The estimation and the explanatory variables are reviewed in detail in Appendix B.

Specifically, we perform a breakdown based on a simulation from the 4th quarter of 1999, the last quarter before short-term bond yields are reflected in the first-year payments. The breakdown covers developments up to the 1st quarter of 2007, at the peak of house prices, and up to the 2nd quarter of 2010, the latest observation of house prices, respectively. The results of these simulations are shown in Table 3.1.

In real terms, house prices rose by 71 per cent from the millennium change until their peak in the 1st quarter of 2007. Just over half (37 percentage points) of this price increase may be distributed directly on the explanatory variables. The key factor is interest-rate developments (after tax), accounting for a total of just over 26 percentage points. The contribution from interest rates may be distributed more or less equally on the effect of lower interest rates in the form of the 30-year bond yield and cost savings from financing based on adjustable-rate loans and hence short-term interest rates rather than 30-year interest rates.

Growth in household income contributes an additional 13 percentage points, just over half of which is neutralised by an increase in the housing stock through new construction. To this should be added small positive contributions from expected rises in real house prices (3.5 percentage points) and from the changes in required repayments. In other words, the latter factor explains only a modest part of the price increase

CONTRIBUTIONS TO EXPLAINING THE INCREASE IN REAL HOUSE PRICES 2000-09

Table 3.1

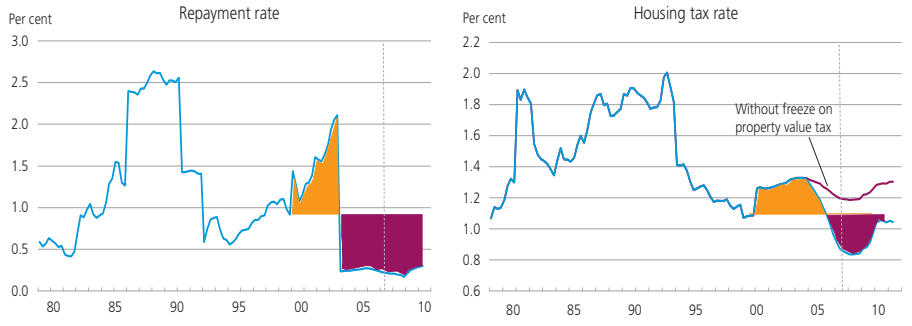
Percentage points	Q4 1999 – Q1 2007	Q4 1999 – Q2 2010
Interest-rate level (30-year), after tax	13.4	12.7
Adjustable versus fixed rate (after tax)	13.1	13.4
Housing taxes	-0.5	1.1
Repayment rate	2.0	4.9
Expected inflation	-0.6	0.6
Expected house prices (real)	3.5	-5.8
Real household disposable income	13.0	20.1
Housing stock	-6.9	-13.6
Total identified contributions	37.0	33.3
Other model effects[1]	11.3	7.3
Total explanatory contribution	48.2	40.6
Not explained	22.8	-2.6
Total real house price increase	71.0	38.0

Note: Individual explanatory contributions have been calculated by dynamic simulation of demand relations as from the 4th quarter of 1999, all other variables being kept constant at their initial levels. Sums may not add up due to rounding.

Source: Statistics Denmark, Association of Danish Mortgage Banks, Realkredit Danmark and own calculations.

[1] Other model effects are non-linear composition effects and adjustment to the initial disequilibrium in the estimated demand relation.

REPAYMENT RATE AND HOUSING TAX RATE Chart 3.1



Note: Calculated repayment rate and housing tax rate, cf. Appendix B. The coloured areas illustrate the difference between actual developments and flat developments since the 4th quarter of 1999, on which the calculations in Table 3.1 are based. The yellow areas designate contributions to lower house prices since the end of 1999, while the red areas designate contributions to higher prices. The dotted lines mark the peak of real house prices in the 1st quarter of 2007. The right-hand Chart also illustrates counterfactual developments in the overall, imputed rate of housing tax, had property value taxes not been frozen in 2002.

Source: MONA databank and own calculations.

in the period up to 2007 – despite the introduction of deferred-amortisation loans as from the 4th quarter of 2003. The reason is that the decline in interest rates during the preceding period triggered a substantial rise in required repayments on adjustable-rate loans, as repayments on these loans go up when interest rates fall and vice versa. This is illustrated by Chart 3.1 (left) where the yellow area indicates that developments in the repayment rate from the 4th quarter of 1999 point to lower house prices, while the red area as from the introduction of deferred-amortisation loans in the 4th quarter of 2003 shows that the repayment rate here points to higher house prices relative to the point of departure at the end of 1999. The net effect on house prices (i.e. the difference between the two areas) is negligible when calculated at the 1st quarter of 2007, at the peak of real house prices. On the other hand, the separate price effect of deferred-amortisation loans was significantly greater than illustrated by Table 2.1. This effect is analysed in more detail below.

Housing taxes play virtually no part in the explanation of the overall increase in house prices from the 4th quarter of 1999 to the 1st quarter of 2007. The reason is that overall housing taxes as a ratio of the market value of the housing stock increase during the first few years, reflecting factors such as the restructuring of taxes introduced by the Whitsun Package of austerity measures, which entered into force 1999, cf. the yellow area of Chart 3.1 (right).

This counters the gradual erosion of the property value tax from 2002 due to the freeze on property value tax implemented as part of the general tax freeze. The separate price effect of the freeze on property

value tax is significantly greater than illustrated by Table 2.1. This effect is analysed in more detail below.

Of the 48 percentage points of the price increase explained by the model as a whole, just under one fourth (11 percentage points) is attributable to more complex model effects. In other words, this leaves 23 percentage points – or just under one third – of the overall price increase during the period that cannot be explained by the model.[1]

If we extend the simulation to cover the period up to the 2nd quarter of 2010, the overall increase in real house prices decreases to 38 per cent. As in the previous case, the total contribution from interest rates is 26 percentage points. On the face of it, the contribution from income has increased, but adjusted for growth in the housing stock, the contribution remains 6-7 percentage points. Now the possibility of opting for deferred amortisation has been allowed to be reflected more fully in prices (5 percentage points), while the expected price increases detract from the calculation (-6 percentage points) in light of the steep fall in 2007-08.

However, the most important difference is that the model now explains the entire development in house prices. The significant portion of the price increase in 2004-06 which the model did not capture has now been eliminated. It is tempting to see this portion of developments in prices as a result of an actual price bubble, entailing that home buyers act on expectations of a future price level that is decoupled from underlying economic fundamentals. In other words, expectations of future capital gains seem to have played a greater role in price formation during this period than in the rest of historical estimation period, cf. the separate discussion below.

New loan types and freeze on housing taxes

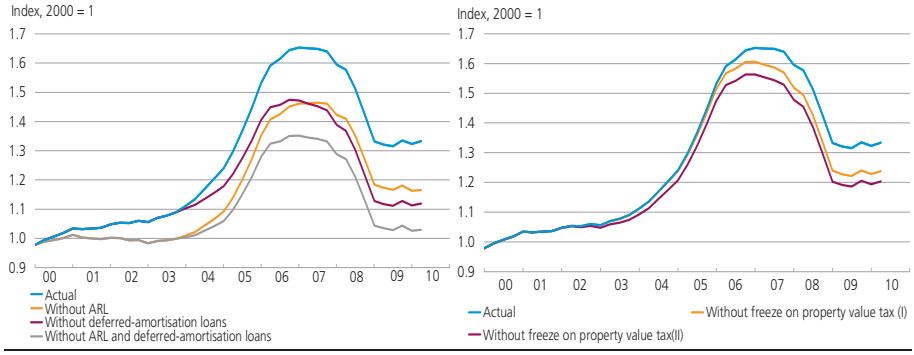
As already mentioned, the period observed (the end of 1999 up to the 2nd quarter of 2010) saw several significant instances of liberalisation of the credit market. Home buyers were given more financing opportunities to choose from in the form of adjustable-rate loans and deferred-amortisation periods – both of which have contributed to reducing the required first-year payments following a home purchase.

At the same time, a tax freeze was introduced after the change of government in 2001. In general, all rates of direct and indirect taxes were frozen, yet a special structure was introduced for property value

[1] We emphasise that this is *not* because the model in general has difficulty explaining large and steep price increases; thus the model easily captures the housing boom and the accompanying price increases in 1983-86, while it actually tends to overestimate the price increases during the upswing in 1993-2000.

REAL HOUSE PRICES WITH AND WITHOUT NEW LOAN TYPES AND FREEZE ON PROPERTY VALUE TAX

Chart 3.2



Note: Counterfactual scenarios based on the estimated demand relation. Adjustable-rate loans (ARL) are not assumed to be reflected until the 1st quarter of 2000. In the absence of the freeze on property value tax, the imputed rate of property value tax of the MONA databank is assumed to be kept constant as a ratio of the housing stock calculated at market value. The freeze on property value tax has been modelled in two alternative ways; (I) as the current realised effective property value tax and (II) as a permanent reduction in property value tax by 63 per cent in the 1st quarter of 2002, cf. Box 3.3.

Source: MONA databank and own calculations.

tax under which nominal tax payments were frozen regardless of developments in house prices and in the consumer price index. This has resulted in erosion of the effective property value tax rate in step with the increase in house prices.[1]

The price effect of these measures may be analysed separately based on the estimated housing-demand relation. In this case, we simulate the counterfactual scenario, entailing that we compare actual developments with scenarios under which we eliminate the possibility of opting for adjustable-rate loans and/or deferred amortisation as well as the effect of the freeze on property value tax, cf. Chart 3.2. The simulations take separate account of how expectations of future house-price increases change and how changes in housing taxes are reflected in household disposable income. The effects are summarised in Table 3.2 for the same sub-periods as applied in the breakdown above.

It is seen that the estimated relation attaches significant effect to both of the new loan types when it comes to house-price developments; at the peak of house prices in 2007, price increases since 2000 would have been 16-20 percentage points lower, had it not been for the new loan types. In the relation, the new loan types primarily act through a shift in the level of underlying demand, to which prices gradually adjust. Thus the price effect of deferred-amortisation loans, in particular, was not fully reflected in prices at the peak of the housing market in 2007; this appears from the even greater effect in the 2nd quarter of 2010, cf. Table 3.2.

[1] The real erosion of housing taxes is partly offset by land tax to the extent that property value tax savings result in an increase in land values.

EFFECTS ON REAL HOUSE PRICES FROM NEW LOAN TYPES AND THE FREEZE ON PROPERTY VALUE TAX

Table 3.2

Reduction of real price increase since Q4 1999, percentage points	Without changed price expectations		With changed price expectations	
	Q1 2007	Q2 2010	Q1 2007	Q2 2010
Without adjustable-rate loans	15.6	15.8	19.9	17.3
Without deferred-amortisation loans	14.7	16.9	18.7	22.2
Total without new loan types	24.9	26.3	31.2	31.4
Without freeze on property value tax (I)	4.3	7.0	4.9	9.9
Total without freeze on property value tax (I) and new loan types	28.5	32.0	35.1	39.2
Without freeze on property value tax (II)	7.5	9.9	9.3	13.4
Total without freeze on property value tax (II) and new loan types	30.5	33.5	38.0	40.9
With proportional correction of unexplained part				
Total without new loan types	32.7	25.2	46.2	28.2
Without freeze on property value tax (II)	10.2	9.5	14.3	12.3
Total without freeze on property value tax (II) and new loan types	40.0	32.1	55.7	36.5

Note: Counterfactual reductions in price increases since the 4th quarter of 1999 have been calculated using the estimated demand relation for owner-occupied housing. The calculations have been performed both with and without inclusion of the resultant changes in the approximated expectations of future real house prices. Adjustable-rate loans are not assumed to be reflected until the 1st quarter of 2000. In the absence of the freeze on property value tax, the imputed rate of property value tax of the MONA databank is assumed to be kept constant as a ratio of the housing stock calculated at market value. The freeze on property value tax from 2002 has been modelled in two alternative ways: (I) as current realised effective property value tax and (II) as a permanent reduction of property value tax by 63 per cent in the 1st quarter of 2002, cf. Box 3.3. In the bottom three rows, unexplained residuals in 2004-09 are dampened by a factor equivalent to the dampening of the explained part of the cumulated real price growth during the period from the 1st quarter of 2004 to the 1st quarter of 2007 that is caused by the counterfactual assumption.

Source: MONA databank and own calculations.

According to the estimated relation, the freeze on property value tax has little effect on house prices, cf. Chart 3.1 and Table 3.2. One implication of the modelling strategy chosen (named I) is that home buyers are not forward-looking – they base their choices on prevailing conditions at any time. Thus they assume that the tax rates prevailing at the time of purchase will apply throughout their financing horizon.

This is a problematic assumption during a period of tax freeze which, over time, erodes the real property value taxation in so far as the freeze is seen as a permanent measure. Under plausible assumptions, a lasting freeze on property value tax would be equivalent to a permanent reduction by just under two thirds as from 2002, cf. Box 3.3. Consequently, we have performed an alternative calculation (named II) under which the effect of the freeze on housing taxes is translated into a permanent proportional reduction of the property value tax included in the housing tax rate of the user cost. This is in contrast to method I, as we now allow the home buyer to factor the full future implications of a lasting freeze

THE FREEZE ON PROPERTY VALUE TAX AND THE EFFECTIVE RATE OF PROPERTY VALUE TAX — Box 3.3

Here we present a simple method for calculating the long-term effect of the freeze on property value tax on effective property value taxation. The method presupposes that the tax freeze is permanent.

Let V_0 denote the total property value at time zero (the present) and let s_0^e specify the effective rate of property value tax at time zero, defined as the current revenue from property value tax in terms of the total current property value. As the nominal principle of the tax freeze freezes the nominal tax payment,[1] the present value of the future tax revenue during the tax freeze (NV^s) may be calculated as

$$NV^s = \int_0^{\infty} s_0^e V_0 e^{-\rho u} du = \frac{s_0^e}{\rho} V_0,$$

where ρ is the nominal discount rate, *e* is the exponential function and *u* denotes the time, treated as a continuous variable.

Now assume that property value tax is instead calculated using a constant effective rate $\bar{s}$ of the current property value at any time, but that this rate is adjusted downwards in relation to the current tax rate s_0^e, so that future revenue with the same present value as the revenue during the current tax freeze is achieved. If the nominal property values on average increase by the rate π^n per period, the hypothetical tax rate $\bar{\tau}$ should thus satisfy the condition

$$\int_0^{\infty} \bar{s} V_0 e^{-(\rho - \pi^n)} du = NV^s \Rightarrow$$

$$\frac{\bar{s} V_0}{\rho - \pi^n} = \frac{s_0^e V_0}{\rho} \Leftrightarrow \frac{\bar{s}}{s_0^e} = \frac{\rho - \pi^n}{\rho}, \quad (1)$$

where we have assumed that $\rho > \pi^n$. It follows from (1) that

$$s_0^e - \bar{s} = \left(\frac{\pi^n}{\rho} \right) \cdot s_0^e. \quad (2)$$

The difference between the two tax rates of (2) specifies the permanent reduction of the effective rate of property value tax which is equivalent to the gradual tax reduction resulting from the nominal principle of the tax freeze.

With realistic parameter values, the tax freeze entails a sharper reduction of the effective property value taxation than in a situation where the principle of assessing tax on the current property value had been retained. If the average annual rate of house-price increase π^n is, say, 2.5 per cent, equivalent to a rate of inflation of 2 per cent and a real price increase of 0.5 per cent, and if the nominal discount rate is 4 per cent, it follows from (2) that retention of the nominal principle of the tax freeze is equivalent to a reduction of the effective property value tax rate by just under 63 per cent.

[1] In practice, the total nominal revenue of property value tax increases slightly from one year to the next, *inter alia* because the tax reduction for housing acquired before 1 July 1998 lapses in case of ownership change. For purposes of simplicity, we disregard this effect, since it will gradually disappear as housing is traded.

into the user cost. However, we still include the current actual property value tax in the expression of the first-year payments as the impact of

these payments on housing demand is based on the assumption that some home buyers are not forward-looking. The calculated effects of methods I and II, respectively, may be viewed as extremes; the actual effect of the freeze on property value tax should probably be found in the spread between the two.

It is important to stress the difference between the calculations in Tables 3.1 and 3.2. In the first Table, we capture, so to speak, how developments in individual market conditions, such as interest rates or income, impacted house prices under the given regulatory framework; Table 3.2 illustrates the same developments from a different angle, i.e. how changes to the regulatory framework in the form of new loan types and the freeze on property value tax from 2002 impacted price developments for the given changes in market conditions. Despite the methodological differences, the two types of calculation may be compared. As price expectations are unchanged in the breakdown exercise of Table 3.1, a comparison with the counterfactual scenarios of Table 3.2 where the change in price expectations is not factored in and where future cost-savings from the freeze on property value tax are not discounted (method I) provides the most accurate view. Thus the effect of applying a variable rather than a fixed rate of interest is roughly the same in the two calculation methods (13 against 16 percentage points). And while the isolated effect of the freeze on property value tax is 4.9 percentage points, cf. Table 3.2, this effect is offset by the preceding tax increase resulting from the Whitsun Package; when developments in housing taxes from the 4th quarter of 1999 up to the 1st quarter of 2007 are considered as one, they have no significant effect on prices (-0.5 percentage point), cf. Table 3.1 and Chart 3.1 above.[1]

If, instead, we consider the overall picture presented by the calculations in the two Tables in terms of price developments from the millennium change until the peak in the 1st quarter of 2007, the situation is as follows: the estimated relation entails that approximately 20 percentage points of the overall price increase of 71 per cent up to the 1st quarter of 2007 may be attributed to income developments (adjusted for the increase in the housing stock) and the low 30-year yields, while the remainder is due to the combined effects of low yields on adjustable-rate loans, the possibility of opting for deferred-amortisation loans and inflated household expectations of future increases in house prices in the mid-2000s. We will proceed to investigate the latter factor in more detail.

[1] The calculation of the price effect of the freeze on property value tax under method I is equivalent to comparing the actual housing tax rate (blue line) in Chart 3.1 (right) with the housing tax rate (red line) that would have applied, had property value tax not been frozen.

Expected house-prices increases in the 2000s – a price bubble?

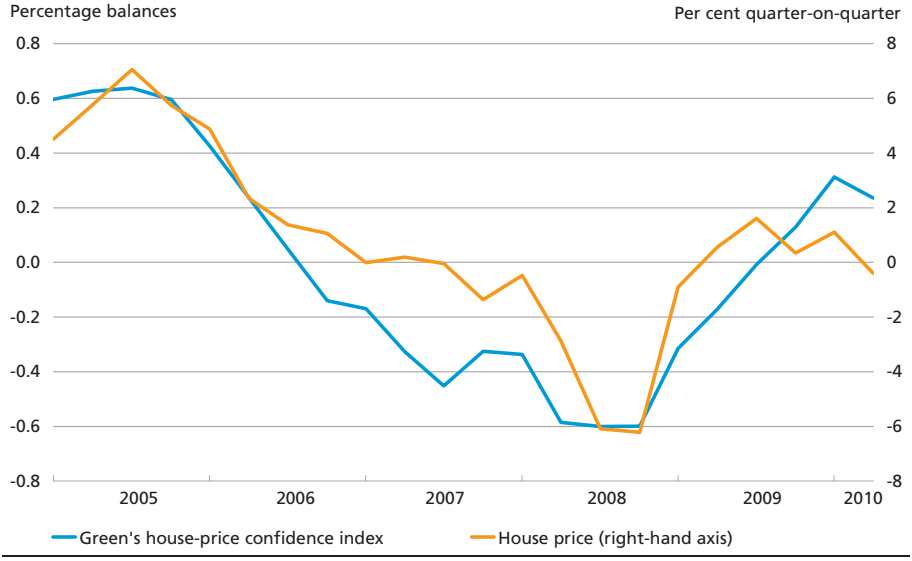
The steep increases in house prices in 2004-06 sharpened the focus on household expectations of price developments. A number of surveys were launched over the next few years, and based on a selection of these, we analyse the role of expectations in price developments.

The Ministry of Economic and Business Affairs (2005) found that in 2005 when house prices were escalating most rapidly, household expectations of future price increases were very high. Six in 10 respondents expected price increases over the next year and just under half expected the price rises to be sustained over a 5-year horizon. Expectations of continued price rises were highest in Greater Copenhagen where three in 10 respondents expected annual price increases of at least 5 per cent over the coming five years. The same trend is shown by Green's house-price confidence index with strong expectations of continued growth in the housing market in 2005 and into 2006.

Green's house-price confidence index dropped from mid-2006 until the turn of the year 2008/09 as house prices flattened and subsequently weakened during 2006-09, cf. Chart 3.3. The Ministry of Economic and Business Affairs (2007 and 2010) follows up on the 2005 survey, confirming that household-price expectations are adjusted significantly downwards as actual house prices start to decline.

GREEN'S HOUSE-PRICE CONFIDENCE INDEX AND GROWTH IN HOUSE PRICES

Chart 3.3



Note: Green's house-price confidence index is a monthly index, with linear interpolation for missing observations.
Source: Green's Analyseinstitut on behalf of Børsen (Danish daily) and Statistics Denmark and own calculations.

In other words, recent surveys show that household expectations are strongly influenced by current trends. In 2005, when the rate of house-price increases was at its highest, many households believed that the trend would continue in the coming years – especially in the areas having experienced the steepest price rises. According to a survey conducted by the Knowledge Centre for Housing Economics in 2010, price developments during the last six months are the most important factor in Danish households' expectations of house prices, while the state of the Danish economy is the second-most important factor. This confirms that expectations of the future are solidly anchored in the current situation. This formation of expectations is consistent with the adaptive modelling of expectations applied in the estimated house-price relation, cf. Appendix B.

