Can House-Price Fluctuations be Dampened?

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1. INTRODUCTION AND SUMMARY

Historically, real prices of owner-occupied housing have shown very large fluctuations. In this article we describe the costs to the whole economy generated by house-price fluctuations, followed by a discussion of various economic-policy measures to dampen the price fluctuations.

The housing supply can only be changed at a slow rate through new construction and wearing down of the existing housing stock. Hence, changes in house prices invariably have a significant impact on the creation of equilibrium between supply and demand in the market for owner-occupied housing when housing demand fluctuates as a result of e.g. changes in interest rates and incomes. Our analysis shows, however, that the house-price fluctuations necessary to ensure equilibrium in the housing market can be reduced through a more appropriate set of rules for housing taxation and financing.

In section 2, we describe the economic costs caused by large house-price fluctuations, with particular emphasis on experience from the "housing bubble" of the previous decade. Property value tax was frozen at the beginning of 2002, and deferred-amortisation mortgage loans were introduced in the autumn of 2003. As a result of these measures, house-price increases during the boom years and the subsequent price drop became much stronger than they would otherwise have been, thereby amplifying the cyclical fluctuations of the economy. A calculation using a macroeconometric model shows that lower unemployment and stronger public finances might have been expected in the coming years if the deferred-amortisation mortgage loans had not been introduced and property value tax had not been frozen. We also show that large house-price fluctuations imply microeconomic welfare costs, as homeowners – due to the combination of strong unexpected price movements and heavy costs of moving – may find themselves fixed in a different housing consumption situation than what they would have preferred in view of the house prices applicable from time to time. Finally, we point out that large house-price fluctuations may lead to significant and often arbitrary redistribution of incomes and wealth.

Section 3 discusses whether it is possible to smooth large house-price fluctuations through more appropriate planning of general monetary and fiscal policy. We point out that Danish monetary-policy interest rates must follow monetary-policy interest rates in the euro area to keep the krone stable against the euro. Accordingly, Denmark's interest-rate policy cannot be planned with a view to dampening Danish house-price fluctuations, even if it might be desired to use monetary policy for this purpose. We also find that while a systematic countercyclical fiscal policy might to some extent dampen house-price fluctuations, it would require an unrealistically high level of fiscal-policy tightening to combat bubble trends in the housing market solely via fiscal policy. The rest of the article therefore focuses on other instruments to reduce house-price volatility.

In section 4 we find, based on various methods of analysis, that the freeze on nominal property value tax may have increased average house-price fluctuations by between one fifth and one fourth. The freeze also implies that the effective property value tax (adjusted for inflation) will fall during periods of economic boom, while on the other hand it tends to increase during downturn periods, thereby amplifying the cyclical fluctuations. Against this background, we discuss the effects of lifting the freeze and restoring the link between property value tax and the current property valuation. If the property value tax rate is adjusted at the same time, thereby preventing a short-term increase in the overall taxation level, lifting the freeze will have no significant adverse impact on house prices in the short to medium term. In the longer term, restoring the link between property value tax and house prices will contribute to stabilising the housing market and the economy and to preventing further weakening of government finances.

In section 5 we point out that the introduction of deferred-amortisation loans has increased house-price instability to an even greater extent than the freeze on property value tax. This speaks in favour of future mortgage loans for owner-occupied housing being granted solely with amortisation. Like lifting the freeze on property value tax, such a reform would reduce long-term fluctuations in the housing market. By ensuring the build-up of larger home equity, phasing out deferred-amortisation mortgage loans would also reduce the vulnerability of homeowners and society at large to unexpected negative shocks to the housing market. To avoid putting too much pressure on the housing market in the short term, access to deferred-amortisation loans should be phased out slowly, e.g. by reducing, over a period of time, the credit limit for new deferred-amortisation mortgage loans by 10 percentage points annually. Our analysis shows that this will only dampen house prices to a limited extent

in the next few years. Our calculation of the long-term impact on house-price fluctuations is based on complete phasing-out of access to deferred-amortisation mortgage loans. In connection with the preparation of a specific proposal, maintaining limited access to this type of loan might be considered if it can be done without compromising the above objectives of the measure.

Section 5 also analyses whether a cyclical restriction of access to the use of adjustable-rate loans and deferred-amortisation loans may contribute to dampening house-price fluctuations. In principle, such cyclical restrictions may reduce fluctuations in the housing market, but there is a significant risk that the timing and dosing of such measures will be wrong because of insufficient information about the current situation in the housing market and uncertainty about the long-term equilibrium level for house prices. Cyclical "loan brakes" should therefore be implemented only when there is an obvious risk that the housing market would otherwise be overheated, and it might be preferable to let the decision or recommendation to implement credit restrictions be up to an independent institution with the necessary expertise.

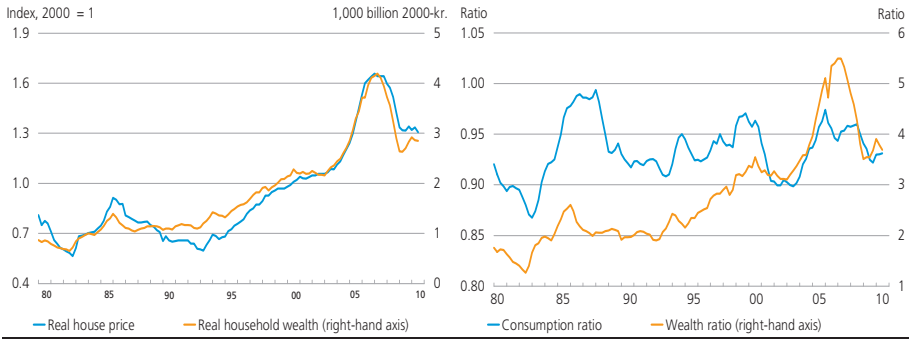
2. SOCIAL COSTS OF HOUSE-PRICE FLUCTUATIONS

Macroeconomic costs of fluctuating house prices

House-price fluctuations generate costs to society by amplifying cyclical fluctuations in economic activity. As shown in the previous article by Dam et al. (2011) in this *Monetary Review*, there is usually a close link between house-price developments and residential investment: the larger the house-price fluctuations, the more unstable the building activity. Variations in house prices have also turned out to be the most important source of fluctuations in the value of household wealth which is one of the drivers of private consumption, cf. Chart 2.1. Rising house prices may thus stimulate private consumption through increasing wealth, whereas consumers will suffer a loss of wealth as a result of falling house prices, encouraging them to rebuild wealth by increasing their savings.

The negative macroeconomic impact of large house-price fluctuations is sometimes amplified by the fact that such fluctuations may also jeopardise financial stability. Strong price increases may be accompanied by unsustainably high credit growth, and banks and mortgage institutes may incur heavy losses on their debtors in the subsequent downturn with price drops, which may force them to tighten their credit standards. This will deepen and prolong the downturn, cf. the article by Abildgren and Thomsen (2011) in part 1 of this *Monetary Review*.

HOUSE PRICES, WEALTH DEVELOPMENT AND PRIVATE CONSUMPTION Chart 2.1



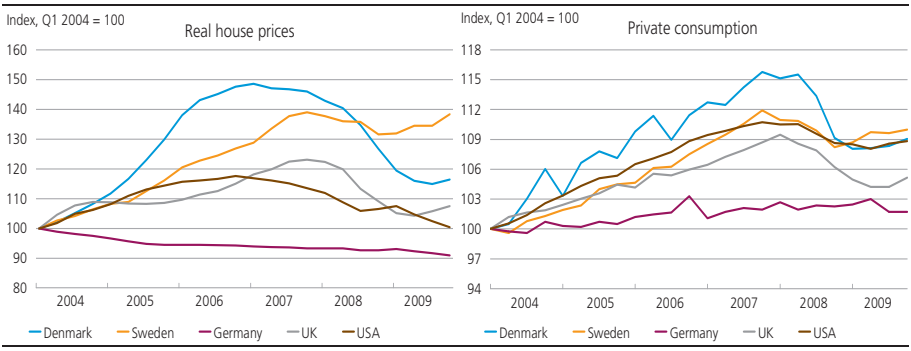
Note: Households' wealth (including estimated after-tax value of total pension savings). In the left-hand chart the house price of single-family houses and household wealth are deflated by the price of private consumption. The right-hand chart shows private consumption and household wealth as a ratio of households' disposable income, including payments to collective pension schemes. The consumption ratio is shown as a four-quarter moving average.

Source: Statistics Denmark and Danmarks Nationalbank.

Experience from the last decade also illustrates the high costs of fluctuating house prices. Chart 2.2 (left-hand side) shows a somewhat faster pace of house-price inflation in the middle of the last decade in Denmark than in its four most important trading partners (Germany, Sweden, the UK and the USA). Presumably, the explosive rise in Danish house prices and the subsequent steep decline are the most significant reasons why private consumption development in Denmark in the 2000s was more unstable than in other countries, cf. Chart 2.2 (right-hand side).

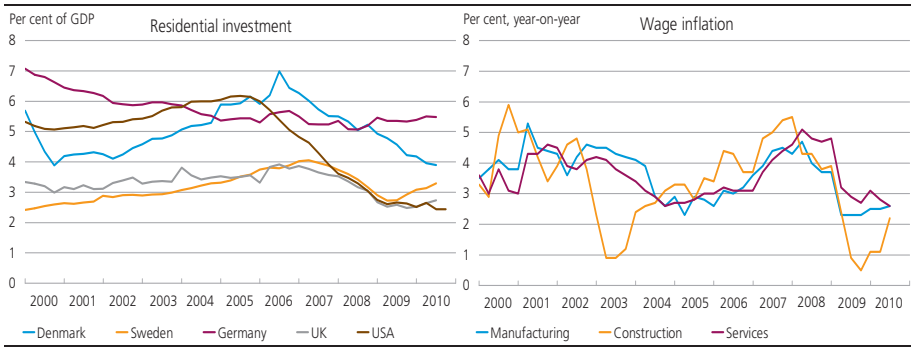
The surge in house prices up to 2007 created a strong construction boom. Residential investment as a ratio of GDP consequently reached a higher level in Denmark than in its most important trading partners, cf. Chart 2.3 (left-hand side). As shown in Chart 2.3 (right-hand side), the

REAL HOUSE PRICES IN DENMARK AND ABROAD (LEFT-HAND SIDE) AND PRIVATE CONSUMPTION IN DENMARK AND ABROAD (RIGHT-HAND SIDE) Chart 2.2



Source: OECD House Price Database and Reuters EcoWin.

RESIDENTIAL INVESTMENT AS A RATIO OF GDP IN DENMARK AND ABROAD (LEFT-HAND SIDE) AND WAGE INCREASES IN DENMARK (RIGHT-HAND SIDE) Chart 2.3



Source: Reuters EcoWin and the Confederation of Danish Employers.

strong demand for labour in the construction sector meant that for a period of time that sector took the lead as regards wages, which may have pushed up wage inflation in the other sectors. The overheating of the construction sector contributed to the general overheating of the Danish economy prior to the financial crisis when demand was not just stimulated by rising house prices, but also by low interest rates and accommodative fiscal policy, cf. Pedersen and Sørensen (2009).

As demonstrated by Dam et al. (2011), the strong price rises up to 2007 were to a high degree driven by the introduction of adjustable-rate loans and deferred-amortisation loans and by the freeze on nominal property value tax as from the beginning of 2002. Chart 2.4 illustrates the impact of this policy on the housing market and its expected impact on macroeconomic developments. The figures are based on medium-term projections of the Danish economy and the implied expectations of house-price developments in the coming years, as presented in Dam et al. (2011). This scenario is compared with a counterfactual scenario where the new loan types had not been introduced and there had been no freeze on property value tax. According to the analysis in Dam et al. (2011), the real house price would then have developed as shown by the blue curve in Chart 2.4 (top left-hand side). The Chart uses MONA, Danmarks Nationalbank's macroeconometric model, to simulate the economic development in the medium-term projection and in the counterfactual scenario where the effects of the housing bubble in the previous decade are practically eliminated.[1]

[1] The simulated house-price development in the counterfactual scenario is based on the analysis behind Chart 3.4 in Dam et al. (2011). Our counterfactual model experiment is vulnerable to the Lucas critique according to which a change of economic-policy regime (e.g. the transition to a regime which ensures higher house-price stability) may influence expectations and thus economic behaviour in a way which traditional macroeconometric models do not take into account.