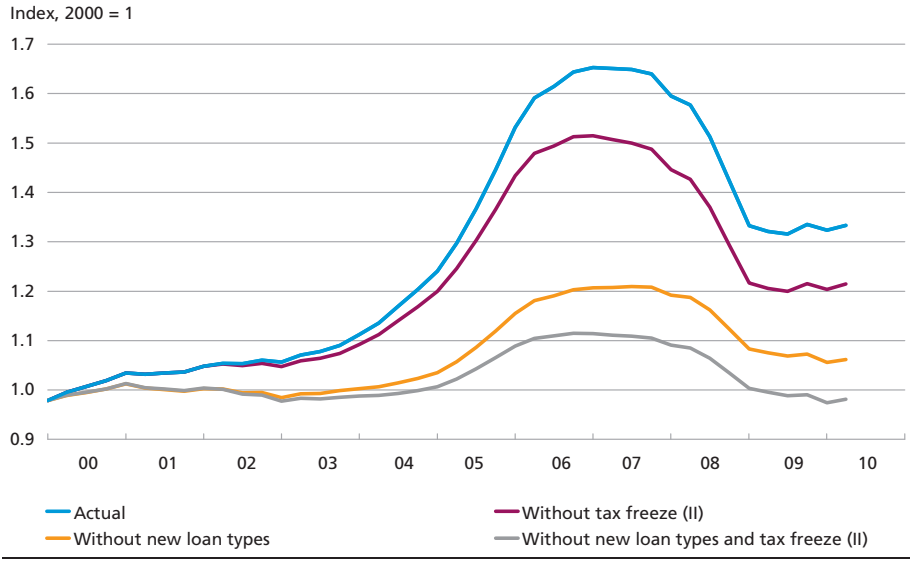
When households extensively base their expectations on current trends, this has a self-reinforcing effect on price developments – both when prices go up and down. The rather high expectations in 2005, indicated by the surveys, probably had a stronger effect – especially in Greater Copenhagen – than captured by the modelled formation of expectations. In other words, we find it likely that the unexplained price increases in 2004-06 are attributable, in large measure, to (unrealistically) high expectations of future house prices. Hence, a housing bubble did exist, especially in and around Copenhagen, cf. also Pedersen and Sørensen (2009). It should be noted, however, that these are high-density areas. This limits the possibility of new construction, particularly houses, thereby contributing to steeper price increases in this region than in the rest of Denmark.

If the steep price increases of 2004-06 were triggered, in part, by self-reinforcing expectation effects, it follows that in the calculations above we tend to underestimate the impact of measures that would have curbed price increases during this period. The immediate reduction in the rate of price increases would also have reduced the bubble element in the form of the extraordinarily high expectations that could not be explained by the estimated relation.

Therefore we have recalculated the counterfactual scenarios without new loan types and the freeze on property value tax, reducing the unexplained portion of price developments in 2004-09 by a factor corresponding to the reduction in the explained price increases in 2004-06 resulting from the measures analysed.[1] When e.g. new loan types reduce

[1] We reduce the unexplained component until 2009, as the sharp price adjustment in 2008-09, including a significant component that is left unexplained by the estimated relation, should be seen in the context of the preceding surge in prices. Accordingly, a smaller rise in the unexplained component should be accompanied by a correspondingly smaller decrease in the subsequent downward price adjustment.

REAL HOUSE PRICE WITH AND WITHOUT NEW LOAN TYPES AND FREEZE, WITH PROPORTIONAL ADJUSTMENT OF UNEXPLAINED PART Chart 3.4



Note: Counterfactual scenario based on estimated demand relation. Adjustable-rate loans are not assumed to be reflected until the 1st quarter of 2000. In the absence of the freeze on property value tax, the imputed rate of property value tax of the MONA databank is assumed to be kept constant as a ratio of the housing stock calculated at market value. The freeze on property value tax is modelled in accordance with method (II) as a permanent reduction in property value tax by 63 per cent in the 1st quarter of 2002, cf. Box 3.3. The red line depicts the total effect of new loan types (blue line) and the freeze on property value tax (yellow line).

Source: MONA databank and own calculations.

the explained price increases in 2004-06 by 56 per cent, we also reduce unexplained developments by 56 per cent. Chart 3.4 shows the results of this simulation for three selected counterfactual scenarios. These results are also included in Table 3.2 (lower section). It is seen that the price effect of the new loan types and the freeze on property value tax increases substantially when we attempt to include their effect via the bubble element. We emphasise that these calculations involve a particularly high degree of uncertainty.

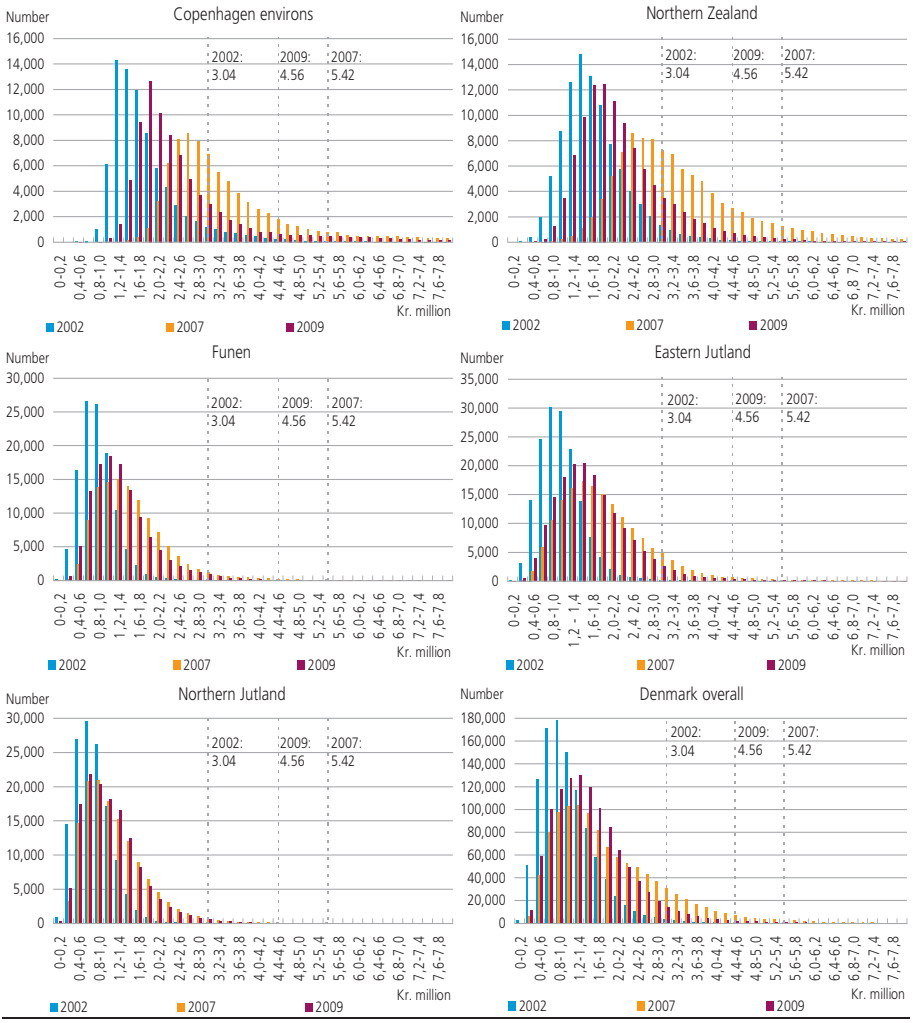
Regional impacts of the freeze on property value tax

The effect of the freeze on property value tax on house prices, calculated on the basis of the estimated house-price relation, is an average consideration for Denmark as a whole. In the areas in and north of Copenhagen, where prices per square metre are high, the increases were especially steep (cf. also Chart 2.2). Accordingly, the impact of the freeze on user cost and first-year payments was significantly greater in these areas than in the rest of the country.

Chart 3.5 shows the distribution of public property valuation figures on single-family houses for selected regions in 2002, when the freeze

SINGLE-FAMILY HOUSES, BROKEN DOWN BY VALUATION PRICE IN SELECTED PARTS OF DENMARK AND FOR DENMARK OVERALL

Chart 3.5



Note: The data referred to as 2002, 2007 and 2009 is census data from 2003, 2008 and 2010 for the housing specified, calculated at the valuation price in 2002, 2007 and 2009, respectively. Houses valued at more than kr. 8 million have been excluded. The dotted lines indicate the actual progressivity threshold for property value tax in 2002 of kr. 3.04 million and the calculated progression limits for 2007 and 2009 of kr. 5.42 million and kr. 4.56 million, respectively, based on developments in average public property valuations.

Source: Statistics Denmark and Danmarks Nationalbank.

was introduced; in 2007 at the peak of house prices; and in 2009, the time of the latest property valuation. The steep price increases around Copenhagen relative to the rest of Denmark are evident in that the distributions in the top two graphs in Chart 3.5 shift substantially more to the right from 2002 to 2007 (and similarly to the left from 2007 to 2009) than the distributions in the other graphs.

Chart 3.5 also reveals that the progressive element of property value tax – i.e. the fact that the value of housing exceeding kr. 3,040,000

CALCULATED EFFECTIVE PROPERTY VALUE TAX RATES, BROKEN DOWN BY AREA

Table 3.3

Per cent	2002	2007		
		With tax freeze	Without tax freeze	Difference[1]
Copenhagen city	1.03	0.52	1.08	0.56
Copenhagen environs	1.08	0.54	1.16	0.62
Northern Zealand	1.05	0.53	1.09	0.56
Bornholm	1.00	0.57	1.00	0.43
Eastern Zealand	1.01	0.54	1.02	0.48
Western and Southern Zealand	1.00	0.56	1.00	0.44
Funen	1.00	0.57	1.01	0.43
Southern Jutland	1.00	0.66	1.00	0.35
Eastern Jutland	1.01	0.55	1.02	0.47
Western Jutland	1.00	0.67	1.00	0.33
Northern Jutland	1.00	0.65	1.00	0.35

Note: Property value tax has been calculated based on extracts of data from Statistics Denmark where all single-family houses are divided into ranges of kr. 100,000 on the basis of their public property valuation. Reductions in property value tax for pensioners and houses traded before 1 July 1998 are disregarded. The counterfactual property value tax has been calculated with a progressivity threshold projected based on the rules applicable until 2002, cf. footnote 1 on this page.

Source: Statistics Denmark and own calculations.

[1] Difference in percentage points between the calculated property value tax rate with and without the tax freeze. Sums may not add up due to rounding.

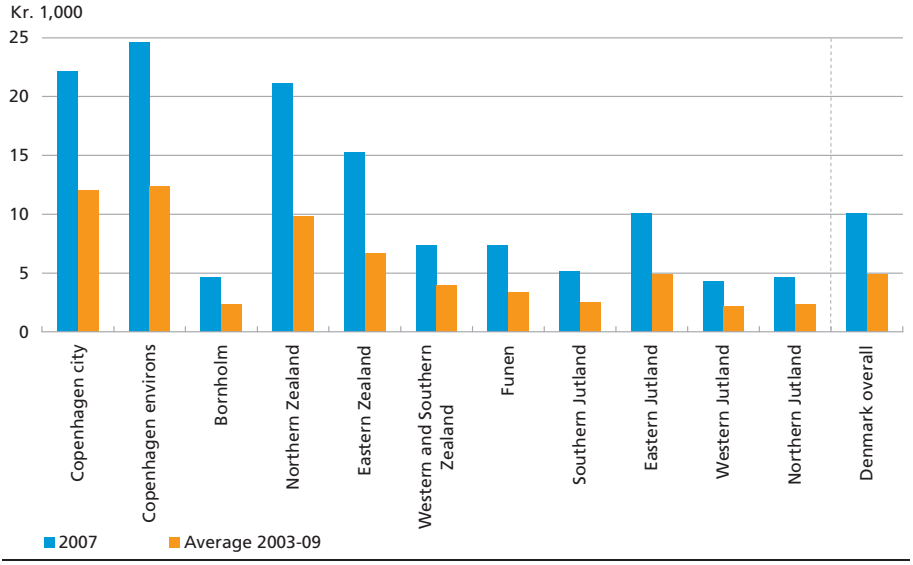
(frozen 2002 level) is triple-taxed – is predominately a Copenhagen phenomenon. This means that the freeze on property value tax has been particularly favourable for expensive houses in and around Copenhagen, which have avoided the high rate of tax on the marginal increase in value despite steep price rises. However, in this respect, it is important to take into account how the progressivity threshold would have developed under the rules applying before the tax freeze.[1] We have calculated these progressivity thresholds, which are shown in Chart 3.5 for the three years. The calculations reveal that although the spread between property values has increased, the separate effect of the freeze through the progressive element of property value tax is of secondary importance in the big picture – despite giving substantial tax cuts to the most affluent homeowners.

Overall, the freeze on property value tax undisputedly led to large tax savings in expensive residential areas around Copenhagen. Thus, the freeze has contributed to higher price increases in these areas than in the rest of Denmark. This is confirmed by Table 3.3, where we have calculated the effective property value tax rates in the different parts of Denmark using simplified assumptions. As shown, during the housing

[1] The progressivity threshold was adjusted annually by weighting together the price increases for owner-occupied housing subject to property valuation, the weighting being 75 per cent for single-family homes, 15 per cent for summer cottages and 10 per cent for owner-occupied flats. We have continued this calculation to 2009 using the valuation statistics of the Danish Tax and Customs Administration (Skat).

REDUCTION IN PROPERTY VALUE TAX PER HOUSEHOLD DUE TO THE NOMINAL PRINCIPLE OF THE TAX FREEZE

Chart 3.6



Note: All amounts at 2010 level. Property value tax has been calculated based on extracts of data from Statistics Denmark where all single-family houses are divided into ranges of kr. 100,000 on the basis of their public property valuation. Reductions in property value tax for pensioners and houses traded before 1 July 1998 are disregarded. The counterfactual property value tax has been calculated with a progressivity threshold projected based on the rules applicable until 2002, cf. footnote 1 on page 27.

Source: Statistics Denmark and own calculations.

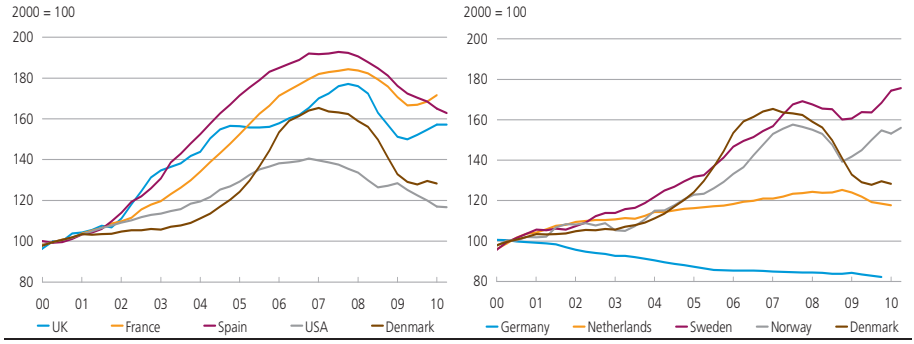
bubble, the greatest reductions in the effective property value tax rates occurred in expensive residential areas in Greater Copenhagen where house prices showed the highest increases – in absolute as well as relative terms. The tax savings per household are illustrated in Chart 3.6. While the average household in the environs of Copenhagen saved kr. 25,000 (2010 level) at the peak of house prices in 2007, savings were less than kr. 5,000 in Northern and Western Jutland.

4. INTERNATIONAL HOUSING MARKETS

Denmark was not the only country to experience rapidly escalating house prices in the early years after the millennium change. The UK, France, Spain, the USA, Norway and Sweden also recorded solid real price increases in the period up to 2007. Subsequently, house prices generally dropped sharply in the period until 2009 and since then they have remained largely static, cf. Chart 4.1.[1] Danish house prices started rising at a relatively late stage, but momentum was strong around 2005-

[1] In Ireland, house price changes have been particularly dramatic over the last decade. Irish house price developments are described in the article by Jakob Ekholdt Christensen on the economic crisis in Ireland, Iceland and Latvia in Part 1 of this Monetary Review.

REAL HOUSE PRICES IN SELECTED OECD COUNTRIES Chart 4.1

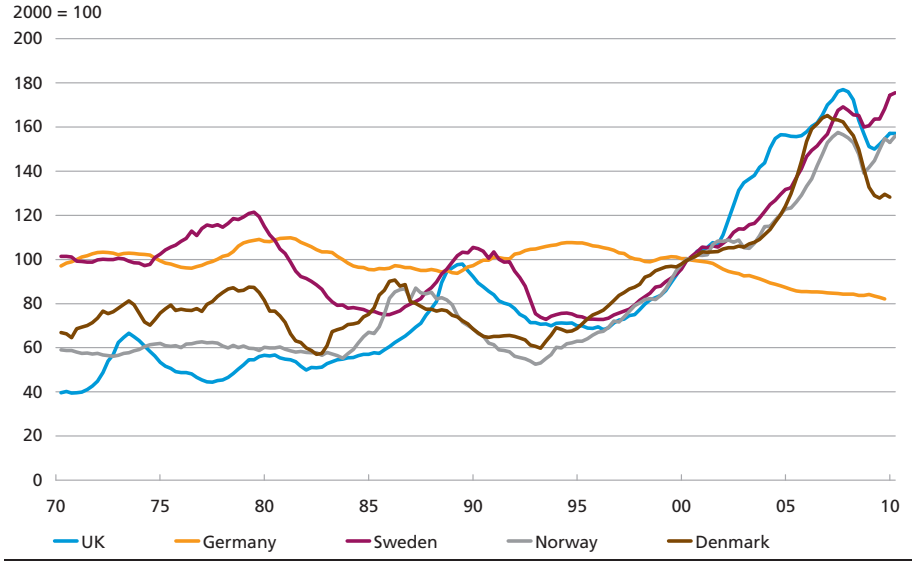


Note: Real house prices: nominal house prices deflated by the national accounts deflator for private consumption. See Appendix C for more details on individual house price series.
Source: OECD House Price Database, cf. Appendix C.

06; in most other countries, the pace of increase was more gradual. Norway and Sweden stand out, as real house prices had already returned to the peak levels of 2007 (or higher) by 2010. In the Netherlands, house prices climbed slowly in the period up to 2008 and the subsequent decline has been modest. Germany stands in stark contrast to most other OECD countries with slightly falling house prices throughout the period.

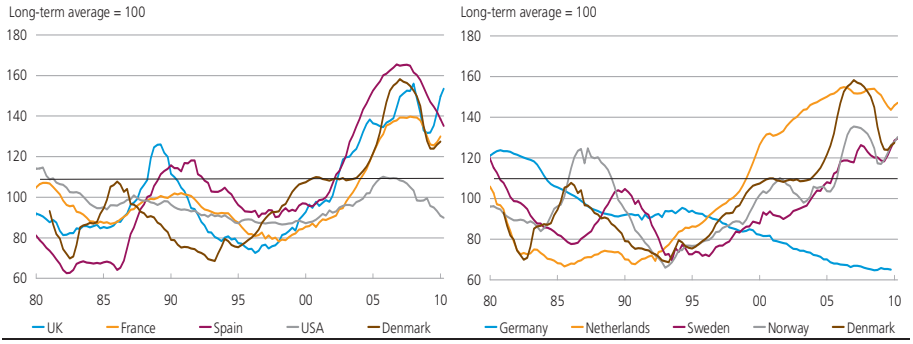
House-price developments have been relatively synchronous across the OECD countries – also relative to previous decades. This is illustrated by Chart 4.2, which shows more uniform developments in house prices in

REAL HOUSE PRICES OF DENMARK'S LARGEST TRADING PARTNERS 1970-2010 Chart 4.2



Note: Real house prices: nominal house prices deflated by the national accounts deflator for private consumption.
Source: OECD House Price Database.

HOUSE-PRICE-TO-INCOME RATIO Chart 4.3



Note: Nominal house prices as a ratio of disposable income per capita. Average for the period 1970-2010 (France, Norway and Denmark from 1978, 1975 and 1981, respectively).
Source: OECD House Price Database and own calculations.

Denmark and our key trading partners during the period 1995-2010 compared with 1970-95. This suggests that house prices are not driven by national conditions alone, but increasingly by ever more synchronised international economic and financing conditions.

House prices relative to income and rents

The ratio of house prices to household disposable income and the ratio of house prices to rents are often used as measures of whether house prices are relatively high or low.[1] Measured in terms of both income and rents, house prices increased far above the long-term average from about 2000 to 2007 in most OECD countries, Germany being the exception, cf. Charts 4.3 and 4.4.

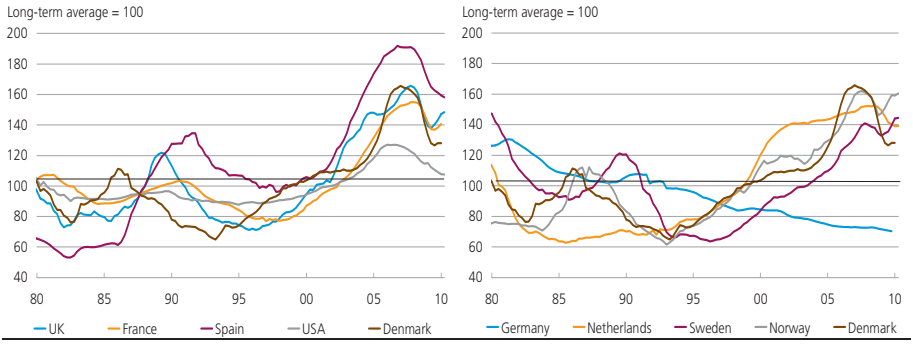
Among the countries observed, the highest increases – and thus the largest deviations from the long-term average – were recorded in Spain, the UK and Denmark. Despite the downturn in 2007, the measures still indicate a certain positive gap in all countries with the exception of the USA, where prices have fallen to or below the long-term average, and Germany, where, according to both measures, house prices are lower than the long-tem average.