MACROECONOMIC CONSEQUENCES OF THE HOUSING BOOM IN THE 2000S

Chart 2.4

Note: Own estimates based on MONA with new relations for house price and residential investment, cf. Dam et al. (2011). The baseline scenario is based on the forecast published in this Monetary Review, Part 1, with a technical projection for 2014-15, cf. Dam et al. (2011, section 5). The counterfactual scenario is based on the assumptions that deferred-amortisation loans and adjustable-rate loans were never introduced, and that property value tax was not frozen in 2002. These assumptions are followed up by a proportional correction of the unexplained residuals in house-price development from 2004 onwards, cf. the discussion in Dam et al. (2011, section 3).

Source: Danmarks Nationalbank.

It appears from Chart 2.4 that in the absence of a housing boom, unemployment would have been higher in the mid-2000s. On the other hand, competitiveness would have developed more favourably, resulting in stronger exports in the coming years, cf. the two lower parts of the Chart. The model calculations behind Chart 2.4 also indicate that the housing boom contributed significantly to a general boom in corporate investment, which will reduce demand for labour in the coming years because expansion of the capital stock to some extent replaces the need for labour in production. Together with the weakening of competitiveness, this explains why the housing boom will lead to higher unemployment in the coming years than might otherwise have been expected. Fluctuations in unemployment have thus been amplified by the housing boom: it pushed unemployment further down during a period when unemployment was already far below the sustainable structural level, and subsequently it seems to have increased unemployment in the wake of the international financial crisis which in itself generated a strong rise

in unemployment. In addition, the freeze on property value tax has weakened public finances. According to the model calculation, the freeze, viewed in isolation, results in a loss of public revenue of approximately kr. 10 billion in 2015, taking into account the derived effects on the economy. This revenue loss makes public spending cuts or higher taxes in other areas more imperative.

Microeconomic costs of fluctuating house prices

Not only do unstable house prices create macroeconomic instability, they may also lead to conversion costs for employees and firms. Large price fluctuations thus cause residential construction to fluctuate more than total output. This triggers a number of adjustment and conversion costs when the construction sector seeks to attract additional resources when construction is booming, and when spare resources are to be channelled from construction to other sectors during recessions when new residential construction has hit rock bottom.

In addition, house-price fluctuations may force consumers to adopt different patterns of consumption than they would actually have preferred. Fluctuating house prices lead to fluctuations in the user cost[1] of owner-occupied housing. If no costs were involved in changing housing consumption, individual households would be able to adjust their housing consumption immediately to changes in the user cost. In practice, moving to another home involves considerable costs in the form of money and time consumption, and people who move may also experience psychological costs because of their attachment to the place where they live. Due to these costs, many consumers will be "tied" to their existing housing consumption even though they would have chosen a different standard of accommodation if the current user cost had applied when they bought their home.

Accordingly, as a result of house-price fluctuations, many consumers may end up spending more or less than they actually want on housing consumption rather than other consumption. The Appendix explains how to quantify the resulting loss of welfare for consumers. The analysis shows that, among other factors, this loss of welfare is dependent on real house-price volatility and the correlation between house prices and interest rates. All other things being equal, the larger the house-price fluctuations, the larger the loss of welfare will be. According to the analysis, house-price fluctuations and their interaction with fluctuations

[1] The user cost equals the real house price multiplied by a factor consisting of the real interest rate after tax plus housing-related taxes and maintenance costs, where costs for taxes and maintenance are calculated per krone of property value. The user cost is thus a measure of the economic cost of owning a home.

in interest rates may have caused homeowners an average annual loss of welfare of up to 2 per cent of the value of owner-occupied housing consumption (corresponding to approximately kr. 2.5 billion in 2009 prices) due to the costs involved in adjusting housing consumption to changed house prices.[1]

House-price fluctuations and distribution of income

Due to the large fluctuations in house prices, periods of large real capital gains on owner-occupied housing are sometimes replaced by periods of large and often unforeseen capital losses. Such gains and losses may have a considerable impact on the distribution of consumption opportunities. For example, increases in house prices were substantially higher in the Copenhagen area than in the rest of Denmark up to 2007. So while an average household in Copenhagen and environs obtained tax cuts of approximately kr. 25,000 by virtue of the freeze on property value tax, the tax cuts obtained by an average household in northern Jutland amounted to only approximately kr. 5,000, cf. Chart 3.6 in Dam et al. (2011).

At the microeconomic level, such fluctuations may lead to more arbitrary redistribution depending on when individual households enter or exit the market for owner-occupied housing. Personal or family circumstances may often reduce an individual's flexibility to choose when to purchase or sell a home. The reduced flexibility is amplified by the fact that in many cases the market for rental housing functions poorly due to the regulation of rents, resulting in long waiting lists. Purchasing a home when prices are high or low can have quite a decisive impact on an individual's private finances and wealth. Large house-price fluctuations may thus lead to more or less arbitrary wealth redistribution across generations and regions, and between owners and tenants. All in all, this "housing lottery" entails unpredictable redistribution which counters the attempts of the political system to ensure more consistent smoothing of consumption opportunities, e.g. via the taxation and transfer system.

3. HOUSING MARKET, CYCLICAL FLUCTUATIONS AND STABILISATION POLICY

As we have seen, large house-price fluctuations may entail substantial economic costs. In this section we discuss whether it is possible to

[1] As explained in the Appendix, the estimated loss of welfare mentioned must be presumed to be on the high side.

dampen house-price fluctuations by changing the stance of macroeconomic stabilisation policy.

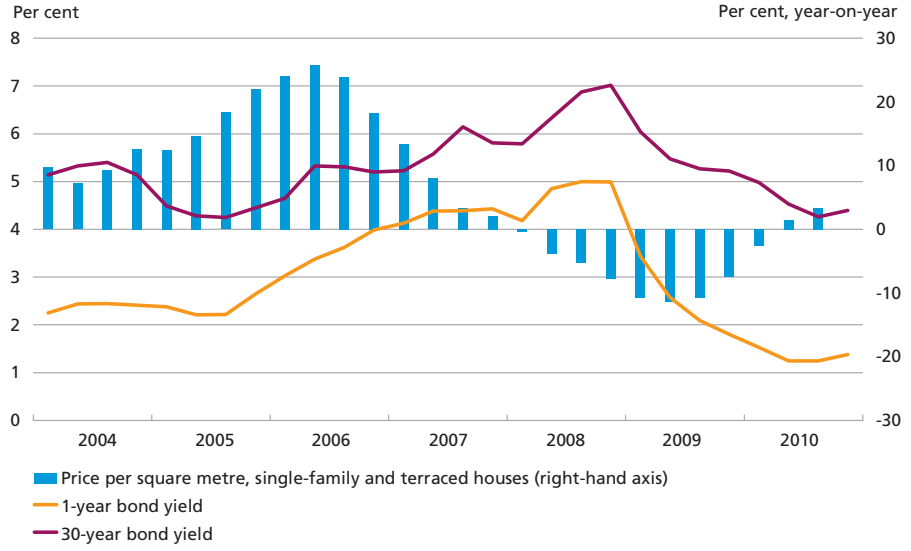
The extent of short-term house-price fluctuations is dependent on the size of the owner-occupied housing demand shocks to which the market is regularly exposed as well as the change in house prices required to restore short-term equilibrium in the market for owner-occupied housing when it is exposed to a shock of a given size.

As housing demand is determined by the development in total incomes, among other factors, shocks to the housing market may be dampened through a counter-cyclical macroeconomic stabilisation policy which reduces fluctuations in total output and employment.

However, experience from both Denmark and abroad clearly indicates that the general ability of monetary and fiscal policy to stabilise the housing market is insufficient. As a result of the fixed-exchange-rate policy, Danish monetary-policy interest rates are pegged to monetary-policy interest rates in the euro area. This does not leave Danmarks Nationalbank much scope for applying interest-rate adjustments as an instrument to counter undesirably large house-price fluctuations.

This issue is illustrated in Chart 3.1, showing the development in house prices and mortgage yields in the second half of the last decade. It is seen that mortgage yields declined throughout most of 2004 and 2005 which saw a considerable acceleration in the rate of house-price increases. The development in interest rates thus contributed to amp-

INTEREST RATES AND HOUSE PRICES — Chart 3.1



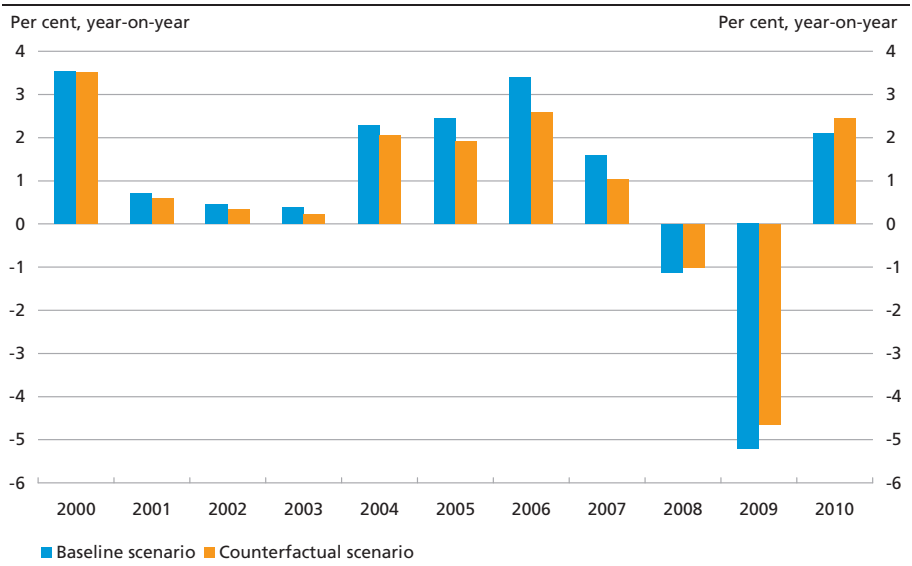
Source: Statistics Denmark and Danmarks Nationalbank.

lifying the unsustainable rise in house prices during that period. It also appears that even though house prices began to fall around the turn of the year 2007-08, interest rates continued to rise throughout most of 2008 due, among other factors, to Danmarks Nationalbank's obligation to defend the krone through interest-rate increases during the financial crisis in the autumn of 2008, thereby amplifying the housing market downturn.

Since monetary policy in Denmark is designed to keep the krone stable against the euro, Danish macroeconomic stabilisation policy must be implemented via fiscal policy. But as Chart 3.2 illustrates, rather tight fiscal-policy measures may be required to smooth the GDP fluctuations resulting from fluctuations in the housing market. The Chart shows the actual GDP growth rates in the Danish economy during the period 2000-10 compared with the growth rates which we would have experienced, according to the model calculation behind Chart 2.4, if the housing market had not been exposed to the fluctuations ensuing from the introduction of new loan types and the freeze on property value tax.

We see from Chart 3.2 that the housing boom and the subsequent downturn in the housing market led to a significant increase in growth rate fluctuations, cf. also the discussion in section 2. For example, the

SIGNIFICANCE OF THE HOUSING MARKET TO GDP GROWTH — Chart 3.2



Note: Own estimates based on MONA with new relations for house price and residential investment. The baseline scenario is based on the forecast published in this Monetary Review, supplemented with a technical projection for 2014-15, cf. Dam et al. (2011, section 5). The counterfactual scenario is based on the assumptions that deferred-amortisation loans and adjustable-rate loans were never introduced, and that property value tax was not frozen in 2002. These assumptions are followed up by a proportional correction of the unexplained residuals in house-price development as from 2004, cf. the discussion in Dam et al. (2011, section 3).

Source: Danmarks Nationalbank.

housing bubble resulted in additional GDP growth of 0.6 percentage points in 2007, virtually all of which was, at that point in time, attributable to the effects of deferred-amortisation loans and the freeze on property value tax. In order to neutralise this driver of growth, which occurred at an unfortunate time when the economy was already overheated, fiscal policy should have been tightened by the equivalent of a negative 1-year fiscal effect of about 0.5 per cent of GDP, i.e. quite a significant tightening.

As mentioned in section 2, stronger general cyclical fluctuations were not the only cost of large house-price fluctuations. Yet, much tighter fiscal-policy measures than those mentioned above would have been needed to halt the skyrocketing house prices in the middle of the last decade. This can be illustrated by a calculation based on the house-price relation for the Danish housing market estimated in Dam et al. (2011). A permanent drop of e.g. 6 per cent in household disposable income (achieved e.g. by raising taxes) would lead to house prices falling by 10 per cent in the medium term. Since the estimated relation entails that the full price reaction will not occur for a number of years, the income reduction must be considerably larger, up to 20 per cent, if the 10 per cent price drop is to be felt within two years. This would require strong fiscal-policy tightening measures, which would trigger a deep economic recession. The calculation is put into further perspective by the fact that it concerns a dampening of house prices of "only" 10 per cent. By way of comparison, real house prices rose by as much as 36 per cent from the 1st quarter of 2005 to the 4th quarter of 2006.