House prices and macroeconomic developments

National house prices have closely tracked cyclical movements, which have been relatively synchronous across countries. For example, house prices generally peaked a couple of quarters before GDP around 2007, cf. Table 4.1. Countries in which house prices had appreciated substantially experienced correspondingly strong GDP growth during the period of rising prices and sharp declines in GDP during the period of falling

[1] Cf. section 5 for a discussion of the house-price-to-rent ratio.

HOUSE-PRICE-TO-RENT RATIO Chart 4.4



Note: House-price-to-rent ratio: nominal house prices as a ratio of nominal rents given by the rent component of the consumer price index. Average for the period 1970-2010 (Spain, Norway and Sweden from 1971, 1979 and 1980, respectively). Rent data from the rent component of the consumer price index, but characteristics and locations of housing may vary somewhat between the owner-occupied and rental housing markets. Differences between developments in rents and house prices may be based *inter alia* on regulation of the rental market.

Source: OECD House Price Database and own calculations.

prices. Denmark, like Sweden and Norway, recorded particularly strong GDP growth and sharp increases in house prices during the period 2003-07, cf. Chart 4.5.

Historically, house prices have tracked cyclical movements, both with a cycle of around 10 years, the expansion phase lasting about six years, cf. André (2010). However, the latest upturn in house prices went on for more than 10 years and house prices have, to some extent, become de-coupled from cyclical movements.

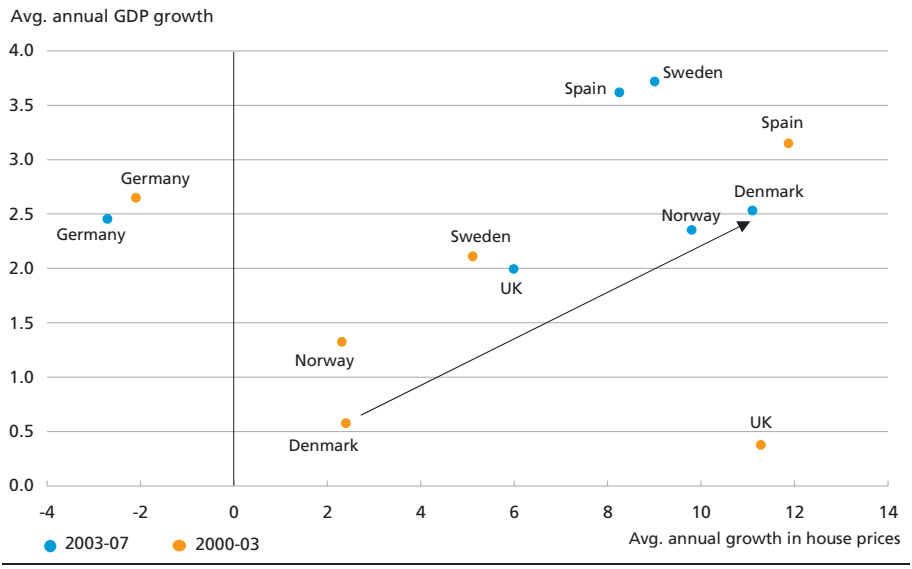
The economic downturn in 2001 was not followed by a decline in house prices, as was the case in 2007-08. In 2001, low monetary-policy interest rates and mortgage-market innovations in many countries

HOUSE PRICES, GDP AND TIMING Table 4.1

	Latest house price peak	Latest GDP peak	Increase in house prices, 2000 house price peak (per cent)	Increase in GDP, 2000 GDP peak (per cent)	Fall in house prices, peak-bottom (per cent)	Fall in GDP, peak-bottom (per cent)
Denmark	Q1 2007	Q4 2007	69	13	23	7
Sweden	Q4 2007	Q4 2007	77	27	5	8
Norway	Q3 2007	Q2 2008	61	15	12	2
Netherlands	Q4 2008	Q1 2008	30	19	6	5
Ireland	Q1 2007	Q4 2007	72	55	36	14
Germany	Q3 1994	Q1 2008	-	13	24	7
France	Q4 2007	Q1 2008	88	16	9	3
Spain	Q3 2007	Q1 2008	93	30	16	5
UK	Q4 2007	Q1 2008	84	22	15	7
USA	Q4 2006	Q4 2007	43	21	17	4

Source: OECD House Price Database.

GROWTH IN GDP AND REAL HOUSE PRICES IN SELECTED COUNTRIES Chart 4.5



Source: Reuters EcoWin and OECD House Price Database.

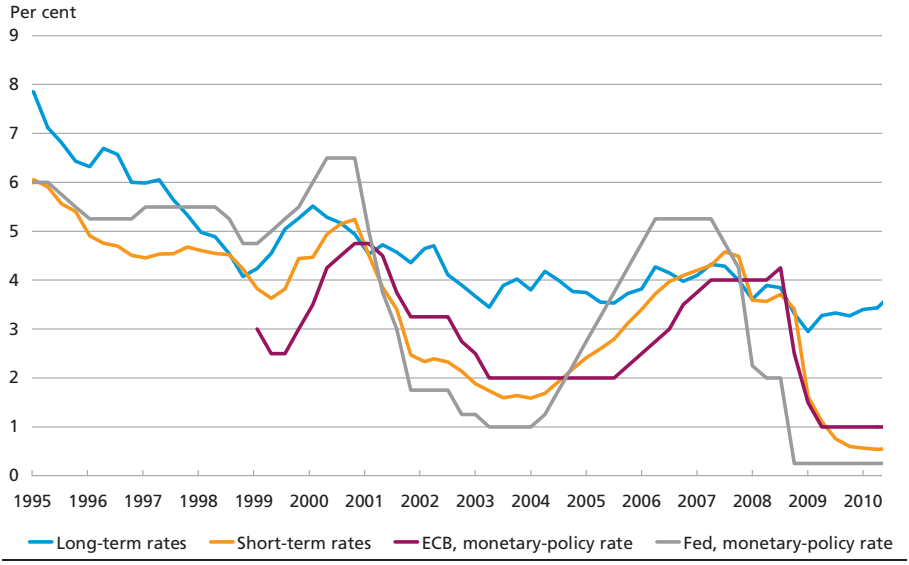
fuelled borrowing and housing demand. As a result, increases in household debt were accompanied by higher house prices.

Interest-rate developments have had a key impact on user cost and thus on the course of house prices and debt. Relevant rates of interest on loans differ across countries, but a simple weighted country average of short-term and long-term interest rates, respectively, underpins the impression of declining interest rates from 2000 to 2004 followed by higher interest rates until the peak of the financial crisis in 2007-08, cf. Chart 4.6. This pattern is clearest for short-term interest rates, which are more closely linked to monetary-policy interest rates.

Lower interest rates have fuelled housing demand and the supply of mortgage loans. As lenders focus on the borrowers' interest expense-to-income ratios, lower interest rates point to credit expansion. Moreover, lower long-term risk-free interest rates may have provided an incentive for investors to increase their portfolio of mortgage loans as part of a global "search for yield", cf. White (2006). A steep yield curve and less volatility in short-term interest rates mean that adjustable-rate loans have become more attractive at the expense of long-term fixed-rate loans.

Over the last two decades, there has been an increasing tendency towards synchronisation of interest-rate movements across countries. Notably, the introduction of the euro caused long-term interest rates in the euro area to converge. This has, to some extent, contributed to con-

SHORT- AND LONG-TERM INTEREST RATES IN SELECTED OECD COUNTRIES Chart 4.6



Note: Weighted average based on PPP-adjusted GDP weights from 2005 for 17 OECD countries. Nominal interest rates. Monetary-policy interest rates are the ECB's interest rate in its main refinancing operations and the Federal Reserve's Fed Funds Target Rate (end of quarter).
Source: OECD and own calculations.

vergence of house prices, cf. André (2010). In 2009-10, yield spreads in a number of countries widened somewhat due to concerns over the size of the government debt. This has had a knock-on effect on mortgage yields and has contributed to less homogeneous house-price developments after the reversal in 2007.

In Denmark and Spain, in particular, lending growth surged by about 25 per cent year-on-year in 2005-06, but subsequently growth has halted and been close to zero since the autumn of 2009, cf. Chart 4.7. Other OECD countries also recorded significant lending growth of about 10 per cent year-on-year during the period 2004-06 and a subsequent fall to very low or negative growth rates. Sweden and Norway are the exceptions, recording only a marginal reduction in lending growth. Germany has had no growth at all.

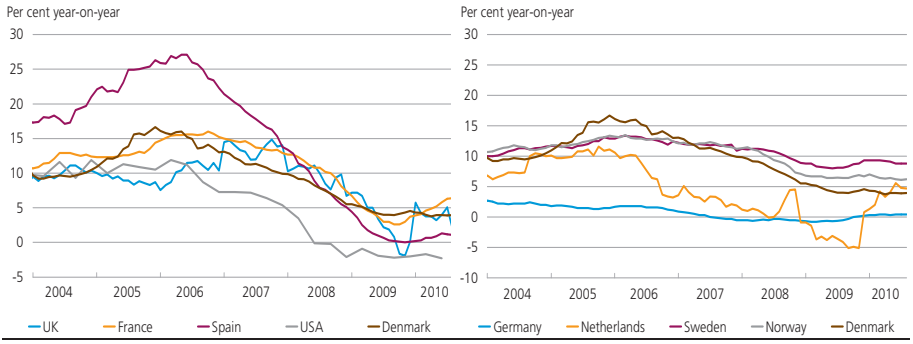
Institutional conditions

Institutional conditions, especially in mortgage markets, play a key role in housing demand and house prices.

Over the last decade, mortgage-market innovations have contributed to improving credit facilities for households and enabled more people to buy their own home despite rising house prices. According to the IMF (2008), mortgage markets in Denmark and the USA are among the most

GROWTH IN LENDING FOR HOUSEHOLDS' HOME PURCHASES IN SELECTED OECD COUNTRIES

Chart 4.7



Note: For Sweden, Norway, the UK and the USA, the figures include financial institutions' total lending to households. Quarterly data for the USA.
Source: ECB and Reuters EcoWin.

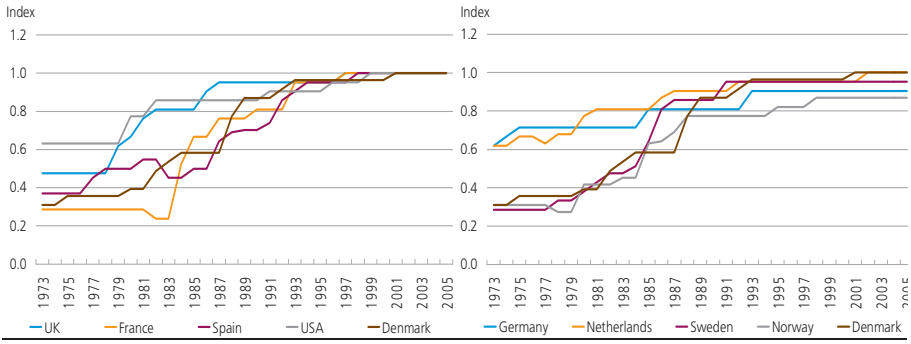
liberal with their possibilities of mortgage equity withdrawal and mortgage refinancing free of charge; a high mortgaging ratio; long-maturity mortgage loans; and a large proportion of mortgage bonds and financial products secured on mortgage bonds. Based on these criteria, the housing markets in Spain, France and Germany are among the least liberal markets. As Spain, in particular, has recorded sharp rises in house prices, the degree of mortgage-market liberalisation is not the only driver of house prices.

Abiad et al. (2008) have attempted to estimate a measure of financial regulation over time. To that end, an index of financial reforms has been designed based on the timing of changes to financial regulation, such as the lifting of credit restrictions, interest-rate control, extraordinarily high reserve requirements, market-access restrictions, government ownership in the banking sector and banking regulation. The index has been set at between 0 and 1 and is a rough measure of policy changes that enabled increased mortgage-market competition during the period 1973-2005.

All countries have deregulated their financial sectors during recent decades, but the timing and point of departure vary greatly, cf. Chart 4.8 and Box 4.1. Most of the observed countries had fully liberalised their financial sectors (index 1) already in the early 2000s, the exceptions being Germany, Sweden and Norway. The Danish index reached the upper limit when deferred-amortisation loans were introduced in 2003.

Home financing also differs across countries in terms of the popularity of different loan types. Fixed-rate loans are the dominant loan types in the USA and the Netherlands, which have the most liberal mortgage markets, and in Germany and France. In Sweden, Norway, the UK and Spain, like in Denmark, adjustable-rate loans account for an equally

INDEX OF FINANCIAL REFORMS IN SELECTED OECD COUNTRIES Chart 4.8



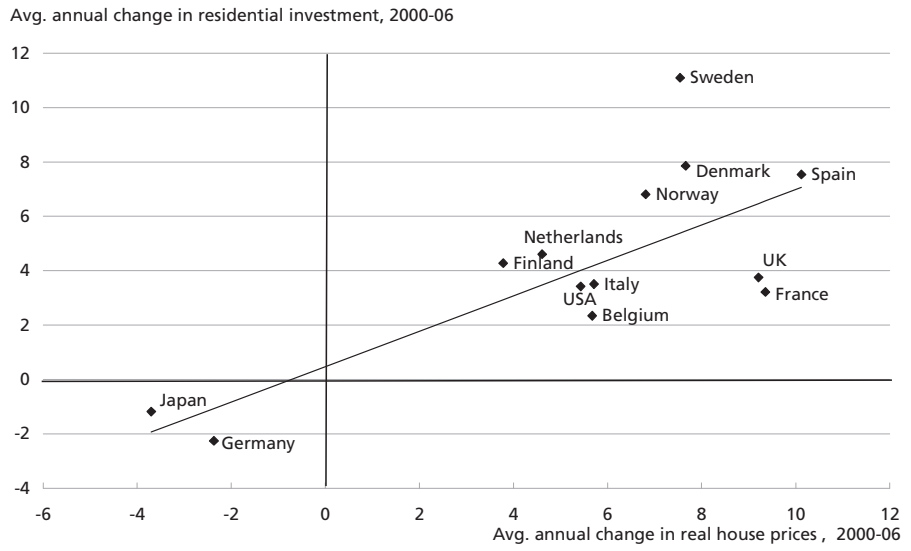
Note: The higher the index, the more liberal the financial system. The index has been normalised to the range between 0 and 1.
Source: Abiad et al. (2008).

large or larger share than fixed-rate loans. This indicates that the volume of adjustable-rate loans in the housing market is not unequivocally linked to the degree of liberalisation of the mortgage market.

Housing supply

The supply of housing is affected by many factors in the form of local conditions such as vacant land for construction, infrastructure, building regulations, construction costs and expectations of future house prices. The latest upswing in house prices saw strong correlation between changes in residential investment and changes in real house prices, cf. Chart 4.9.

CHANGE IN RESIDENTIAL INVESTMENT AND REAL HOUSE PRICES Chart 4.9



Source: OECD (2010) and OECD House Price Database.

FINANCIAL LIBERALISATION IN SWEDEN, THE UK AND SPAIN Box 4.1

According to the OECD (2006), the Danish mortgage market has become more "complete" than most other European home financing systems following extensive innovation since the mid-1990s. An international survey shows that the average price of a mortgage loan is among the lowest in Europe and the product range is broader. Moreover, few other countries enable homebuyers to redeem mortgage loans prematurely and to take over existing mortgage loans. However, experience from Sweden, the UK and Spain indicates that financial deregulation and innovation in the mortgage markets have also impacted housing demand and house prices in these countries – despite a smaller volume of loans.

As far as Sweden is concerned, Nyberg (2006) notes that sweeping changes in the mortgage market have contributed to a sharp increase in house prices. The crisis in the early 1990s delayed financial market deregulation, but subsequently the mortgage market, among others, underwent major changes. Competition was strengthened and margins were squeezed, causing mortgage yields to drop. Moreover, mortgage banks became more flexible in terms of mortgaging ratios and offered a wider selection of loan products. Nyberg particularly emphasises less stringent repayment requirements with extended maturities and the fact that fewer borrowers opted to amortise their loans – probably in expectation of higher house prices. Unlike in Denmark, deferred amortisation has been an option for Swedish mortgage borrowers all along, but it became increasingly popular during the latest upswing in house prices. Moreover, adjustable-rate loans[1] accounted for a still higher portion of loans.

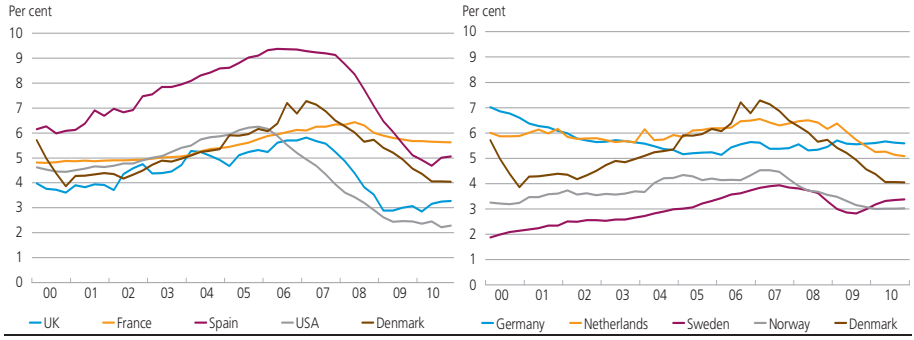
In the UK, according to Kuenzel and Bjørnbak (2008), credit market liberalisation contributed substantially to boosting housing demand. Financial deregulation, underpinned by innovation and new mortgage instruments, enabled lenders to diversify their credit risk. This helped to increase the credit supply and intensify competition in the mortgage market. In the years before the reversal in house prices in 2007, there was also an increase in subprime-style mortgage loans with mortgaging ratios exceeding 100 per cent. According to the authors, credit terms were eased particularly from the mid-1990s when house prices also gained momentum.

In Spain, credit market liberalisation contributed to increasing competition between financial institutions from the mid-1990s. Competition has taken place both through prices and through the issuance of mortgage products with greater flexibility in terms of maturity and mortgage yields. Since then, credit institutions have started launching mortgage products which can be directed to uses other than home purchases, cf. Manzano (2005). Lending for new construction saw a particular increase. Stronger demand for loans has been met, in part, through foreign finance and mortgage refinancing.

Overall, the mortgage markets in Sweden, the UK and Spain, as well as Denmark, have undergone substantial changes since the mid-1990s. In all cases, these changes have increased housing demand as well as house prices – especially through the introduction of adjustable-rate loans. Denmark stands out with a particularly high degree of innovation in this field, however.

[1] Reference is made to Frisell and Yazdi (2010) for a recent analysis of the Swedish housing market.

RESIDENTIAL INVESTMENT-TO-GDP RATIO Chart 4.10



Note: Residential investment and GDP calculated at current prices.
Source: OECD (2010).

However, residential investment has responded very differently to house-price increases. In the UK and France, investment has risen relatively slowly despite high increases in house prices; Denmark, Norway and Sweden, on the other hand, have seen relatively large increases. This indicates that the housing supply is more elastic in the Nordic countries, cf. André (2010). As shown by Chart 4.10, the volume of residential construction remains moderate in Norway and Sweden, however, while it is somewhat higher in Spain and, to some extent, France expressed as a ratio of total GDP. In Germany, which has recorded a decline in house prices, residential investment has also dropped, albeit from a high level. This should be seen in light of German reunification in 1991.

Rural-urban differences

In urban areas, the housing supply is determined also by factors such as the number of inhabitants, population growth and density, as well as transport costs and the degree of regulation of new construction. Across countries, it applies that large towns and cities have experienced the highest house-price increases, while rises have been more subdued in rural areas and small towns.

According to Hiebert and Roma (2010), house-price cycles in urban areas in the four largest euro area member states (Germany, France, Italy and Spain) and the USA have been relatively uniform since 1990. But developments in national housing indices conceal considerable heterogeneity in house prices in towns and cities within individual countries. In the four euro area member states, average house prices in the most expensive towns and cities were 2-4 times higher than in the towns and cities with the lowest house prices. The spread was significantly wider in the USA, where these prices were about 10 times higher.

5. ARE DANISH HOUSE PRICES OVERVALUED?

Having dropped sharply throughout 2008 and the first part of 2009, Danish house prices seem to have stabilised for now, although the correction in 2008-09 eliminated only part of the escalation in real house prices occurring from 2003 to 2007. Whether further downward adjustment in real house prices is required over the coming years or whether the necessary correction of the housing bubble of the previous decade must be assumed to be complete will have a significant bearing on the Danish economy over the coming years.

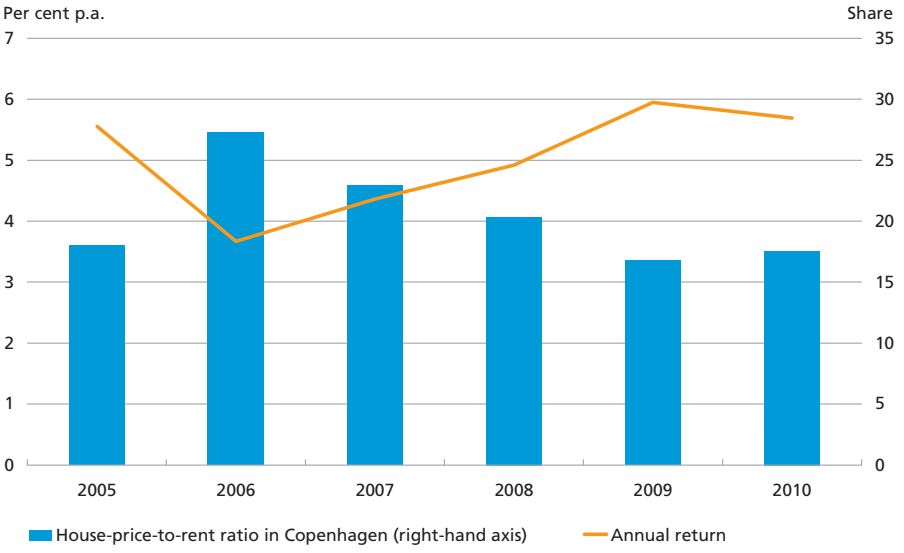
In this section, we present a number of methods to assess whether and to which extent real house prices are overvalued relative to a level that is compatible with long-term equilibrium in the housing market. The results are not unambiguous. Some of the methods reviewed would indicate that the housing market is still overvalued, while other methods indicate that real house prices have already more or less reached a long-term sustainable level. What is certain, however, is that it is important to distinguish between developments in Greater Copenhagen and the rest of Denmark. The analysis also indicates that prices of and access to building plots play a key role in price formation in the housing market.

Is the current house-price-to-rent ratio sustainable?

The ratio of the house price per square metre to rent per square metre of similar rental housing is sometimes used as an indicator of whether the housing market is overvalued. Rent represents the housing cost homeowners would have had, should they have rented similar housing. The reciprocal value of the house-price-to-rent ratio can thus be seen as the annual return accruing to homeowners from owning their home (excluding possible capital gains or losses on the home). Obviously, the price-to-rent ratio also determines the return received by homeowners if they decide to let their home. If the price-to-rent ratio e.g. is 15, implying that the price per square metre when purchasing the home is 15 times the annual rent per square metre, the annual return is 6.7 per cent (100*(1/15)). This return may be compared with the return on alternative investments to assess whether house prices are in disequilibrium.

In practice, the price-to-rent ratio for comparable houses may be reasonably calculated only for large towns and cities with a certain number of rental single-family houses. Søndagsavisen (Danish weekly), in association with Boligportal.dk, has performed such calculation for large Danish towns and cities, cf. Søndagsavisen (2010). In the 2nd quarter of 2010, the house-price-to-rent ratio of similar housing in

HOUSE-PRICE-TO-RENT RATIO IN COPENHAGEN Chart 5.1



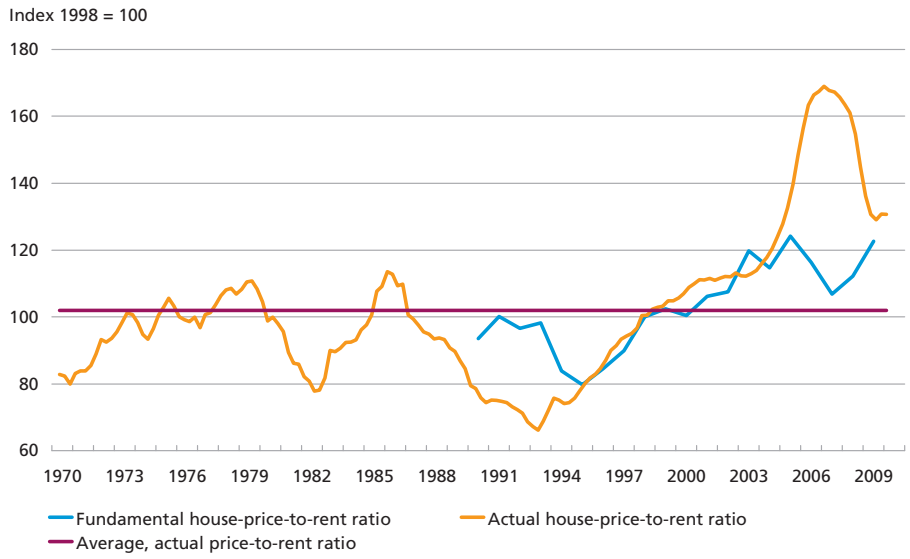
Note: Annual return is calculated as the reciprocal value of the house-price-to-rent ratio.
Source: Søndagsavisen (2010).

Greater Copenhagen was just under 18, equivalent to an annual rental return of 5.6 per cent, cf. Chart 5.1. In addition to the actual return on invested capital, the rental return is to cover depreciation and risk premium. Against this backdrop, the calculated return of 5.6 per cent seems to be on the low side in a long-term perspective. A low current return indicates that owner-occupied house prices are too high – unless there are expectations of future capital gains on the home that may offset the low direct return.

A related method for investigating whether house prices are overvalued is to calculate the house-price-to-rent ratio – not in Danish kroner (as done above) but as an index. This is referred to as the "actual house-price-to-rent ratio" in Chart 5.2. This measure is used e.g. by the OECD. According to this method, a comparison of the current level of the house-price-to-rent ratio and the average of the ratio over an extended period shows whether the housing market is overvalued. Chart 5.2 shows that, in 2009, the actual house-price-to-rent ratio was more than 25 per cent higher than the average for the period 1970-2009. This could suggest that the Danish housing market is substantially overvalued.

The OECD recently assessed the level of Danish house prices by comparing an index of a "fundamental" house-price-to-rent ratio with the index described above of the actual house-price-to-rent ratio, cf. André (2010). The fundamental ratio calculates a rate of return based on the user cost of owner-occupied housing. The calculation is based on the

HOUSE-PRICE-TO-RENT RATIO, NATIONWIDE AVERAGE Chart 5.2



Source: André (2010).

Poterba model for determining house prices where the rent in equilibrium is equal to the user cost of investing in owner-occupied housing, cf. Poterba (1984).

For the 2nd quarter of 2009, the calculation in André (2010) results in a user cost of 5.64 (the sum of a rate of interest after tax of 3 per cent, property value tax of 0.6 per cent, depreciation of 0.04 per cent and expected capital gains of 2 per cent). The reciprocal value of 5.64 gives a fundamental house-price-to-rent ratio of 18. Chart 5.2 shows the series as an index (blue graph). A comparison of this index with the actual house-price-to-rent ratio provides an indication of how much house prices deviate from a level of equilibrium under the given assumptions. With this calculation, Danish house prices were almost 10 per cent overvalued in 2009. According to this measure, house prices were significantly more overvalued during the period 2005-07, cf. Chart 5.2.

The approaches described for assessing the housing market are not without problems. In its calculation of the actual house-price-to-rent ratio, the OECD uses the housing item of the consumer price index as a rental index. However, the consumer price index measures the rent for all types of rental flats, including subsidised housing – not just rental single-family houses. Consequently, the housing units in the numerator and the denominator do not match. Moreover, the theoretical assumption of equivalence between user cost and rent requires that the markets are free, efficient and unregulated.

In Denmark, the usefulness of the method applied by Søndagsavisen is hampered by the relative smallness of the rental market for single-family houses, which is hardly likely to have any impact on owner-occupied house prices – not even in large towns and cities. The return to be used for comparison is not clear either. Interest rates affect house prices, but, in practice, they do not impact rents to the same extent. Thus a high price-to-rent ratio is more a reflection of low interest rates than of overvalued house prices. In order to apply this ratio, assumptions have to be made of a normal rate of return against which rents are to be measured.

A general problem of all the methods described is that, in large segments of the Danish housing market, rents are regulated to some extent; thus the comparison is not between two free markets and, furthermore, significant friction exists in mobility between the two markets. Below we will focus on other methods of assessing the sustainability of house prices.

House-price-to-constructioncost ratio calculated as an index measure

In the short term, house prices fluctuate with housing demand, but in the long term, prices of existing housing must be assumed to adjust to the cost of new construction, cf. Box 5.1. In other words, an assessment of whether house prices are overvalued or undervalued in a long-term perspective may be based on the ratio of prices of existing housing to the cost of new construction. This price ratio, described in the literature as "Tobin's Q for the housing market",[1] can often be calculated only as an index measure. This makes it possible to monitor *developments* in the price ratio relative to a given base year or a given trend level for the index.

However, Tobin's Q calculated as an index measure makes it possible to assess whether house prices are overvalued or undervalued only if there is reason to assume that the base year or trend level selected represents a situation in which the housing market was in long-term equilibrium (i.e. a situation where prices of existing housing were equivalent to prices of similar new housing).

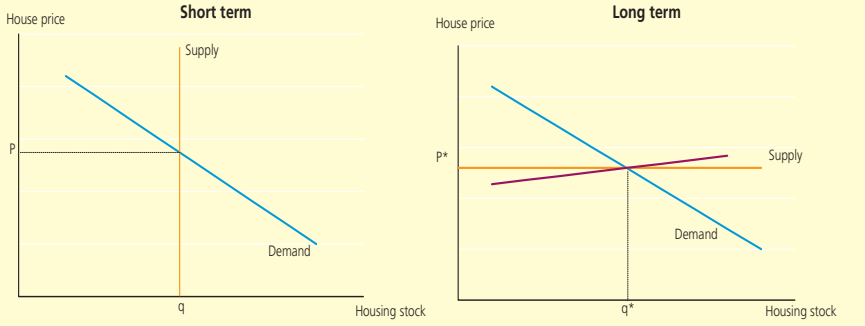
Tobin's Q as an index measure is calculated by deflating a house-price index by an index of construction costs measured in terms of the national

[1] The name is based on Tobin (1969), who developed the theory that business investment is stimulated, the higher the market value of existing business assets (e.g. measured in terms of share prices) is relative to the cost of acquiring new capital goods. Correspondingly, it must be assumed that it will be attractive to acquire new housing rather than similar existing housing when the latter is more expensive than the former.

PRICE ADJUSTMENT IN THE HOUSING MARKET Box 5.1

In the housing market, as in other markets, the price is determined by supply and demand. However, the housing market differs from other markets in that supply cannot be changed overnight, i.e. the supply curve is vertical in the short term, cf. Chart 5.3 (left). So the price of owner-occupied housing is determined initially by housing demand and may fluctuate relatively widely with cyclical trends as there is no short-term supply response to dampen the movements.

PRICE ADJUSTMENT IN THE HOUSING MARKET, SHORT AND LONG TERM Chart 5.3



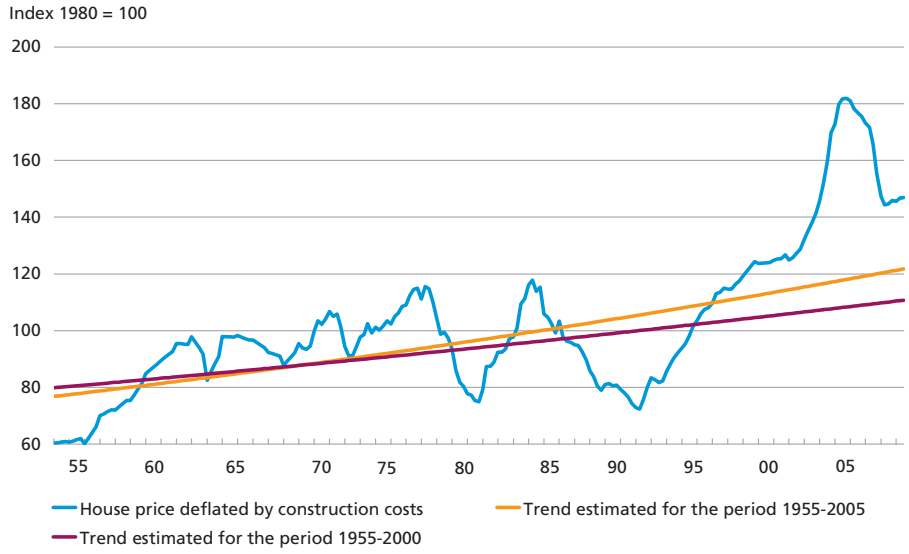
Demand for housing increases with income, i.e. the demand curve is continuously shifted to the right, with a tendency towards higher prices so that residential construction is boosted. Construction activity will continue for as long as the price of existing housing exceeds the price of new construction, i.e. for as long as it pays to acquire new housing rather than purchasing existing housing stock. The increased supply of housing gradually drives the price down towards the cost of new construction, which thus determines house prices in the long term.

The horizontal long-term supply curve in Chart 5.3 (right) reflects the real cost *P** of constructing new housing. If the long-term supply curve is actually horizontal, the real house price will be constant in the long term. In that case, the increase in the nominal house price will be equivalent to general inflation. If, on the other hand, the long-term real marginal cost of increasing the housing stock is rising, the long-term housing supply curve will have a positive slope, as indicated by the red curve in Chart 5.3 (right). In that situation, the increase in housing demand prompted by economic growth will be reflected in higher real house prices – even in the long term. As explained in the main text, shortage of building plots could mean that the long-term real marginal cost of expanding the housing stock rises.

accounts deflator for new construction, cf. chart 5.4. Assessing developments in the Tobin's Q index based on very long historical time series is not unproblematic, as the time series go back to times when the regulatory framework in terms of financial market regulation, the economic policy pursued, land zone legislation, etc. were very different from current conditions.

HOUSE-PRICE-TO-CONSTRUCTION COST RATIO, CALCULATED AS AN INDEX MEASURE

Chart 5.4



Note: The estimated trend curve is a logarithmic trend. Growth at a constant rate results in a linear trend. The house-price-to-construction cost ratio has been calculated as kp/pih in the ADAM notation.

Source: Statistics Denmark and own calculations.

However, as previously mentioned, the main problem with the interpretation of the index in Chart 5.4 is that it is unclear where to establish the fundamental level, i.e. which year to choose as the equilibrium year. This makes it difficult to assess how far the current value is from equilibrium. If a logarithmic trend line is included, current prices are significantly above the trend level. Based on an almost identical analysis, the Danish Economic Councils (2010) assess that house prices at the national level are currently 10-20 per cent too high.

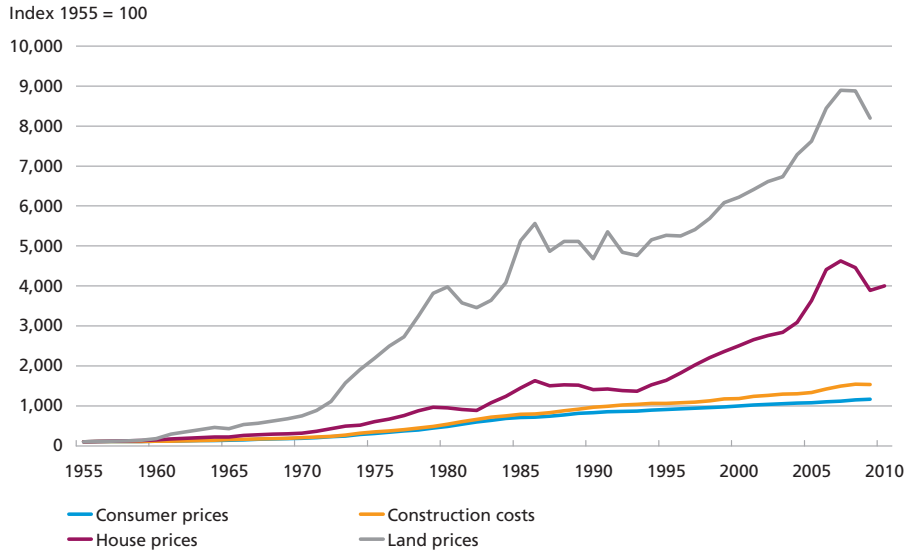
According to the traditional housing market model, described in Box 5.1, house prices will track construction costs in the long term. Based on this theory, the trend lines of Chart 5.4 should thus be completely horizontal. But in fact, the trend lines increase over the observed periods, i.e. house prices tend to increase more rapidly than the cost of new residential construction. Presumably the reason is that house prices include not just the cost of buildings but also land values, which have historically risen more than construction costs, cf. Chart 5.5.[1]

The long-term trend towards relatively steep increases in prices of building plots may reflect that – since the overall supply is constant – the supply of land for housing purposes is not easy to increase. Other things

[1] Thus the construction cost indices in Charts 5.4 and 5.5 include only the cost of new construction, not the cost of building plots.

DEVELOPMENT IN LAND PRICES, CONSTRUCTION COSTS, HOUSE PRICES AND CONSUMER PRICES

Chart 5.5



Note: All indices state developments in nominal prices and costs.
Source: Statistics Denmark.

being equal, increases in the prices of building plots will provide an incentive to convert land from other purposes to housing. However, general economic growth also tends to increase the shortage of land for alternative uses. As a result, prices of land e.g. for agricultural and other business purposes are bid up, thereby reducing the incentive to develop land for housing purposes. As land is a non-reproducible resource, there is thus an underlying tendency for land prices to increase more rapidly than prices of reproducible construction materials, etc.

On average, both land prices and construction costs have increased more rapidly than the consumer price index since 1955. So it is hardly surprising that house prices have also risen faster than consumer prices, cf. Chart 5.5. Obviously, it is of key importance in the assessment of the outlook for nominal house prices whether the historical long-term trend towards increasing real prices of owner-occupied housing is likely to continue. If real house prices are currently overvalued, a period of significant nominal price falls is not necessarily required, provided that the underlying trend is for house prices to increase significantly more than the consumer price index. If this historical trend does not continue, and the housing market is currently overvalued, the adjustment to a new long-term equilibrium may, on the other hand, require a long period of declining nominal house prices. This will erode homeowners' home equity, rendering many technically insolvent.

As mentioned earlier, the inelastic supply of land gives reason to assume that real increases in prices of building plots will also occur in future due to land shortage. It is more uncertain whether the historical trend towards systematic increases in real construction costs will also continue. The trend reflects that, so far, productivity growth in the construction sector has been relatively weak; as a result, there may be potential for catching up on the productivity backlog in future.[1]

It is sometimes argued that there would not be room in household budgets to finance the observed increase in the scope and quality of housing consumption if significant permanent increases in real house prices actually did occur, cf. e.g. Laursen et al. (2010). This argument is, however, based on the assumption that the ratio of housing consumption to total consumption is more or less constant. As Chart 5.6 shows, there has, actually, been a tendency for the ratio of housing consumption to total Danish private consumption to increase during the period after World War II. Thus expenditure for housing consumption has risen more rapidly than that for other consumption and, accordingly, there has been "room" both for a relative increase in the price of housing consumption and a rise in the scope and quality of the housing stock.

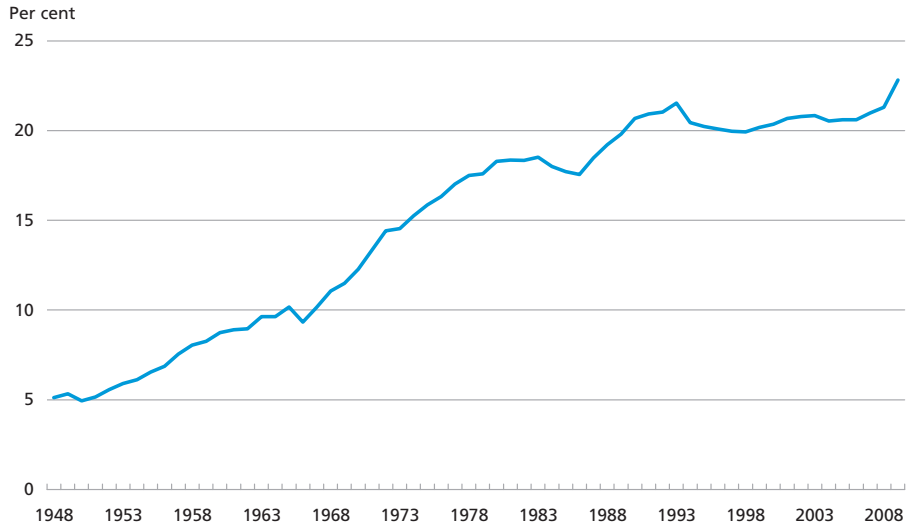
The analysis in Box 5.2 also illustrates a clearly increasing trend in the ratio of owner-occupied housing consumption to household disposable income. As explained in the Box, this budget ratio depends on income and price elasticities in the demand for owner-occupied housing. These elasticities do not necessarily imply that the ratio of owner-occupied housing consumption to total consumption should be constant over time.

It is clear, however, that the housing consumption budget ratio cannot increase indefinitely; a saturation point must be reached sometime before the budget ratio reaches 100 per cent. If, in future, construction costs rise only at the general rate of inflation, while real land prices on average increase in line with real GDP growth (entailing that the ratio of ground rent to GDP is constant), at GDP trend growth of about 1.5 per cent, the average annual real growth in the price of new housing will be approximately 0.3 per cent. This calculation is based on the premise that, according to Statistics Denmark, the cost of the building plot accounts

1 In 2008, the Danish Competition Authority focused critically on productivity developments in the Danish construction sector and demonstrated very subdued growth for a number of years, apparently due to lack of competition. Sharpening competition in the sector could probably boost productivity growth over the coming years. In an assessment of developments in the construction sector, it should be taken into account, however, that the official index of construction costs by Statistics Denmark is not adjusted for any quality improvements of new houses. Thus the construction cost index of Chart 5.4 probably overvalues the real cost increase. Similarly, it is possible that recorded house prices of existing housing overvalue the real increase in prices to the extent that higher prices reflect ongoing improvements to the existing housing stock.