Experience from abroad in recent years also shows very clearly that a successful macroeconomic stabilisation policy will not in itself prevent large fluctuations in the housing market. In the OECD countries, the period from the late 1980s to the impact of the financial crisis on the real economy in the late 2000s has been referred to as the "Great Moderation", because it was characterised by fairly limited fluctuations in output and employment and relatively low and stable inflation. This favourable development is often attributed to a period of successful stability-oriented monetary policy in the major countries. Despite the general macroeconomic stability, a large number of countries did not manage to avoid unsustainably strong house-price increases followed by a severe downturn in the housing markets which had a strong negative impact on the dramatic recession in 2008-09. In fact, the long preceding period of macroeconomic stability may even have contributed to amplifying the fluctuations in the housing market by promoting the assumption that periods of plunging house prices were a thing of the past, thereby causing the risk elements of residential investment to be underestimated.

Since general macroeconomic stabilisation policy does not provide sufficient opportunities to stabilise the housing market, the two subsequent main sections focus on the question whether it is possible via economic policy to affect the structure of the housing market in such a way as to cushion the reaction of house prices to shocks to the market.

4. HOUSING TAXATION AND HOUSE-PRICE FLUCTUATIONS

As demonstrated by van den Noord (2005), among others, the reaction of house prices to housing demand shocks is dependent on the tax system. Under the tax rules in many OECD countries, including Denmark, interest on mortgage debt is deductible (in countries other than Denmark there is often a ceiling on permissible interest deductions, however). Mortgage interest tax relief reduces homeowners' costs of financing housing purchases, meaning that increases in house prices have a lower impact on current housing costs. Accordingly, mortgage tax relief causes housing demand to be less sensitive to house-price fluctuations. If more people wish to purchase a home due to an increase in total incomes, a higher increase in house prices is required to restore equilibrium in the housing market as a result of the mortgage tax relief. Box 4.1 further explains and illustrates this mechanism.

While the mortgage tax relief increases house-price volatility, all other things being equal, residential property taxation will have the opposite effect to the extent that taxes are levied on the basis of current property values and thus adjusted in step with the development in house prices. If an increase in house prices results in higher housing tax, such an increase will have a more significant impact on housing costs, causing housing demand to be more sensitive to house-price increases. Hence, housing taxes which follow the development in property values will reduce the house-price fluctuations caused by housing demand shocks.

The total effect of the tax system on house-price volatility is thus dependent on the total tax subsidy for owner-occupied housing consumption which is given as

$$\text{tax subsidy} = t \cdot r - s, \tag{1}$$

where r is the nominal interest rate before tax, t is the capital income tax rate which determines the tax value of the mortgage tax relief, and s is housing-related taxes as a ratio of the current property value. The tax subsidy in (1) indicates the total reduction of the user cost of owner-occupied housing consumption compared with a situation without tax. It should be noted that the tax subsidy for housing consumption is given in

HOUSE-PRICE FLUCTUATIONS AND TAX SUBSIDIES Box 4.1

In the following we show how tax subsidies for owner-occupied housing consumption causes larger fluctuations in the prices of owner-occupied housing. The real user cost of owner-occupied housing (bp) can be expressed as follows

$$bp = p^h \cdot u, \qquad u \equiv r - \pi + d - \pi^h - \left(t \cdot r - s\right), \tag{1}$$

where p^h is the real house price, r is the nominal interest rate, π is the general rate of inflation, d is the necessary costs for housing repairs as a ratio of the current property value, π^h is the expected real rate of increase in house prices (the expected real capital gain), t is the capital income tax rate, and s is housing-related taxes as a ratio of the current property value. The quantity $t \cdot r - s$ constitutes the tax subsidy for owner-occupied housing consumption, given that $t \cdot r$ indicates the tax value of the mortgage tax relief. If $t \cdot r - s$ is positive, the tax system reduces the user cost of owner-occupied housing relative to a situation without taxes.

Now assume that in accordance with the empirical analysis in Dam et al. (2011) owner-occupied housing demand K^D is an increasing function of the user cost and a decreasing function of the real disposable income *Y*, so that

$$K^D = K\left(bp, Y\right) = K\left(p^h u, Y\right), \qquad K_p < 0, \quad K_Y > 0, \tag{2}$$

where K_p and K_Y are the partial derivatives of the housing demand function $K(\bullet)$ in terms of the user cost and income, respectively. Equations (1) and (2) can be used to illustrate the short-term effect on the house price p^h of a change in housing demand stemming from a change in income. By linearising (2) (and keeping *u* constant), we find that

$$\Delta K^D = K_b \cdot u \cdot \Delta p^h + K_Y \cdot \Delta Y, \tag{3}$$

where the operator Δ indicates a change in the following variable. In the short term, the total supply of owner-occupied housing is approximately constant. To restore short-term equilibrium in the housing market after a change in income, the house price must therefore be adjusted to ensure that the total change in owner-occupied housing demand equals zero $\left(\Delta K^D = 0\right)$. If this condition is inserted in (3), the outcome after rearrangement is the following change in the house price that ensures equilibrium:

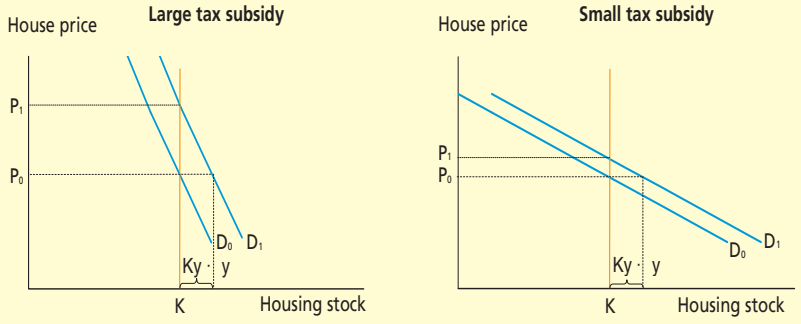
$$\Delta p^h = -\left(K_Y / uK_b\right) \cdot \Delta Y. \tag{4}$$

Equation (4) shows that the lower the normalised user cost *u*, i.e. the larger the tax subsidy $t \cdot r - s$ in equation (1), the larger will be the short-term change in the house price as a reaction to a change in income. The intuitive explanation of this outcome is given in the main text. Chart 4.1 provides a supplementary graphical explanation of the outcome. The vertical lines marked by $\overline{K}$ indicate the supply of owner-occupied housing which is completely inelastic in the short term when the housing stock is given. The declining curves marked by *D* are housing demand curves where the slope is $1/uK_b < 0$ according to equation (3). So the lower *u* is, i.e. the larger the tax subsidy for owner-occupied housing, cf. (1), the steeper will be the slope of the housing demand curve.