DEVELOPMENT IN THE RATIO OF HOUSING CONSUMPTION TO TOTAL PRIVATE CONSUMPTION

Chart 5.6



Source: Statistics Denmark.

for an average of 20 per cent of the total cost of acquiring new housing. At this annual rate of real growth, it will require just over four years without nominal house price increases to return to a long-term sustainable level for real house prices, if the price of existing housing is, in general, 10 per cent higher than the cost of acquiring similar new housing and the average annual rate of inflation is 2 per cent. Underlying real growth in house prices of 0.3 per cent a year is a relatively conservative estimate in view of the average increase in real house prices of about 1.5 per cent a year during the period from 1955 to 2005.

House-price-to-construction cost ratio calculated as a level measure

Unless there are strong indications that the housing market was in long-term equilibrium in the base year chosen for calculating the index, as mentioned earlier, the Tobin's Q index measure cannot be used as a measure of how far house prices are from equilibrium. According to the classic Tobin's Q approach, the housing market is in long-term equilibrium if the prices of existing housing are equivalent to the costs of constructing similar new housing. Consequently, we now seek to directly measure the prices of existing housing relative to the costs of acquiring new housing. The measure can only be approximated, *inter alia* because data on building plot prices is very sparse.

DEVELOPMENT IN HOUSE PRICES AND THE BUDGET SHARE OF HOUSING CONSUMPTION Box 5.2

Is a situation of sustained real price increases for owner-occupied housing compatible with ongoing improvement of housing standards? To investigate this question, we assume, once again, that demand for owner-occupied housing is given by the function $K(bp,Y)$, where *bp* is the real user cost of owner-occupied housing consumption and *Y* is real household disposable income. The total cost of owner-occupied housing consumption is then $bp \cdot K(bp,Y)$ and its share of disposable income (the budget share) is thus:

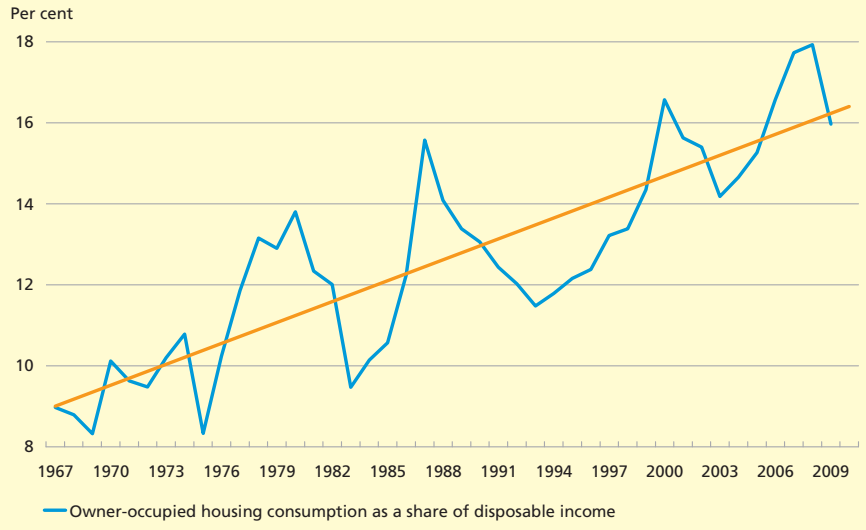
$$B = \frac{bp \cdot K(bp,Y)}{Y}. \qquad (1)$$

By differentiating the expression in (1), after a transformation, we find that the relative change of the budget share of owner-occupied housing consumption over time is given by the expression

$$\frac{\Delta B}{B} = (1-\varepsilon_b)\cdot\frac{\Delta bp}{bp} + (\varepsilon_Y - 1)\cdot\frac{\Delta Y}{Y}, \qquad \varepsilon_b \equiv -\frac{\partial K}{\partial bp}\frac{bp}{K}, \qquad \varepsilon_Y \equiv -\frac{\partial K}{\partial Y}\frac{Y}{K}, \qquad (2)$$

where ε_b is the numerical elasticity of owner-occupied housing demand in terms of user cost, ε_Y is the income elasticity of housing demand and the operator Δ is the change in the subsequent variable.

DEVELOPMENT IN OWNER-OCCUPIED HOUSING CONSUMPTION AS A SHARE OF HOUSEHOLD DISPOSABLE INCOME Chart 5.7



Source: Statistics Denmark and own calculation.

Chart 5.7 shows that the budget share of owner-occupied housing consumption has had an underlying tendency to increase during the last 45 years (short-term fluctuations in the budget share reflect that housing consumption develops more evenly

CONTINUED Box 5.2

than income during cyclical fluctuations). In equation (2), ΔY will usually be positive due to ordinary economic growth. If real house prices have an underlying tendency to increase, Δbp will also, on average, be positive. According to (2), the increasing budget share of owner-occupied housing consumption may thus reflect that the income elasticity of owner-occupied housing demand is higher than 1 and/or that the numerical user-cost elasticity is lower than 1. In fact, empirical studies of owner-occupied housing demand have often found numerical price elasticities somewhat below 1, cf. e.g. the overview in Englund (2003).

It also follows from equation (1) that

$$\frac{\Delta K}{K} = \frac{\Delta Y}{Y} + \frac{\Delta B}{B} - \frac{\Delta bp}{bp}. \qquad (3)$$

The fraction on the left-hand side of (3) is a measure of the relative quantitative and qualitative improvement in standards of owner-occupied housing. According to the data on which Chart 5.7 is based, the budget share of owner-occupied housing consumption has increased by an average of 1.34 per cent a year during the period 1966-2009, i.e. $\Delta B / B = 0.0134$. In the long term, developments in the real user cost will be driven primarily by real house prices, which have increased by an average of 1.55 per cent a year during the period specified. Against this backdrop, we can specify $\Delta bp / bp \approx 0.0155$ in equation (3). The equation then implies that there has been scope for an annual improvement in housing standards of approximately 0.2 percentage point less than the annual increase in income. With an average annual rise in real income of about 2 per cent, there has thus been ample scope for an increase in real housing consumption – despite the relatively high increases in real house prices.

The data basis for the analysis is described in more detail in Box 5.3. We have performed two types of calculation. In item 4 of Table 5.1, we remove the land value from the price per square metre of the total property before comparing with construction costs. Accordingly, Tobin's Q is calculated as the price of an existing building relative to the price of a newly constructed building of the same size.

In item 5 of Table 5.1, the price of an existing housing unit including the building plot is compared with the sum of the price of a newly constructed building and the price of an undeveloped plot. This approach provides more stable figures for Tobin's Q than the calculation under item 4.

The calculations show that, historically, Tobin's Q has been significantly below 1, and still remains below 1, although the estimate of construction costs in Table 5.1 is conservative, cf. Box 5.3.[1] Thus the price of existing housing is generally lower than the price of new housing of the same size. The reason may be that new housing is of a higher quality and, in some

[1] An analysis conducted by the Association of Danish Mortgage Banks has also demonstrated that, since 2007, prices of new housing have been 25-30 per cent higher than prices of other housing. This is in line with the results of item 5 in Table 5.1.

CALCULATION OF TOBIN'S Q AS A LEVEL MEASURE — Table 5.1

Kr. per square metre of living space	1989	1995	2008	2010
1. Price of existing housing according to ADMB				
Capital Region	5,400	6,500	20,900	18,900
Rest of Denmark	4,000	4,300	10,800	10,000
2. Price of new construction, incl. garage				
Statistics Denmark, national accounts	6,300	6,200	9,500	10,000
3. Land prices[1] per square metre of house				
Capital Region	4,007	3,550	19,590	14,600
Rest of Denmark	860	1,015	5,380	5,090
4. Tobin's Q for buildings: (1-3)/2				
Capital Region	0.26	0.39	0.13	0.43
Rest of Denmark	0.46	0.41	0.56	0.50
5. Tobin's Q for the entire property: 1/(2+3)				
Capital Region	0.51	0.55	0.72	0.74
Rest of Denmark	0.52	0.48	0.69	0.66

Note: When Tobin's Q is less than 1, the price of existing housing is lower than the price of new construction. Figures for 2010 are based on the first three quarters.

Source: Statistics Denmark, Association of Danish Mortgage Banks (ADMB) and own calculations.

[1] Land prices according to Statistics Denmark's 10-year statistical overview and StatBank Denmark, "Grunde under 2.000 kvm" (Plots below 2,000 square metres – in Danish only). The calculation is based on a plot of 1,000 square metres and a house of 130 square metres. Land price per square metre of house is thus calculated as (Land price per square metre*1,000)/130. In 2010, land prices were thus approximately kr. 1.9 million in Greater Copenhagen and kr. 620,000 outside Greater Copenhagen.

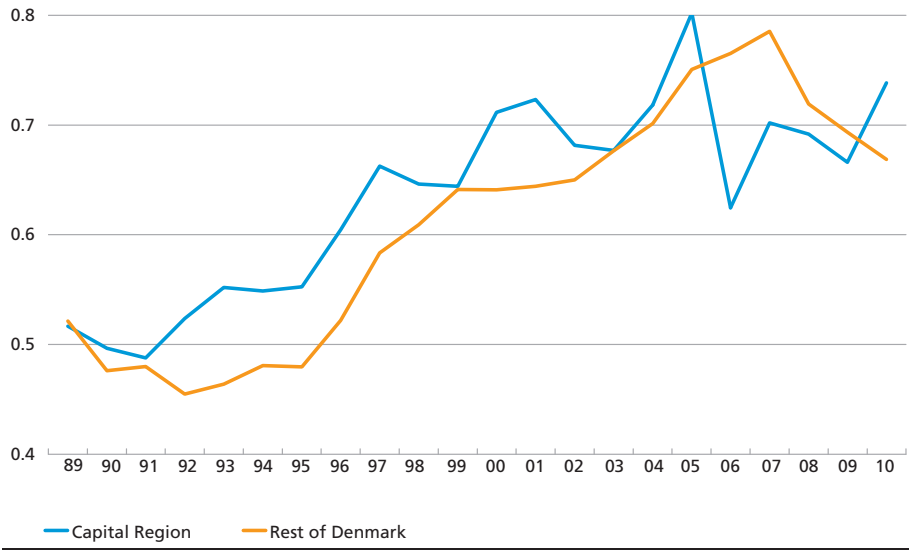
cases, new construction makes it easier to accommodate home buyers' individual needs and preferences. However, it is not clear how much the price of existing housing should be below the price of new housing in order for the housing market to be in long-term equilibrium.

Chart 5.8 shows Tobin's Q calculated using the method in item 5 of the Table. The Chart indicates that, during the 1990s, Tobin's Q shifted to a higher underlying level close to 0.7. Interestingly, the Chart also shows that Tobin's Q is currently at roughly the same level as in the early 2000s – before the housing bubble. If the increase in Tobin's Q in the 1990s represented an adjustment to a new long-term equilibrium in the wake of the protracted downturn in the housing market from 1987 to 1993, there is reason to believe that current prices of existing housing are not significantly overvalued relative to the prices of new housing. The estimated relations for house prices and residential investment presented in section 3 indicate that the housing market was actually close to long-term equilibrium around the year 2000. This underpins the hypothesis that Tobin's Q was at a long-term sustainable level around this time. We emphasise, however, that this conclusion is uncertain.

The uncertainty of our calculations may be attributed in part to the use of data for land prices that comprises only recorded selling prices of

RATIO OF HOUSE PRICE TO CONSTRUCTION COSTS, CALCULATED AS A LEVEL MEASURE

Chart 5.8



Note: Tobin's Q has been calculated using the method stated in item 5 in Table 5.1.
Source: Statistics Denmark, Association of Danish Mortgage Banks and own calculations.

undeveloped plots. In many key areas, relatively few undeveloped plots are traded. Consequently, selling prices in these areas may be subject to random fluctuations that make it difficult to assess the price of constructing new housing on an undeveloped plot. The shortage of undeveloped plots is particularly prevalent in and around large towns and cities where recorded selling prices may thus fluctuate greatly depending on the specific location of the plots traded. This probably explains the relatively wide fluctuations in the calculated value of Tobin's Q in Greater Copenhagen shown by Chart 5.8.

Using Tobin's Q as an indicator of whether or not the housing market is overvalued also raises a problem of a more fundamental nature. As previously mentioned, land price is part of the numerator as well as the denominator of Tobin's Q, but two different land prices are involved. The price in the numerator is the price of a developed plot, which may be located close to the centre of a town. The price in the denominator, on the other hand, is the price of an undeveloped plot, often located on the outskirts of the town. If a large urban area is involved, in practice, the same type of housing is not compared, as most people would find that it is very different to live close to the centre of town and on the periphery of town.

Even if existing and new housing were of the exact same quality, the equilibrium for Tobin's Q for the housing market would hence not be 1,

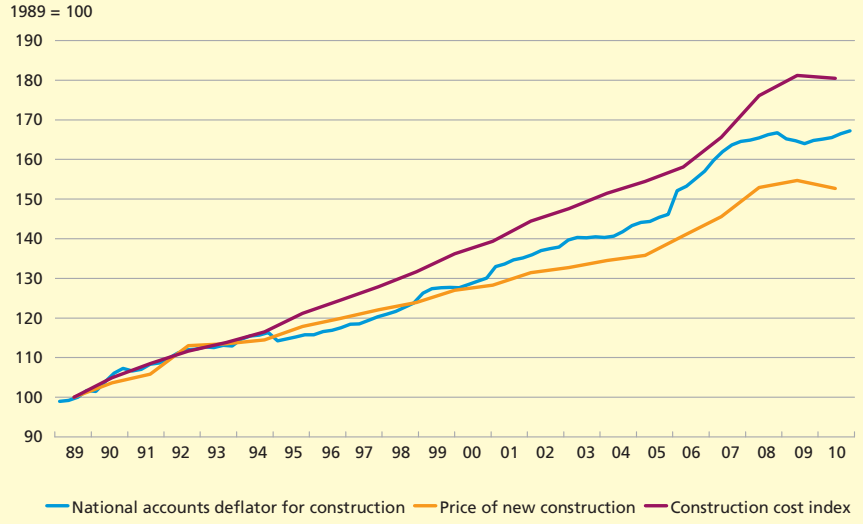
DESCRIPTION OF DATA BEHIND TABLE 5.1 Box 5.3

Price of existing housing: Data for prices per square metre is provided by the Association of Danish Mortgage Banks.

Price of new construction: These figures are provided by Statistics Denmark. They are part of the national accounts. The assumption in Table 5.1 of a price of new construction in 2010 of kr. 10,000 per square metre excluding VAT is comparable with the extensive survey of construction costs conducted by the National Agency for Trade and Industry in 2000. According to this survey, the price of new construction was approximately kr. 8,500 in 1999. According to the national accounts, the price has since then increased by 25 per cent, indicating good consistency between the estimate of the Agency and the estimate used in Table 1. According to Danish Building Information Centre 2010, single-family houses can be constructed at a cost of about kr. 11,000 per square metre excluding VAT and a number of other costs.

Statistics Denmark's figure for the price of new construction has developed more slowly than both the construction cost index and the national accounts deflator for construction, cf. Chart 5.9. One reason is that the price of new construction is adjusted for construction productivity increases of an estimated 1 per cent p.a. The national accounts deflator is not delimited in the same manner as the figures for new construction, as it is based on a broader delimitation than merely construction of single-family houses.

DEVELOPMENT IN CONSTRUCTION COSTS Chart 5.9



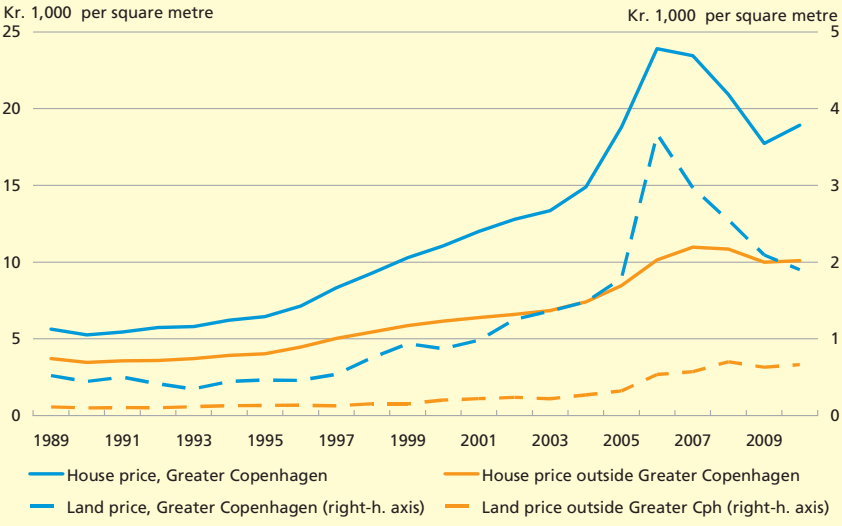
Note: "Price of new construction" is the figures behind the calculation of Tobin's Q in Table 5.1.
Source: Statistics Denmark.

Price of building plots: These figures are particularly uncertain. They are Statistics Denmark's data for the price per square metre for plots below 2,000 square metres, cf. Chart 5.10. The category comprises both undeveloped plots for housing purposes, plots for recreational use and plots for commercial construction. In other words: a highly heterogeneous group of plots. Moreover, some of the observations are based on a relatively small number of transactions, rendering prices very volatile.

CONTINUED Box 5.3

Short-term fluctuations in house prices must be attributed mainly to fluctuations in land prices, as developments in construction costs are more subdued. However, construction costs do have a strong cyclical element. All in all, the costs of new construction are conservatively estimated in the calculation in Table 5.1. Higher construction costs than assumed will strengthen the hypothesis that current house prices are not significantly overvalued.

HOUSE PRICES AND LAND PRICES Chart 5.10



Note: The land price outside Greater Copenhagen is a simple average of land prices, excluding the Capital Region. Nominal values.
Source: Association of Danish Mortgage Banks and Statistics Denmark.

as the location value differs for the plots on which existing and new housing is constructed. The problem with comparability is probably most pronounced in built-up urban areas, rendering it particularly difficult to identify an equilibrium level for our measure of Tobin's Q in an area such as Greater Copenhagen. If economic developments lead e.g. to a relative improvement of employment and education possibilities in and around large towns and cities, or if transport costs go up and congestion worsens, demand for centrally located housing in built-up urban areas will grow. Given the limited possibilities of constructing new housing in these areas, these developments will increase the equilibrium price level for existing housing relative to new housing in more peripheral areas. Conversely, if home buyer preferences change towards more rural and scenic surroundings, this will contribute to lowering our Tobin's Q measure for areas such as Greater Copenhagen, since such change will result in a relative increase in demand for more remotely located plots.

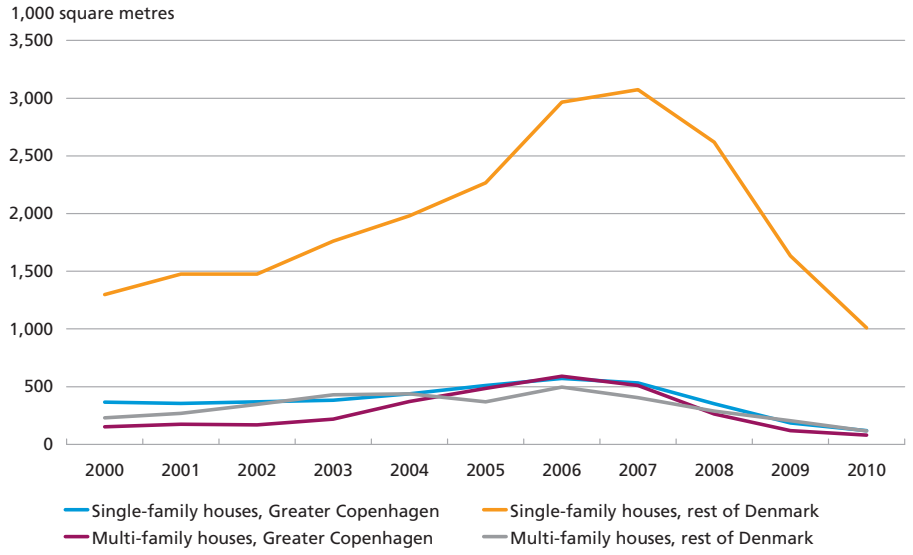
Accordingly, in an area such as Greater Copenhagen, the costs of acquiring new (often more peripherally located) housing are not a firm long-term anchor for the prices of existing housing. Even in a long-term perspective, the size of Tobin's Q in Greater Copenhagen will, to a great extent, be determined by demand for centrally located housing. In the provinces, on the other hand, the supply of building plots will often be more ample, partly due to better possibilities of rezoning agricultural land for residential purposes. Thus the difference in the location value of existing housing relative to new housing will typically be smaller, and the possibilities of countering increases in the price of existing housing by constructing new housing will be greater.[1]

The chain of reasoning above is based on the assumption that it is more difficult to acquire vacant building plots in built-up urban areas – and thus more difficult to meet a rise in housing demand through new residential construction. This assumption is supported by the observations in Chart 5.11, showing developments in new construction over the preceding decade. At the height of the boom in 2007, the number of newly constructed square metres of single-family houses in the provinces was 2.5 times higher than in 2000. In Greater Copenhagen, the increase in the supply of new single-family houses was only 50 per cent. On the other hand, the construction of multi-family homes, mostly owner-occupied flats, almost quadrupled in Greater Copenhagen from 2000 to 2007. So it is actually possible to substantially increase the housing supply even in Greater Copenhagen if house prices rise sufficiently, but the increase in supply will mainly be in the form of flats, requiring less land than single-family houses. Since the peak in 2007, new construction activity has been plunging all over the country. An important reason is undoubtedly that land prices reached a very high level during the boom.

The shortage of land is particularly acute in Greater Copenhagen and, historically, prices of owner-occupied housing have risen more rapidly in this area than in the rest of Denmark, cf. Chart 5.12, and real capital gains have been made over an extended period. As mentioned earlier, there may be several reasons for this. Since many people want to live in Copenhagen, preferably close to the centre, upward pressure is exerted on real prices in Copenhagen relative to the rest of Denmark. Moreover, house prices are more volatile to fluctuations in demand in Greater

[1] Brøchner Madsen (2007) investigates a hypothesis that the price of undeveloped plots on the periphery of town is related to alternative use of agricultural land. In this case, the price of undeveloped plots is thus anchored in the price of agricultural land and the knock-on effect of price rises for existing properties on undeveloped plots is smaller. As already mentioned, the theory of the price of agricultural land as an anchor for building plot prices seems most relevant in areas outside Greater Copenhagen.

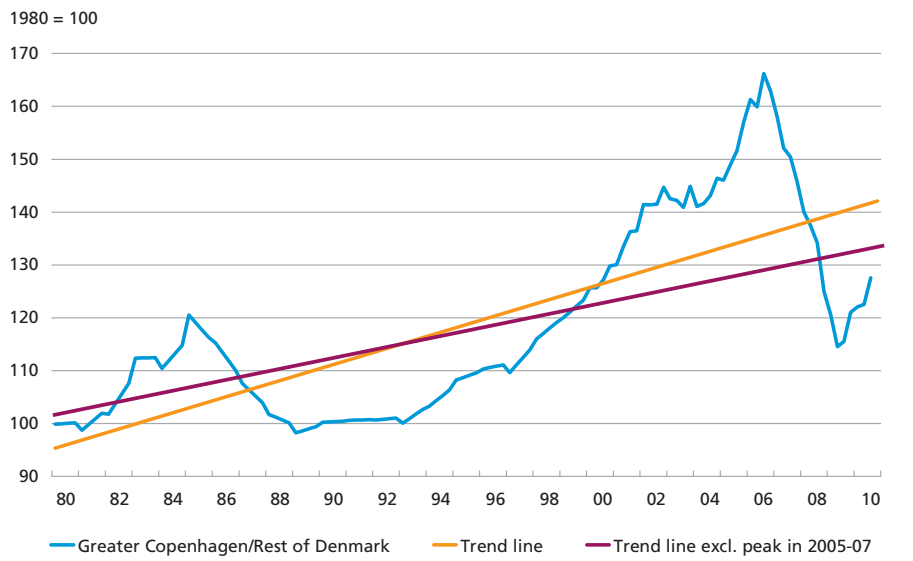
NUMBER OF NEWLY CONSTRUCTED SQUARE METRES — Chart 5.11



Note: The 2010 figures are estimated based on the 1st half of the year.
Source: Statistics Denmark.

Copenhagen than in the rest of the country. This is a reflection of the shortage of vacant plots – and thus the reduced potential for new construction to keep price increases at bay.

RATIO OF HOUSE PRICES IN GREATER COPENHAGEN TO THE REST OF DENMARK — Chart 5.12



Note: House prices in Eastern Jutland have been used as an indicator of prices outside Greater Copenhagen. The flatter of the trend lines has been calculated by disregarding the peak in 2005-07.
Source: Association of Danish Mortgage Banks, Statistics Denmark and own calculation.

Factors contributing to curbing price increases in Greater Copenhagen include the ability and willingness to meet payment obligations by people migrating to the city from the rest of Denmark. In general, prices cannot be too far out of line with prices in the rest of the country. As a substantial degree of substitution must be assumed to exist between houses and owner-occupied flats, the supply of owner-occupied flats may also put a damper on house-price appreciation in Greater Copenhagen. Single-family houses and terraced houses in Greater Copenhagen account for 20-25 per cent of the total number in Denmark – somewhat more if values are considered. Owner-occupied flats in Greater Copenhagen, on the other hand, account for more than 60 per cent of the total number in Denmark.

As shown by Chart 5.12, house-price developments during the latest boom bifurcated, with significantly higher price increases in Greater Copenhagen than in the rest of Denmark. Developments in Greater Copenhagen were unsustainable, and prices subsequently dropped. Despite recent increases, prices in Greater Copenhagen relative to the rest of Denmark are still below the long-term trend.

The question is whether, over the long term, prices in Greater Copenhagen can continue to rise at a faster pace than in the rest of Denmark. This would seem unrealistic and the limit may be close to being reached. To assess this in more detail, we will investigate the ratio of housing costs to disposable income at the current house prices in different parts of Denmark.

Is the current ratio of housing costs to income sustainable?

A frequently used measure for assessing the level of house prices is the housing burden – i.e. costs of ongoing financing of owner-occupied housing relative to the household income. A special and somewhat simplified measure of the housing burden is the ratio of the house price of owner-occupied housing to household income, as described in section 4.

We have chosen to consider developments in actual financing costs for a fully leveraged purchase of an average house with a garden, including property value tax and land tax, cf. Box 5.4.[1] These housing costs are compared with average household disposable income. We include all households, whether homeowners or tenants, as (many) tenants are potential home buyers. Thus the housing burden can be used to assess

[1] We disregard other housing-related costs, such as water and heating, insurance and maintenance. The Ministry of Finance (2010) uses a closely related measure of the housing burden, but does not extend the statement of the housing burden as far back as we do in this article.

CALCULATION OF THE HOUSING BURDEN Box 5.4

The housing burden *B* may be calculated as follows:

$$B = \frac{E\left(V^e\right) + G\left(g, V^g\right) + \sum_i w_i R\left(r^i, t, repay, P^h\right)}{Y}.$$

The numerator is the housing cost, where property value tax *E* is based on the public property valuation V^e, land tax is a function of land tax rate *g* and the assessed taxable land value V^g, while the total financing payment is a weighted sum of the relevant loan products with financing payment *R*, depending on interest rates *r*, the rate of capital income tax *t*, the repayment profile *repay* and the nominal house price P^h. We assume that the home purchase is fully leveraged, so a solution with e.g. a fixed-rate 30-year mortgage bond loan with amortisation will indicate a weight *w* of 0.8 for a financing payment *R* based on a 30-year annuity loan at the 30-year mortgage rate of interest; and a weight *w* of 0.2 at a financing payment *R* based on the banks' lending rate to households for housing purposes.

The denominator *Y* is the household disposable income. The calculations are based on an average house of 140 square metres on a plot of 1,860 square metres. The data basis and the calculations are described in detail in Appendix D.

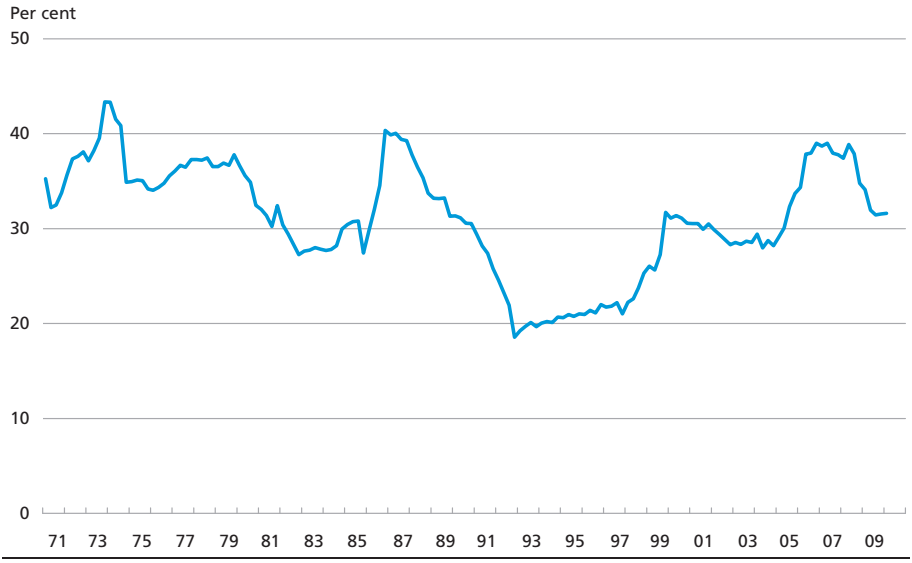
whether the price of owner-occupied housing results in financing costs that are affordable to the average household.

Theoretically, our measure of the housing burden may be criticised for including mortgage repayments, which should not be seen as costs, but rather as savings.[1] However, the empirical analysis in section 3 showed that housing demand among households responds, to a great extent, as if mortgage repayments are costs in line with interest payments and housing taxes. The reason may be that many home buyers are liquidity constrained and/or simply short-sighted. Our measure of the housing burden assesses the ability and willingness of this apparently large group of home buyers to pay the current house prices. Below we assess current house prices based on the house-price relation estimated in section 3, in which mortgage repayments are seen only in part as costs.

Obviously, financing costs vary depending on the home buyer's choice of loan type. As discussed in sections 2 and 3, the (re)introduction of adjustable-rate loans in 1996 and the possibility of opting for deferred amortisation as from the autumn of 2003 resulted in the launch of new loan products, which have become popular. However, fixed-rate loans with amortisation have been the prevailing type of financing in a longer-term perspective. By focusing on this type of loan, we get a consistent picture of housing burden developments over time. Chart 5.13

[1] Conceptually, the housing burden thus differs materially from the national accounts measure of housing consumption, which e.g. does not include loan repayments and housing taxes.

HOUSING BURDEN SINCE 1971 Chart 5.13



Note: The housing burden in the form of stylised financing costs, including property taxes, on the purchase of a single-family house as a ratio of the average household disposable income, cf. Appendix D. Financing costs are based on a fixed-rate mortgage loan with amortisation plus a bank-financed loan for the portion that cannot be financed by a mortgage loan.

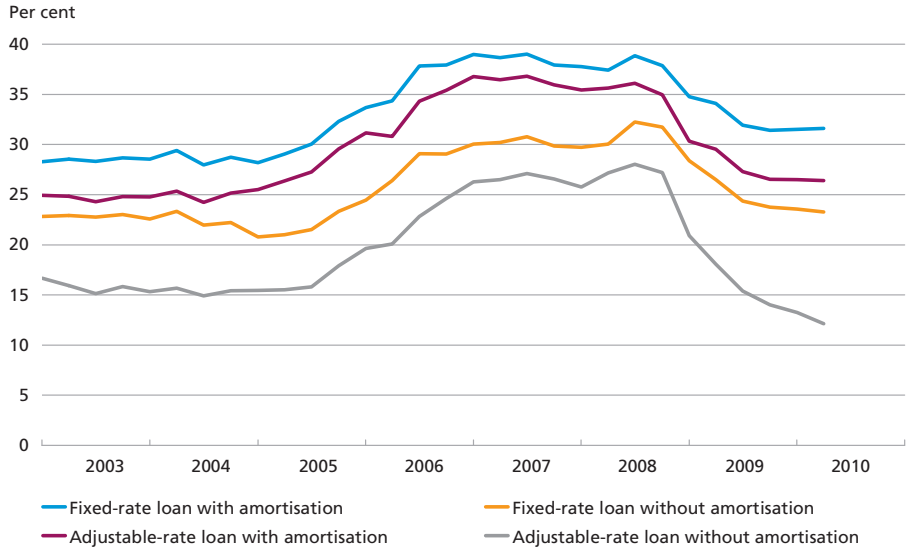
Source: Statistics Denmark, Association of Danish Mortgage Banks, the Danish Customs and Tax Administration (Skat) and Danmarks Nationalbank.

shows how the average housing burden for Denmark as a whole has changed since 1971.

The Chart shows that the housing burden is currently very close to the average of the last almost 40 years, i.e. 31 per cent. Accordingly, the housing burden has dropped by just over 8 percentage points since the latest peak in 2007 when prices of owner-occupied housing were at their highest. It is also worth noting that the housing burden has previously exceeded the levels seen during the latest boom – i.e. during the boom in the mid-1980s and during the period after the first oil crisis when inflation and interest rates were high. Based on this consideration, the current price of owner-occupied housing thus does not seem to have outpaced income and interest developments for Denmark as a whole.

Chart 5.14 shows how the housing burden has varied in recent years, depending on the type of financing selected. This illustrates the considerable increase in the disposable amount immediately available to home buyers who choose either adjustable-rate loans or deferred amortisation. It is also seen that with the current low interest rates, the housing burden for adjustable-rate loans without amortisation is now below the level prevailing before house prices began to soar.

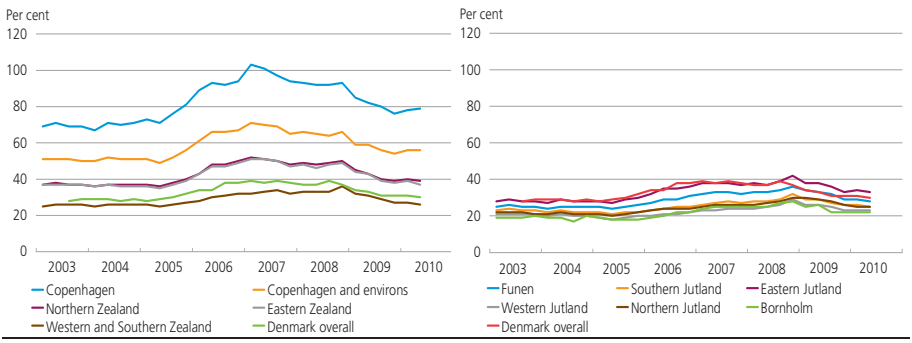
HOUSING BURDEN FOR VARIOUS TYPES OF FINANCING Chart 5.14



Note: The housing burden in the form of stylised financing costs, including property taxes, on the purchase of a single-family house as a ratio of the average household disposable income, cf. Appendix D. Financing costs are based on the loan type specified plus a bank-financed loan for the portion that cannot be financed by a mortgage loan.
Source: Statistics Denmark, Association of Danish Mortgage Banks, the Danish Customs and Tax Administration (Skat) and Danmarks Nationalbank.

We have also calculated housing burdens for the different parts of Denmark over recent years, cf. Chart 5.15. Again, we assume that mortgage financing is based on a fixed-rate loan with amortisation. The Chart illustrates a wide spread in the housing burden for the different parts of Denmark. Thus the purchase of an average-sized house absorbs a much larger proportion of the average household disposable income

HOUSING BURDEN IN DIFFERENT PARTS OF DENMARK Chart 5.15



Note: The housing burden in the form of stylised financing costs, including property taxes, on the purchase of a single-family house as a ratio of the average household disposable income, cf. Appendix D. Financing costs are based on a fixed-rate mortgage loan with amortisation plus a bank-financed loan for the portion that cannot be financed by a mortgage loan.
Source: Statistics Denmark, Association of Danish Mortgage Banks, the Danish Customs and Tax Administration (Skat) and Danmarks Nationalbank.

east of the Great Belt (Bornholm excluded) and especially in and around Copenhagen. This should be seen in the context of a significant spread in income levels in Copenhagen where the average household cannot afford to buy a normal-sized house in the City itself.

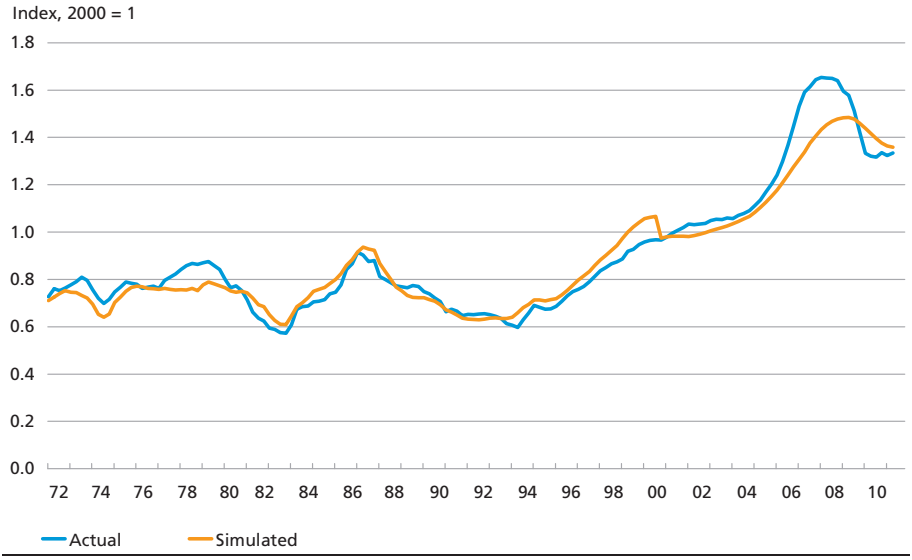
Although the housing burden in Copenhagen and environs has dropped substantially since the peak of the housing market in 2006-07, it still remains higher in these areas than in early 2003, before house prices began to accelerate rapidly. This could indicate that prices in these areas are still slightly overvalued.

In the rest of Denmark, the housing burden has more or less returned to the level from early 2003. Measured in terms of the housing-burden index, a further significant correction in house prices in the provinces thus does not seem to be required.

Prospects for house prices over the new few years

Another method for determining whether the housing market is over-valued is to compare current house prices with the price level predicted by the house-price relation estimated in section 2. Chart 5.16 compares historical developments in real house prices with a simulated scenario calculated using the house-price relation. From the early 1970s up to the period around 2005, the relation captures house-price movements fairly well, but it underestimates the large price boom in 2004-07 and the size

REAL HOUSE PRICES, ACTUAL AND SIMULATED — Chart 5.16



Note: Simulated house prices are based on a dynamic simulation of the demand relation introduced in section 3. Simulations are made as from the 1st quarter of 1972.

Source: MONA databank and own calculations.

of the subsequent price fall. As discussed in section 3, this is probably because increases in house prices in the mid-2000s were driven, to an extraordinary degree, by self-reinforcing expectations of further increases in the future – expectation effects that are difficult for a house-price relation estimated over a longer historical horizon to capture.

However, during 2010, actual house prices and the price level predicted by our house-price relation just about coincided again, cf. Chart 5.16. This could be interpreted as a return to normal economic conditions in the housing market after some exceptional years with a housing bubble succeeded by a financial crisis. Assessed on the basis of our house-price relation, there are thus no indications that house prices are currently overvalued, given the current levels of income, interest rates and other credit terms, etc. In that context, it is worth noting that our house-price relation takes account of the extensive residential construction of the preceding decade, which has put a damper on house prices.

An important question is, however, whether new sharp declines in house prices are likely over the coming years, when interest rates must be expected to rise from their current very low level to a more normal level. To investigate this question, we have incorporated our estimated relations for determining residential investment and house prices (cf. Appendices A and B) into MONA, Danmarks Nationalbank's macroeconometric model, and have calculated a medium-term projection of house-price trends, allowing for expected macroeconomic developments over the coming years. The advantage of incorporating house price and residential investment relations in the MONA model is that this allows us to take account of the interaction between the housing market and the rest of economy, including the fact that changes in house prices affect the overall economic activity, and hence income formation, which, in turn, impacts housing demand and house prices.

Our medium-term projection of the Danish economy up to and including 2015 is based on the assessment of cyclical developments presented in Part 1 of this Monetary Review. Table 5.2 summarises the key calculation assumptions and the main elements of the expected macroeconomic developments.

The projection is based on the assumption that, by 2015, the Danish economy will approach a situation with normal capacity utilisation as the rates of private consumption and investment increase from their current low levels. In that case, there will be basis for growth in output and income and some decline in unemployment, although interest rates are also expected to rise to a more normal level. An important precondition for this scenario is that the economy does not suffer further

KEY ASSUMPTIONS OF THE PROJECTION OF THE DANISH ECONOMY UP TO 2015

Table 5.2

	2011	2012	Avg., 2013-15
Export market growth, per cent year-on-year	7.5	6.5	4.4
Short-term mortgage yield[1], per cent p.a.	1.7	2.7	3.5
Long-term mortgage yield, per cent p.a.	5.5	6.0	6.0
Real GDP growth, per cent year-on-year	1.9	1.9	1.7
Net unemployment, 1,000 people	113	106	99
Real household disp. income, per cent year-on-year	0.3	0.9	1.3

Note: Projection based on MONA extended by new relations for house price and residential investment.
Source: Danmarks Nationalbank.
[1] The short-term mortgage yield is assumed to reach a level of 4 per cent by the end of the period.

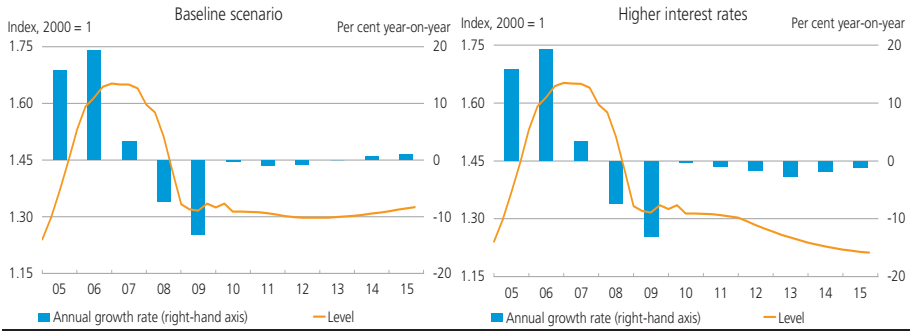
severe shocks – e.g. in the form of a strong international slowdown and/or financial market events triggering a sudden hike in interest rates.