CONTINUED Box 4.1

Chart 4.1 illustrates a situation where income increases by the amount ΔY . According to (3), this will shift the housing demand curve to the right by the distance $K_Y \cdot \Delta Y$. This means that in the short term when housing supply is given, equilibrium in the housing market can only be restored if the house price increases from p_0^h to p_1^h , as shown in Chart 4.1. In the left-hand side of the Chart, the tax subsidy for owner-occupied housing consumption is assumed to be substantial, resulting in a steep housing demand curve. As a consequence, we see that an increase in income will trigger a large increase in the house price. In the right-hand side of Chart 4.1 a limited tax subsidy results in a flatter housing demand curve. In this situation we see that the same increase in income will result in a somewhat smaller increase in the house price.

SHORT-TERM ADJUSTMENT OF THE HOUSING MARKET TO DEMAND SHOCKS Chart 4.1



Equation (4) can be converted to

$$\frac{\Delta p^h}{p^h} = \frac{\varepsilon_Y}{u\eta_u} \cdot \frac{\Delta Y}{Y}, \qquad (5)$$

$$\varepsilon_Y \equiv \frac{\partial K}{\partial Y}\frac{Y}{K}, \qquad \eta_u \equiv -\frac{\partial K}{\partial u}\frac{1}{K} = -p^h \cdot \frac{\partial K}{\partial bp}\frac{1}{K},$$

where ε_Y is the income elasticity of housing demand, and η_u is the semi-elasticity of housing demand in terms of the normalised user cost. Accordingly, the parameter η_u indicates the relative change in housing demand when the normalised user cost defined in (1) is changed by 1 percentage point. In equation (5) house-price volatility is measured in terms of the relative change in the house price as a function of the relative change in income. It follows from the definition of η_u that the quantity $u\eta_u$ equals the elasticity of housing demand in terms of the user cost. As *u* is declining in the tax subsidy for owner-occupied housing, equation (5) thus shows that the relative fluctuations in house prices are amplified by increasing tax subsidies if the price elasticity of housing demand is an increasing function of the normalised user cost. This will be the case e.g. if the semi-elasticity η_u is constant. The housing demand relation estimated in Dam et al. (2011) meets this condition.

(1) whether or not (part of) the housing purchase is financed out of the homeowner's own funds. The reason is that the taxation of interest income reduces the yield that the homeowner might otherwise have obtained by placing his funds in interest-bearing assets. Accordingly, the taxation of interest reduces the opportunity cost of investing funds in an owner-occupied home, which is captured by the term $t \cdot r$ in (1), where t is the relevant marginal rate of tax on positive net capital income in respect of persons with positive financial net worth.

Van den Noord (2005) has calculated the size of the tax subsidy in (1) in a number of European OECD countries where comparable data were available and compared the subsidy with house-price volatility in the period 1970-2001.[1] According to van den Noord, it is clear that countries providing a higher tax subsidy for owner-occupied housing consumption tend to have experienced larger house-price fluctuations. In cooperation with van den Noord we have extended his analysis to cover the whole period from the beginning of 1970 to the end of 2009, incorporating data for Denmark that was not included in the original analysis. The size of the tax subsidy for owner-occupied housing consumption in individual countries is measured on the basis of the tax rules in 1999. This implies a certain degree of imprecision, as the tax rules in most countries, including Denmark, have changed over time. House-price volatility is measured by the average percentage deviation of real house prices from the underlying trend in each year of the period 1970-2009. Chart 4.2 illustrates how house-price volatility mirrors tax subsidy developments.

A regression analysis of the data plotted in Chart 4.2 shows that about 85 per cent of the difference in house-price fluctuations across countries can be explained by a simple regression equation of the form

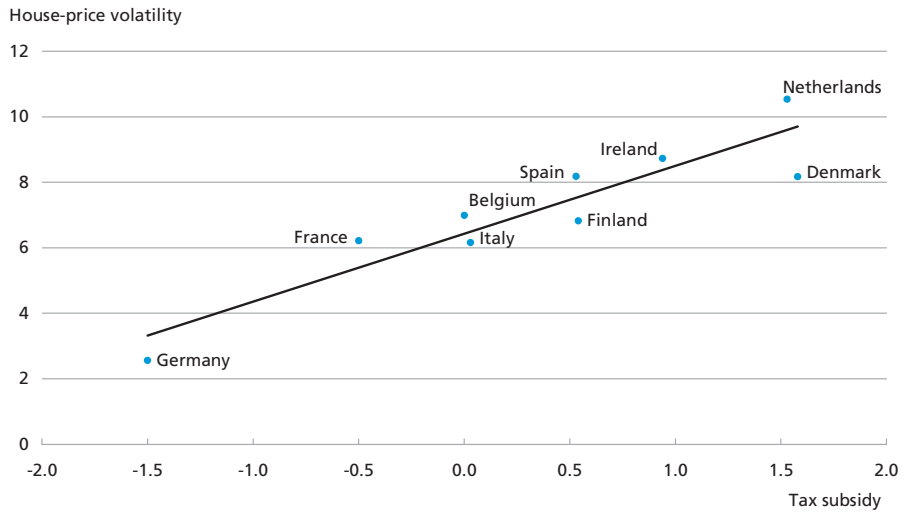
$$\sigma \approx 6.42 + 2.07 \cdot sub, \qquad (2)$$

where σ is house-price volatility, and sub is the tax subsidy defined in (1) in percentage points. The implications of equation (2) can be illustrated by an example. According to Chart 4.2, the tax subsidy for owner-occupied housing consumption in Denmark was just over 1.5 percentage points in 1999. According to (2), abolishing a tax subsidy of this size would reduce house-price volatility by just over 2 x 1.5 = 3 percentage points. This means that average house-price fluctuations around their long-term trend will be reduced from just over 8 to just over 5 percentage points.

[1] Van den Noord's analysis is based on data for Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands and Spain.