In the scenario summarised in Table 5.2, according to the model, real house prices will develop as illustrated by Chart 5.17 (left).[1] The Chart shows that the expected modest growth in income provides a basis for maintaining real house prices more or less unchanged despite a gradual normalisation of interest rates. Another reason why a rise in interest rates does not trigger a decline in house prices is that, according to the estimated house-price relation, house prices are currently at a lower level than would be expected in light of the current very low interest rates, cf. the observations for 2010 in Chart 5.16. The explanation could be that the very pessimistic expectations in the wake of the financial crisis have caused some degree of negative overreaction in house prices. As this overreaction is corrected, house prices will, to a certain extent, recover, which may offset the impact of the expected interest-rate increase.

Chart 5.17 (right) shows simulated developments in housing under an alternative scenario in which international and Danish interest rates as from 2012 rise at a steeper pace than in the baseline scenario above. In this scenario, both the short-term and long-term bond yields in 2015 are 1 percentage point higher than in the baseline scenario. Higher international and Danish interest rates may occur if international economic growth exceeds the assumptions of the baseline scenario, so that foreign central banks are compelled to raise interest rates more aggressively to keep inflation in check. In that case, the negative impact of interest-rate rises on house prices will be countered by the stimulus provided to Danish exports by stronger international growth, entailing

[1] As the economy frequently suffers new, unexpected shocks, actual developments will undoubtedly be more erratic than illustrated by the Chart. Accordingly, more emphasis should be placed on the underlying trend shown than on the developments described for individual years.

MEDIUM-TERM PROJECTION OF REAL HOUSE PRICES Chart 5.17



Note: Projection of real house prices based on MONA extended by new relations for house price and residential investment.
Source: Danmarks Nationalbank.

that growth in the Danish economy, and thus housing demand, is underpinned. More rapid increases in international and Danish interest rates may also occur, however, in the event of financial market turmoil, e.g. as a result of deepening of the European sovereign debt crisis. In that case, interest-rate rises must be expected to go hand in hand with a foreign downturn.

In other words, it is not clear how export market growth will perform in a situation of stronger-than-expected interest-rates rises. To serve as a neutral indicator, we have assumed the same market growth as in the baseline scenario of the model simulation on which the alternative scenario in Chart 5.17 (right) is based. The interest-rate rise will dampen growth in the Danish economy, which will reduce housing demand and thus house prices. In addition, there is a direct negative impact on house prices since the extra interest-rate rise will increase the households' housing costs. The result is illustrated in Chart 5.17 (right): real house prices drop by 6-7 per cent in the period up to 2015.

The scenarios indicate that quite substantial interest-rate hikes will be required to trigger a steep fall in Danish house prices over the coming years. But our alternative scenario also demonstrates that some decline in real house prices can by no means be ruled out. Moreover, as previously mentioned, both scenarios presume that a new severe international recession does not occur.

Summary: Is the housing market overvalued?

In this section, we have used five different methods in an attempt to assess whether Danish house prices are currently unrealistically high viewed in a long-term perspective.

The first method was based on the house-price-to rent-ratio – i.e. the ratio between current prices of owner-occupied housing and the rents for similar housing. A comparison of current and average historical price-to-rent ratios provides an indication of whether current house prices ensure that homeowners receive a normal return on their housing investment. The current price-to-rent ratio could suggest that owner-occupied house prices are above the long-term sustainable level. In a Danish context, however, the weakness of this method is that the rental market for single-family houses is very thin and that rents for rental housing hardly provide a true and fair view of the price at which owner-occupied housing could be rented, given that the market for rental housing is not free. Hence, the data basis for calculating the price-to-rent ratio is very small and, consequently, this method cannot be accorded much weight.

We then assessed house prices using two variants of the Tobin's Q method. This method is based on the assumption that, in the long term, prices of existing housing are determined by the costs of acquiring similar new housing. The first and most widely-used variant (Tobin's Q as an index measure) compares *developments* in house prices with *developments* in construction costs. However, unless the housing market happened to be in long-term equilibrium in the base year (or at the trend level) selected for the calculation, this does not provide a basis for determining whether house prices are above or below their long-term equilibrium.

In the second variant of the method (Tobin's Q as a level measure), the *level* of existing house prices is compared with the *level* of costs of acquiring new housing of the same size. In this case, the crux is that existing and new housing may be difficult to compare due to differences in quality and location. In built-up urban areas, in particular, new housing will often have to be constructed on more remotely located plots with a lower location value than the centrally located plots on which much existing housing has been constructed. The problem of comparability renders it difficult to identify a "normal" long-term level for prices of existing housing relative to prices of new housing (Tobin's Q). The reason is that changes in employment and transport opportunities and in location preferences could cause the demand for centrally located housing relative to more peripherally located housing to shift over time. According to our analysis, Tobin's Q is currently at roughly the same level as in the early 2000s – before the housing boom.[1] This could indicate that prices have reverted to a long-term sustainable level after the

[1] We here refer to our calculation of Tobin's Q as a level measure rather than as an index measure.

"bubble years" in the mid-2000s. However, our analysis also shows that Tobin's Q remains somewhat above the average level of the 1990s. The reason could be that prices of existing housing were very low in the early 1990s following the long period of slow growth starting in 1987. All in all, a calculation of Tobin's Q thus gives us only a very uncertain indication of whether or not house prices are overvalued.

A fourth method for assessing house prices is by calculating the housing burden. The housing burden is calculated as the sum of housing taxes and financing costs of a fully leveraged purchase of a typical single-family house as a ratio of average household income. Assuming that a fixed-rate mortgage loan with amortisation has been chosen, we were able to calculate developments in the average housing burden for Denmark as a whole from 1971 up to the present. The calculations showed that the current housing burden is almost exactly in line with the average housing burden of the last 40 years. We also investigated how the housing burden varies with the type of financing selected. We found that the housing burden for an adjustable-rate loan without amortisation is currently lower than it was in 2003 – although real house prices are higher today. Finally we examined developments in the housing burden for different parts of Denmark during the last decade, assuming that financing was in the form of a fixed-rate loan with amortisation. This analysis showed that the housing burden in Copenhagen and environs is currently slightly higher than in early 2003, while it is roughly unchanged in the rest of Denmark. Overall, our analyses of the housing burden do not indicate that house prices are currently overvalued at the prevailing low interest rates.

We reached the same conclusion using the house-price relation estimated in section 3. According to this relation, house prices are currently slightly below the level to be expected based on the historical impact of developments in income, housing taxes, interest rates and other financing conditions on house prices. We subsequently incorporated the house-price relation into MONA, Danmarks Nationalbank's macroeconometric model, to investigate how house prices can be expected to develop over the next five years, taking into account that interest rates must be expected to increase from their current very low levels. We found that the expected improvement of cyclical conditions by 2015 provides a basis for maintaining the current level of real house prices despite gradual normalisation of interest rates. However, house prices may fall if interest rates rise more suddenly and rapidly or in case of a new international slowdown.

Overall, the analyses based on the house-price-to-rent ratio and Tobin's Q could indicate that current house prices are still above their

long-term sustainable level. However, as mentioned, it is very difficult to identify a long-term equilibrium for real house prices based on these measures. This speaks in favour of placing more emphasis on analyses based on calculations of the housing burden and on the empirical house-price relation. These analyses do not indicate that the housing market is generally overvalued at the current level of interest rates and income, etc. This conclusion is in line with the econometric analysis in Skaarup and Bødker (2010).

Our analyses have also shown that wide regional differences may exist in house-price developments. In Greater Copenhagen, in particular, prices seem to be more volatile to cyclical fluctuations; one explanation could be greater shortage of vacant building plots in the capital. Thus modest increases in average house prices for Denmark as a whole may coincide with price falls in parts of the country.

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APPENDIX A: RESIDENTIAL-INVESTMENT RELATION

The residential-investment relation determines net investment as a function of the ratio of the house price to investment cost. When the price of existing housing is high relative to construction costs, it is advantageous to construct new housing, causing residential investment to expand, cf. section 2. In this context, we choose to disregard the fact that some areas may have a shortage of building plots.

In the long term, house prices are determined by investment costs in accordance with the theory of Tobin's Q, cf. section 5. Thus the long-term supply curve is horizontal:

$$\log P^h = \log P^i + \beta,$$

where β is a constant, depending *inter alia* on the coefficients in the estimated relation below.

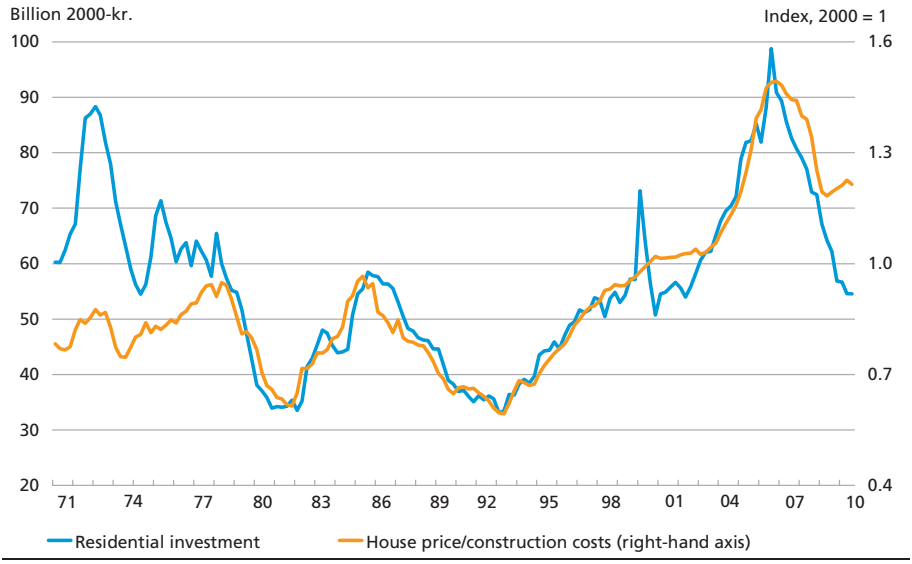
As mentioned above, disequilibrium in the Tobin's Q price ratio, i.e. the house-price-to-construction cost ratio, affects investment activity. Thus short-term dynamics are given by:

$$I^h/K^h_{-1} = \alpha_0 + \alpha_1\left(I^h/K^h_{-1}\right)_{-1} + \alpha_2 D\log\left(P^h/P^i\right) + \alpha_3 \log\left(P^h/P^i\right)_{-1},$$

where I^h is net residential investment, K^h is housing stock, P^h is house price and P^i is investment cost, reflecting construction costs.

Historically, as Chart A.1 illustrates, there has been close correlation between residential investment and Tobin's Q. However, residential investment was some-

HOUSE PRICES, CONSTRUCTION COSTS AND RESIDENTIAL INVESTMENT — Chart A.1



Note: Annualised seasonally adjusted quarterly data for residential investment. The national accounts deflator for construction investment is used as construction costs. The extraordinary and temporary increase in the 1st half of 2000 is due to the December 1999 hurricane.

Source: Statistics Denmark and Danmarks Nationalbank.

RESIDENTIAL-INVESTMENT RELATION — Table A.1

Variable	Name	Coefficient	t value
Net investment/housing stock	$fIhn/fKbh_{-1}$		
Net investment/housing stock	$fIhn_{-1}/fKbh_{-2}$	0.8573	19.8
Tobin's Q, change	$Dlog(kp/pih)$	0.0137	2.7
Tobin's Q	$log(kp/pih)_{-1}$	0.0033	2.8
Dummy[1]	*D100q1*	0.0094	5.9
Dummy	$D100q1_{-1}$	-0.0048	3.0
Constant		0.0017	2.9

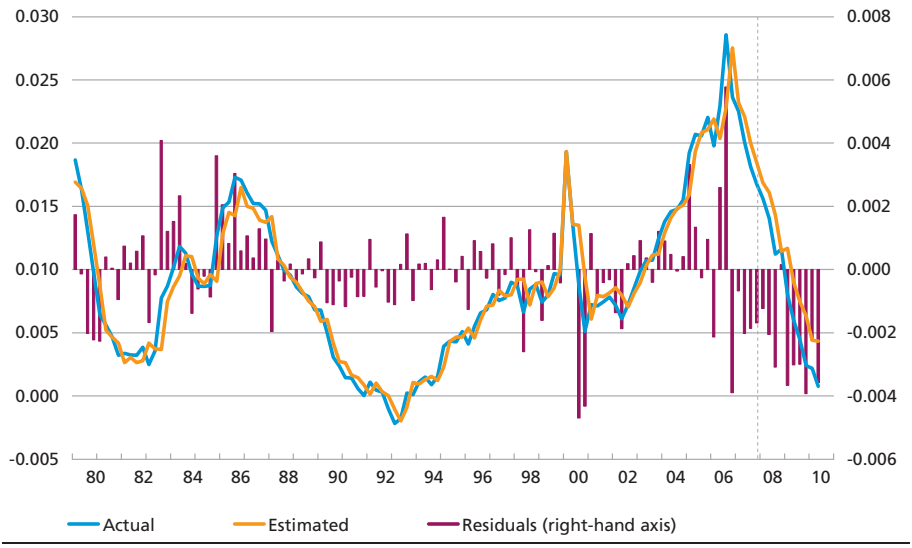
T	=1980Q1 – 2007Q4	DW	= 1.634	AR(1)	= 5.062	SE	= 0.0016
R^2	= 0.9429	JB	= 27.607	AR(4)	= 13.851		

Note: Names refer to the MONA nomenclature rather than the one applied in the text.
(1) The dummy captures the extraordinarily high level of residential investment in the 1st half of 2000 due to the December 1999 hurricane.

what higher in the 1970s than can be explained by Tobin's Q, presumably reflecting extensive subsidised housing activity in the early 1970s; at the same time, it was easier to obtain financing for new construction than for existing housing. As these factors are both a thing of the past, we choose to disregard the period before 1980. The relation estimated for the period from the 1st quarter of 1980 to the 4th quarter of 2007 includes a dummy variable to capture the outliers in the 1st half of 2000 when residential investment was extraordinarily high due to the December 1999 hurricane.

The estimation results are set out in Table A.1, while the explanatory power is shown by Chart A.2. All coefficients are significant and a recursive estimation

RATIO OF NET INVESTMENT TO HOUSING STOCK, ACTUAL AND ESTIMATED — Chart A.2

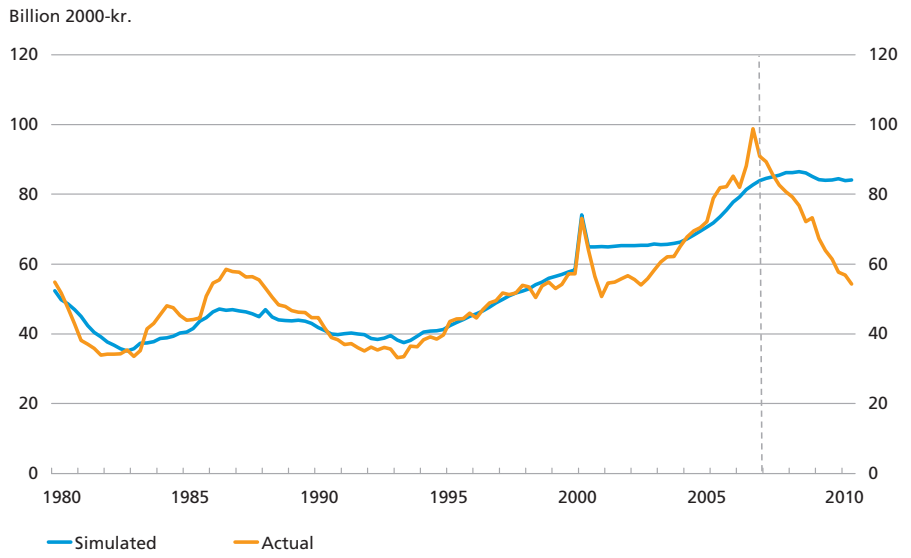


Note: The estimation covers the period from the 1st quarter of 1980 to the 4th quarter of 2007.
Source: MONA databank and own calculations.

shows relatively stable parameters. However, when the last few years are included in the estimation, the coefficient for Tobin's Q decreases. It should be noted that the coefficient for the lagged net investment is relatively high; residential investment thus displays considerable stickiness. It should also be noted that there seems to be some systematic correlation in the residuals that is not captured by the relation.

A dynamic simulation shows that, over a longer horizon, the relation captures developments in residential investment fairly well, cf. Chart A.3, but that it has particular difficulty capturing the sharp decline since 2006, during which period investment has fallen far more than indicated by Tobin's Q.

RESIDENTIAL INVESTMENT, ACTUAL AND SIMULATED — Chart A.3



Note: Simulated values are based on dynamic simulation of the residential-investment relation as from the 1st quarter of 1980.
Source: MONA databank and own calculations.

APPENDIX B: HOUSE-PRICE RELATION

The house-price relation is an inverse relation of household demand for housing. The relation is formulated in error-correction form for quarterly data where house prices gradually adjust to the price that makes the underlying demand match the overall supply of housing, which cannot be changed in the short term, cf. the discussion in section 3.

Definitions and variables

Accordingly, we refer to the long-run relation as the underlying demand for houses. The relation is assumed to depend on real household income, user cost and first-year payments, as well as the real house price;

$$K^D = F\left(Y, u, y, p^h\right), \tag{B.1}$$

where K^D is the overall housing demand, Y is the household disposable income deflated by the price of private consumption and p^h is the real house price (cf. the overview below). u and y are user cost and the lowest possible first-year payments, respectively, defined as follows:[1]

$$u = \left[(1-t)r^{30} - \pi\right] + s + d, \text{ and} \tag{B.2}$$

$$y = (1-t)r^{min} + s + repay, \tag{B.3}$$

where t is the relevant tax rate for housing-related interest costs, r^{30} is the 30-year bond yield, while r^{min} is the lowest possible bond yield and π denotes the expected inflation rate; s is total housing taxes as a ratio of the total housing stock calculated at market price, d is repairs and depreciation and *repay* are the lowest possible repayments on a fully leveraged home purchase.

We do not have observations of the expected inflation rate of households. We thus approximate this rate through an autoregressive process, assuming adaptive expectations;[2]

$$\pi = (1-\gamma)\pi_{-1} + \gamma \log\left(P / P_{-4}\right), \tag{B.4}$$

where we set $\gamma = 0.125$, and P denotes the price of private consumption.

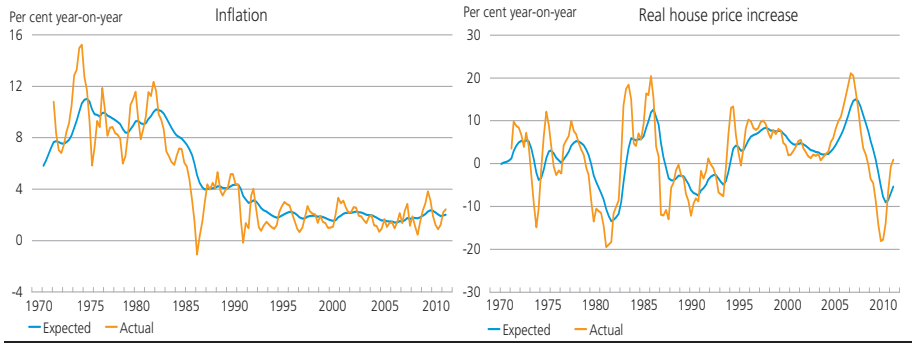
Changes in house prices result in capital gains or losses for homeowners. Strictly speaking, user cost u should therefore include expected future annual changes in real house prices, referred to as π^h. As in the case of inflation, we do not, however, have consistent observations of these expectations. Again, we

[1] Note that in line with the previous practice used in MONA, we define user cost as the factor by which the real house price must be scaled to obtain the economic costs of one unit of housing. The product of the user cost defined here and the real house price, $u \cdot p^h$, thus denotes what is referred to in other contexts as user cost.

[2] This expression is identical to Cogley's (2002) *exponential smoother* estimate. Cogley argues in favour of using this estimate of core inflation (which is, in turn, linked to inflationary expectations). This may be interpreted as a learning process based on *constant gains* updating; i.e. an updating algorithm where the agents attach greater importance to the latest developments when using historical data to form expectations of the future.

PRICE INCREASES FOR HOUSES AND PRIVATE CONSUMPTION, ACTUAL AND EXPECTED

Chart B.1



Note: House prices are deflated by the price of private consumption. Expected price increases have been approximated by autoregressive processes as specified in the text. Annual percentage price increases have been calculated as the logarithmic change over four quarters scaled up by a factor of 100.

Source: MONA databank and own calculations.

approximate these through an autoregressive process of the same type as (B.4), setting $\gamma = 0.20$. However, due to significant fluctuations in house prices and our insufficient identification of these expectations, we have decided to include them as a separate explanatory variable in the relation of underlying demand so as not to distort the estimated parameter of user cost.[1] Actual and expected price increases for private consumption as well as houses are illustrated by Chart B.1.

As already mentioned, the expression of the first-year payments has been designed to denote the lowest possible payments on a fully leveraged home purchase. This entails that both the relevant bond yield and the repayment rate are affected by changes in available credit facilities. Adjustable-rate loans were formally (re)introduced in 1996, but did not gain ground until after the millennium change. Consequently, we have constructed the lowest bond yield, r^{min}, as the long-term (30-year) bond yield up to and including the 4th quarter of 1999, while it subsequently comprises a short-term bond yield.[2]

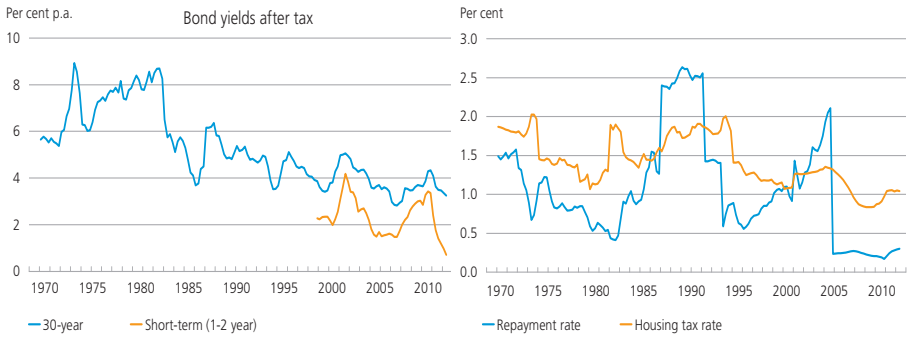
The repayment rate is based on available loan types over time. This entails that the rate is affected by the possibility of opting for adjustable-rate loans as from the 1st quarter of 2000 (it rises as low short-term interest rates result in higher repayments) and especially by the possibility of opting for deferred-amortisation periods as from the 4th quarter of 2003. The bond yields applied (after tax) and the repayment rate as well as the imputed rate of property taxes are shown by Chart B.2.

In line with the practice previously used in MONA, we disregard repairs and depreciation (i.e. $d = 0$). We thus obtain the time series for user cost u and first-year payments y shown by Chart B.3, cf. the discussion below.

1 The estimation confirms that user cost, u, and the approximation of the expected house price changes, π^b, have significantly different effects on underlying housing demand.

2 More specifically, the average yield on bonds with maturities of 1 and 2 years, calculated by the Association of Danish Mortgage Banks.

BOND YIELDS, REPAYMENT RATE AND HOUSING TAX — Chart B.2



Note: The short-term bond yield is an average of maturities of up to two years. The repayment rate has been calculated based on fully leveraged loan financing composed in accordance with current rules, including deferred amortisation as far as the bond loans (but not supplementary bank loans) are concerned, as from the 4th quarter of 2003. Housing taxes include land tax and the imputed rate of property value tax as a ratio of the housing stock, calculated at market value.

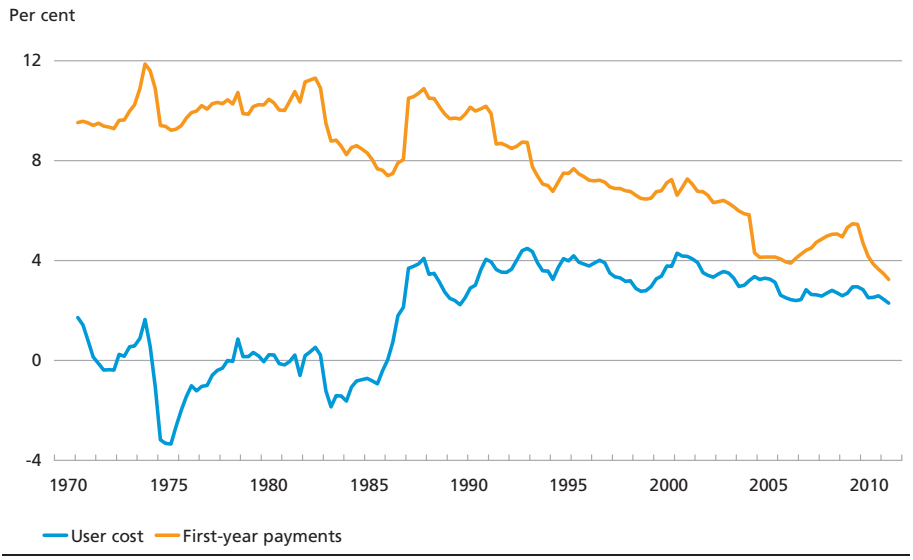
Source: Association of Danish Mortgage Banks, Realkredit Danmark and Danmarks Nationalbank, including the MONA databank.

Estimation results

We let the relation of underlying demand, (B.1), assume a linear form with appropriate use of logarithms, and subsequently invert it to a relation of the real house price:

$$\log p^h = a_1 \cdot u + a_2 \cdot y + a_3 \cdot \pi^h + a_4 \log(Y / K) + a_5, \qquad \text{(B.5)}$$

USER COST AND FIRST-YEAR PAYMENTS — Chart B.3



Note: User cost and first-year payments as defined in equations (B.2) and (B.3), respectively, with related explanations.

Source: Association of Danish Mortgage Banks, Realkredit Danmark and Danmarks Nationalbank, including the MONA databank.

REAL HOUSE PRICE — Table B.1

Variable	Name	Coefficient	t value
Real house price, change	Dlog(*kp/pcp*)		
Real house price, lagged change ..	Dlog(*kp/pcp*)$_{-1}$	0.3215	5.0
Interest and tax rates, change[1]	D(*rente30* + *ssats*)·*db98k4*	-3.7212	9.8
Real house price	log(*kp/pcp*)$_{-1}$	-0.0473	4.6
User cost	*rente30*$_{-1}$ + *ssats*$_{-1}$ –*dpcpe*$_{-1}$	-0.2878	2.9
First-year payments	*rentemin*$_{-1}$ + *ssats*$_{-1}$ + *afdrag*$_{1}$	-0.4435	3.2
Expected change in house price ...	*drkpe*$_{-1}$	0.0938	3.0
Real income/housing stock	log(*Ydph/pcp*)$_{-1}$ - log(*fKbh*$_{-1}$)	0.0729	1.7
Constant		0.1106	2.6

T	=1972Q1 – 2010Q2	DW	= 1.904	AR(1)	= 0.910	SE	= 0.0177
R^2	= 0.6413	JB	= 0.358	AR(4)	= 7.007		

Note: Names refer to the MONA nomenclature rather than the one applied in the text.
[1] Change in the sum of the imputed rate of housing tax and bond yields after tax before the 4th quarter of 1998.

where, according to the theory, a_1 and a_2 are negative, while a_3 and a_4 are expected to be positive.

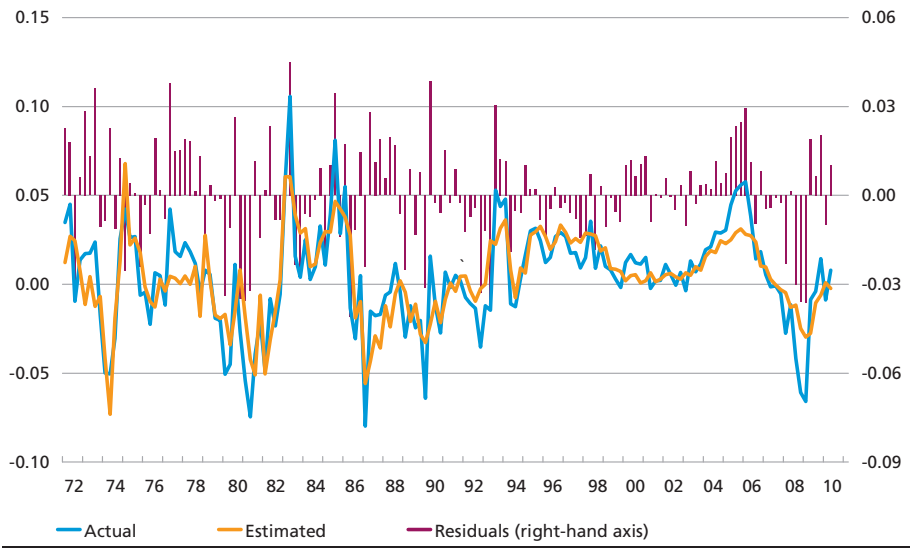
The relation is used as a long-run relation in a univariate error-correction model, estimated for the period from the 1st quarter of 1972 to the 2nd of 2010. We test a number of different variables for the short-term dynamics but – based on statistical criteria – end up including only the lagged change in the real house price and the sum of changes in the bond yield after tax and the imputed rate of property tax. The latter variable has significant short-term effects at several times during the years up to the second half of the 1990s, but subsequently the immediate pass-through effect of interest rates and taxes on house prices declines. This could reflect that homeowner financing has become more flexible. Using a dummy structure, we eliminate this short-term effect as from the 4th quarter of 1998.[1]

The estimation results are shown in Table B.1, while the predicted price increases are compared with actual increases in Chart B.4. As shown, the relation generally captures the most important fluctuations up to 2004 fairly well, while it has difficulty explaining the steep rise in prices in 2005-06 and the subsequent fall in 2008-09, cf. also the discussion in section 3. There are also clusters of residuals with the same sign earlier in the estimation period, although the statistical tests of the properties of the residuals do not indicate any problems with auto correction.

A dynamic simulation in which predicted house prices in a given period are based on the predicted prices of previous periods shows that, also over a longer horizon, the relation captures large movements in real house prices – although with the problems of the boom-bust cycle in 2004-09 mentioned in section 3; in addition, the declining interest rates in the mid-1990s also warranted a higher increase in house prices than actually occurred. cf. Chart B.5.

[1] A *t* test confirms that, as from the 4th quarter of 1998, the effect is insignificant.

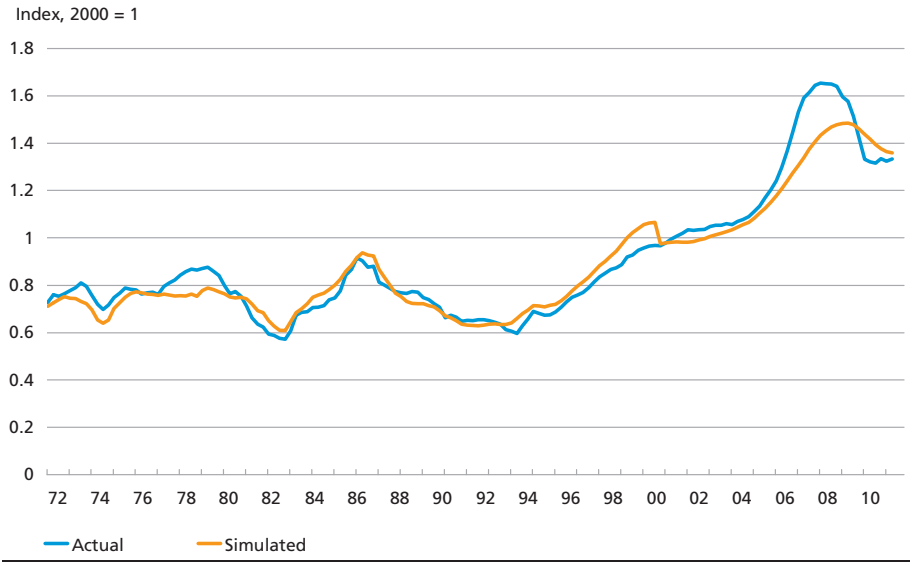
CHANGES IN REAL HOUSE PRICES, ACTUAL AND ESTIMATED Chart B.4



Note: Changes in the logarithm of the average house price divided by the implied private consumption deflator.
Source: MONA databank and own calculations.

The long-term relation is reviewed in Box 3.2 in section 3. It should be noted that we have restricted the income elasticity to unity, so that housing demand increases on a one-to-one basis with real income. In a free estimation, the

REAL HOUSE PRICES, ACTUAL AND SIMULATED Chart B.5



Note: Simulated house prices are based on a dynamic simulation of the demand relation as from the 1st quarter of 1972.
Source: MONA databank and own calculations.

income elasticity is somewhat lower (0.40) and the restriction imposed gives a *p* value of 0.03; thus data is somewhat at odds with the restriction.

The estimated relation suffers somewhat from unstable parameters. Moreover, the parameters changed in 2005-06 in response to sharp increases in prices, which the relation has difficulty explaining. However, if the relation is estimated on data for the period up to the 4th quarter of 2004, price-development predictions for the entire period match those obtained from the relation in Table 3.1.[1]

User cost, first-year payments and repayment rate

The house-price relation used in MONA so far did not factor in the first-year payments – only the economically-based user cost, cf. Danmarks Nationalbank (2003).[2] As Chart B.3 illustrates, there are significant trend-related deviations between the expressions. This may be attributed predominantly to inflationary expectations since – unlike the first-year payments – the user cost allows for inflation representing a real repayment on the debt.[3]

As inflation (and the value of mortgage tax relief) was high in the 1970s, in real terms, it was thus quite inexpensive to borrow money and thus to buy a home. However, current expenses were high, which is reflected in the high first-year payments. The consequence is well-known: during this period, home buyers tightened their belts and cut back on other consumption immediately after the home purchase and in the course of a few years, inflation reduced the real payments on the mortgage loan, thus making funds available for other consumption. The transition to a regime of low and stable inflation during the 1980s has ensured greater consistency between first-year payments and user cost.

As we combine user cost and first-year payments in the house-price relation, we allow these different perceptions of the costs of a home purchase to affect demand. A conversion of (B.5) gives the following:

$$\log p^h = b \cdot omk + a_3 \pi^h + a_4 \log(Y/K) + a_5, \qquad \text{(B.6)}$$
$$b = a_1 + a_2, \quad \lambda = a_1/(a_1 + a_2) \quad \text{and} \quad omk = \lambda \cdot u + (1-\lambda) \cdot y,$$

where λ can be seen as the weight of the user cost in the combined expression of total housing costs, *omk*, cf. also Box 3.2 in section 3. The empirically determined weighting of user cost and first-year payments in total costs can be interpreted in several ways; thus $(1-\lambda)$ may be interpreted as the proportion of home buyers who are subject to credit restrictions and are therefore limited by their immediate financial resources in the form of the first-year payments. Alternatively, each home buyer may take account of both factors in his cal-

1 There is also a general match between the parameter estimates for the samples from the 1st quarter of 1972 to the 4th quarter of 2004 and to the 2nd quarter of 2010, albeit with shifts in individual parameters.

2 Until recently, a similar modelling strategy was applied by other Danish macroeconometric models such as ADAM and SMEC.

3 The user cost thus includes real interest rates after tax (the square brackets in equation (B.2)), while the nominal rate after tax is included in the first-year payment, cf. (B.3).

culation and λ thus captures the weight of the respective factors in the calculation.

A comparison of equation (B.6) with (B.2) and (B.3) shows that inflation is included in *omk* with a weight of only λ. Downweighting of inflation in the definition of costs is not unknown in Danish macroeconometric tradition. It has been widely used in both ADAM and MONA and may be interpreted *inter alia* as a tendency among households and firms to expect that periods of high inflation will not last, cf. the discussion in Knudsen (2002). Thus, while this house-price relation explains the downweighting of inflation by combining user cost and first-year payments, respectively, that is not the only possible explanation.

Another important implication of the approach chosen is that, through the first-year payments, repayments on the loan are included in the overall cost term with a weight of $(1-\lambda)$. By isolating *repay* as a separate variable from *y*, we test this implication of including the first-year payments by re-estimating the house-price relation. This results in the following long-run relation:

$$\log p^h = c_1 \cdot u + c_2 (y - repay) + c_3 \cdot repay + c_4 \cdot \pi^h + c_5 \log(Y / K) + c_6, \qquad \text{(B.7)}$$

and the hypothesis on which our demand function is based is thus $c_3 = c_2$. This hypothesis cannot be rejected based on a statistical *t* test. On the other hand, the parameter for *repay* is weakly determined in the regression, so neither can it be ruled out that it is zero, i.e. $c_3 = 0$.

In other words, based on statistical criteria, it is not possible unambiguously to determine the effect of deferred-amortisation loans on housing demand – and thus their significance for house prices. Our preferred relation is based on expressions of costs that are in line with the stated economic considerations in terms of user cost and first-year payments, and this relation cannot be rejected based on common statistical criteria.

As interest and tax rates are included in both user cost and first-year payments, the impact of the various factors on housing demand, and thus house prices, is slightly more complex than in a model in which costs are based solely on user cost. By combining the equations (B.2) and (B.3), the definition of total costs may thus be stated as follows:[1]

$$\begin{aligned} omk &= \lambda \cdot u + (1-\lambda) \cdot y \\ &= \left[\underbrace{(1-t) r^{30} - \pi}_{\text{real interest rate}} \right] + s + (1-\lambda) \left[\underbrace{(repay + \pi)}_{\text{real repayment}} - \underbrace{(1-t)\left(r^{30} - r^{min}\right)}_{\text{yield spread}} \right]. \end{aligned}$$

The weighted definition of cost may thus be interpreted as comprising long-term real interest rates after tax and housing tax (fully included), the full repayment in real terms and the spread between long and short-term interest rates after tax weighted by the weight of the first-year payments, (1-λ).

[1] Here we have used the assumption *d* = 0, i.e. no depreciation.

APPENDIX C: DATA FOR INTERNATIONAL HOUSE PRICES

The OECD database is quarterly and goes back to the 1st quarter of 1970. Where national data is available from a later time only, the OECD has used quarterly and/or annual data from the Bank for International Settlements, BIS, cf. André (2010).

National data varies considerably in terms of frequency and underlying data, cf. below.

Country	Specification	Source
Denmark	Index of single-family houses sold	Statistics Denmark
France	Index of existing housing	INSEE
Netherlands	Existing housing	Nederlandsche Bank
Norway	Nationwide index	Statistics Norway
Spain	Price per square metre, >2-year old housing	Banco de España
UK	Weighted average of housing types	CLG
Sweden	Properties with 1-2 housing units	Statistics Sweden
Germany	Resale prices	Deutsche Bundesbank
USA	Index of single-family homes	FHFA

APPENDIX D: BASIS FOR THE HOUSING-BURDEN INDICES

Here we document the basis for the housing-burden indices shown and discussed in section 5. The point of departure is a single-family house of 140 square metres with a plot of 1,860 square metres (the average area in 2001).

By way of introduction, we repeat the expression of the housing-burden index presented in Box 5.4, where the housing burden *B* was defined as follows:

$$B = \frac{E\left(V^e\right) + G\left(g, V^g\right) + \sum_i w_i R\left(r^i, t, repay, P^h\right)}{Y},$$

where the property value tax *E* is a function of the public property valuation V^e, land tax *G* is a function of the land tax per thousand *g* and the taxable land value V^g, while the total financing payment is a weighted sum of the *i* relevant loan products with financing payments *R*, depending on the specific rate of interest r^i, the capital income tax rate *t*, the repayment profile *repay* and the nominal house price P^h. Finally, *Y* is household disposable income.

The housing-burden index for Denmark as a whole

We calculate four different indices based on national averages, i.e. fixed and adjustable-rate loans with and without amortisation. First, a number of time series are stated, which are the same for all four indices and based on a single-family house:[1]

- The price per square metre P^h is derived from the statistics of the Association of Danish Mortgage Banks.
- The public property valuation V^e is calculated by adjusting the price per square metre by the ratio of the property's purchase price to the property value as calculated by Statistics Denmark. The property value tax *E* is then calculated as 1 per cent of the property valuation up to the 1st quarter of 2002, after which time it is kept constant.
- Land tax *G* is calculated based on the land tax rate *g*, compiled by Statistics Denmark, and the land value V^g, calculated on the basis of the valuation statistics of the Danish Customs and Tax Administration (Skat).
- Total household disposable income is based on data from Statistics Denmark. Total income is compared with the number of households according to Statistic Denmark's annual data, interpolated linearly to quarterly figures.

As mentioned above, we calculate four different financing payments. In all four cases, we assume that a fully leveraged home purchase is involved, distributed by 80 per cent ($w_i = 0.8$) on a mortgage loan as stated below and 20 per cent ($w_i = 0.2$) on a 30-year annuity loan at the banks' average lending rates for housing purposes, as calculated by Danmarks Nationalbank. The four different types of bond are:

[1] All series are seasonally adjusted except for interest rates and the ratio of the property's purchase sum to the property value.

1. *Fixed-rate loan with amortisation*: The payment is based on a 30-year annuity loan at the 30-year mortgage bond yield calculated by Danmarks Nationalbank.
2. *Adjustable-rate loan with amortisation*: The payment is based on a 30-year annuity loan at the Association of Danish Mortgage Banks' weighted yield to maturity for 1- and 2-year adjustable-rate loans.
3. *Fixed-rate loan without amortisation*: The payment is the 30-year mortgage bond yield calculated by Danmarks Nationalbank.
4. *Adjustable-rate loan without amortisation*: The payment is the Association of Danish Mortgage Banks' weighted yield to maturity for 1- and 2-year adjustable-rate loans.

The housing-burden index for different parts of Denmark

A housing index, based on a fixed-rate loan with amortisation, is calculated for each part of the country. The sources of the time series used are identical to the sources used for Denmark as a whole. However, for some series, other calculations have been carried out to obtain observations for parts of Denmark.

- The ratio of the property's purchase price to the property value, used to calculate public property valuation on the basis of the price per square metre, is based on weighted averages for the former counties until 2007. From 2007 onwards, Statistics Denmark's calculation of the purchase price for each part of the country is used.
- Land tax rates have also been calculated based on weighted averages for the former counties until 2007.
- The taxable land value is based on the valuation statistics of the Danish Customs and Tax Administration (Skat) for single-family houses at municipality level, which is available for odd years only. Even years are calculated by writing back data using the Danish Customs and Tax Administration's growth rates. Until the tax freeze in 2002, the taxable land value is equal to the assessed land value, lagged two years. After the tax freeze, it is equal to the lower of the assessed land value, lagged two years, and the latest taxable value, adjusted by the rate of adjustment for each part of the country, calculated by the Ministry of Taxation.
- Household disposable income, distributed on the different parts of Denmark, is based on annual data from Statistics Denmark, interpolated linearly to quarterly figures based on the growth rate for the disposable income of Denmark as a whole. The income of the different parts of the country is divided by the number of households, calculated by Statistics Denmark on an annual basis and interpolated linearly to quarterly figures.