HOUSE-PRICE FLUCTUATIONS AND TAX SUBSIDIES IN SELECTED OECD COUNTRIES

Chart 4.2



Note: The tax subsidy for owner-occupied housing consumption is calculated in accordance with the tax rules and levels of interest rates in 1999. The regression line inserted is estimated using ordinary least squares ($R^2 = 0.847$).
Source: Data supplied by Paul van den Noord and own estimates for Denmark.

So, in accordance with the previously published study by van den Noord (2005), we see a systematic tendency for countries with a larger tax subsidy to have experienced larger house-price fluctuations around their long-term trend, which was to be expected based on the theoretical reasoning above.

Tax subsidies and house-price fluctuations in Denmark: What is the effect of the freeze on property value tax?

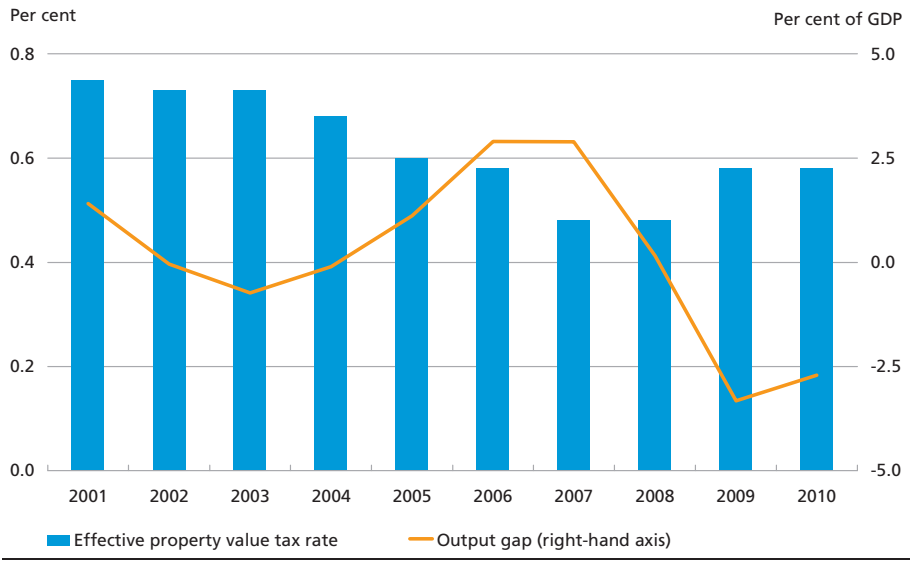
According to the analysis above, housing taxes will only dampen house-price fluctuations if a house price increase automatically triggers a tax increase and vice versa. In Denmark this automatic stabilisation mechanism has been deactivated for the time being with regard to government property value tax. This is attributable to the "nominal principle" of the tax freeze, which entails a freeze on property value tax in monetary terms. So, unlike the situation prior to the introduction of the tax freeze at the beginning of 2002, property value tax is no longer dependent on the current property value.[1]

[1] Specifically, the current form of the tax freeze implies that the calculation of property value tax is based on the *smallest* of the following three amounts: 1. The property valuation for 2001, subject to an addition of 5 per cent. 2. The property valuation for 2002. 3. The property valuation for the property concerned as at 1 October of the assessment year. In practice this means that property value tax constitutes a fixed nominal amount except in extraordinary cases when the current nominal property value falls below the 2001 level, subject to an addition of 5 per cent (or below the level in 2002).

Because of the freeze on nominal property value tax, real tax revenue is gradually eroded by inflation. Furthermore, the nominal principle implies that the effective property value tax rate (the tax share of the current property value) will decline when house prices go up, while on the other hand the effective tax rate will increase when house prices go down. As house-price fluctuations typically mirror the general cyclical developments, the nominal principle will therefore tend to amplify the cyclical fluctuations.

Chart 4.3 and Table 4.1 illustrate this. Chart 4.3 shows how the surging house prices in the mid-2000s led to a significant drop in the effective property value tax rate. This occurred during a period of soaring demand pressure as measured by the output gap (the percentage deviation between actual GDP and GDP under "normal" economic conditions) when dampening of demand was necessary to avoid overheating of the economy. The falling property value tax rate contributed to increasing demand pressure in several ways, however. Firstly, as result of the decrease in effective taxation, house prices increased more than they would otherwise have done. This created additional wealth increases which amplified the increase in private consumption, and the higher price increases also drove up residential investment. Secondly, due to the decrease in the effective property value tax rate, households obtained tax cuts which further stimulated private consumption. For example, it is

EFFECTIVE PROPERTY VALUE TAX RATE AND OUTPUT GAP — Chart 4.3



Note: The effective property value tax rate is calculated as revenue from property value tax as a ratio of the public valuation of the housing supply taxed in accordance with the "Law Model" of the Ministry of Finance. The output gap is estimated by the Ministry of Finance (2010).
Source: The Ministry of Economic and Business Affairs and the Ministry of Finance.

EFFECTS OF THE FREEZE ON PROPERTY VALUE TAX Table 4.1

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Property value tax of owner-occupied home valued at kr. 1.1 million in 2002	kr. 1,000 (2010 level)								
- with tax freeze	13	13	12	12	12	12	11	11	11
- without tax freeze	13	13	14	16	19	19	17	15	15
Total revenue from property value tax	kr. billion (2010 level)								
- with tax freeze	12	12	12	12	12	13	13	13	13
- without tax freeze	12	12	14	17	21	22	21	18	18

Note: The counterfactual property value tax in the situation without the nominal tax freeze is calculated on the basis of a simulated house-price development allowing for the fact that house prices would have been lower in a situation without a tax freeze. The simulation uses the house-price relation estimated in Dam et al. (2011). The tax revenue at 3 per cent property value tax on the value exceeding kr. 3,040,000 (2002 level) has been taken into account.

Source: The Central Tax Administration (SKAT), Statistics Denmark and own estimates.

evident from the two bottom rows of figures in Table 4.1 that at the height of the boom in 2006-07, households would have had to pay kr. 9 billion in extra property value tax (calculated at 2010 level), if the freeze on nominal tax payments had not been allowed to undermine the effective property value tax rate.

On the other hand, Chart 4.3 shows that the decline in house prices combined with the nominal principle of the tax freeze led to an *increase* in the effective property value tax rate in 2008 and 2009 as a result of the decline in house prices that started at the end of 2007. In parallel with this, it appears from Table 4.1 that the property value tax for a typical owner-occupied home would have *fallen* in 2008 and 2009 if there had been no freeze. So the freeze contributed to amplifying the sudden economic downturn which occurred in the wake of the international financial crisis.

Based on the analysis in the previous section, we can present a rough estimate of the contribution of the freeze to house-price volatility in Denmark. The point of departure is a calculation of the current tax subsidy for owner-occupied housing consumption, cf. (1). In Denmark, housing-related taxes consist of government property value tax and local-government land tax, which is charged on land values only. To adapt equation (1) to Danish conditions the expression of tax subsidy is therefore converted as follows:

$$\text{tax subsidy} = t \cdot r - D \cdot s^e - a \cdot s^g. \qquad (3)$$

The product $a \cdot s^g$ represents the effect of the land tax on the normalised user cost of owner-occupied housing where the parameter a indicates

the land tax proportion of the total property value, and s^g is the land tax rate. The quantity s^e is the effective property value tax rate which measures the property value tax as a ratio of the current property value. *D* is a dummy variable which assumes the value of 1 if the property value tax is charged on the current property value, and the value of 0 if the property value tax constitutes a fixed amount that is unrelated to the current property value, as has been the case in Denmark since the introduction of the tax freeze in early 2002. The inclusion of the dummy variable *D* is motivated by the analysis in Box 4.1, which showed that a housing tax will dampen house-price fluctuations only if it mirrors the development in house prices. Conversely, if the tax remains constant irrespective of the development in property values, as is currently the case with the Danish property value tax, it will not dampen the impact of shocks to housing demand on house prices. Hence, the effect of the nominal tax freeze on house-price volatility in Denmark can be analysed by changing the value of *D* in equation (3) from 1 to 0, as property value tax was charged on the most recent public property valuation before the introduction of the tax freeze.[1]

For persons with negative net capital income, the tax value of the mortgage tax relief is currently 33.5 per cent in an average local-government district. Therefore, in equation (3) we set $t = 0.335$. Moreover, we assume a nominal interest rate of 4 per cent ($r = 4$), which may be seen as an estimated average interest rate on short-term and long-term mortgage loans. The size of the tax subsidy for owner-occupied housing consumption implied in the income tax system then equals 0.335 x 4 = 1.34 per cent of the value of the property. In 2010, the average local-government land tax was 25.92 percentage points (i.e. $s^g = 2.592$). According to the most recent data available, land values for Denmark as a whole constitute approximately 29 per cent of the public property valuation of owner-occupied housing, and thus we set $a = 0.29$. In the year before the introduction of the tax freeze (2001) the effective property value tax rate was 0.75 per cent, cf. Chart 4.3. We therefore set $s^e = 0.75$.

By inserting these parameter values in (3), we find that the tax subsidy that is relevant to house-price volatility constitutes just under 0.6 percentage points of the property value under the current nominal tax freeze where $D = 0$. In a situation without a freeze on the nominal

[1] The tax subsidy measure set out here is relevant only when analysing the impact of the tax system on the volatility in house prices. When calculating the efficiency and revenue impacts of taxation, property value tax must always be recognised (i.e. *D*=1). On the other hand, it should also be borne in mind that property value tax, land tax and the tax value of the mortgage tax relief will to a large extent be capitalised in the price of land. Sørensen (2011) presents a method to calculate the efficiency and revenue impacts of tax subsidies while taking such capitalisation impacts into account.

property value tax ($D = 1$), where the effective property value tax rate applicable in 2001 had been maintained, the tax subsidy in (3) would have been reversed to a modest positive tax of approximately 0.15 percentage points.

By inserting these estimates for the variable *sub* in regression equation (2), we can present a rough estimate of the contribution of the nominal principle of the tax freeze to increasing real house-price fluctuations in Denmark. According to this calculation, house prices will on average deviate by just over 7.5 percentage points from their long-term equilibrium value as a result of the tax freeze on property value tax, whereas the average price deviation from the equilibrium value would only amount to 6 percentage points in the situation without a tax freeze. This means that the freeze on nominal property value tax has amplified the average annual house-price fluctuations by just over 1.5 percentage points, corresponding to an increase in house-price volatility of just over one fourth compared to a situation where a freeze had not been implemented.

These quantitative results should be interpreted with considerable caution as the underlying regression analysis is very simple and comprises only a limited group of OECD countries. In a recent OECD study, Andrews (2010) extended the previous analysis by van den Noord (2005) by including data for a larger number of OECD countries as well as more variables in addition to the tax subsidy to explain the differences in house-price volatility across countries. Andrews' quantitative analysis implies that a reduction of the tax subsidy by 0.75 percentage points – corresponding to the one analysed above – will reduce house-price volatility by just under 0.9 percentage points. The effect is smaller than the fall in volatility of just over 1.5 percentage points following from the simple regression analysis in (3), but it still constitutes a significant dampening of house-price fluctuations.

In order to assess the credibility of these quantitative results, it may be useful to examine the quantitative implications of an alternative calculation method based on the link that must be assumed to exist between the user cost and housing demand. The calculation method is described in Box 4.2.[1] In the numerical examples presented in the box, the freeze on property value tax increases house-price volatility to about the same extent as predicted by regression equation (2). It generally follows from the calculation method in Box 4.2 that the freeze leads to a higher increase in house-price volatility, the more the property value exceeds the progression limit for property value tax. Practical experience seems to

[1] This method is inspired by Møller (2005).

TAX FREEZE AND HOUSE-PRICE FLUCTUATIONS Box 4.2

In this box we show the effect of the nominal principle of the tax freeze on the size of the house-price fluctuations resulting from housing demand shocks.

Let B_0 and B_1 indicate the annual housing cost that the marginal home buyer is willing to pay for a home of a specific size and quality before and after a change in income, respectively. If the house price is P_0 and P_1, respectively, in the two situations, and if we reuse the notation from Box 4.1 and equation (3) in the main text, the following applies in a situation without a tax freeze

$$\frac{B_1}{B_0} = \frac{\left[r(1-t) + s^e + as^g + d\right]P_1}{\left[r(1-t) + s^e + as^g + d\right]P_0} \quad \Rightarrow \quad \frac{P_1}{P_0} = \frac{B_1}{B_0}. \tag{1}$$

The expressions in square brackets in (1) are the normalised user cost of owner-occupied housing consumption, which is the same before and after the house-price change in a situation without a tax freeze where the property value tax is charged on the current property value. Accordingly, equation (1) shows that a change in home buyers' willingness to pay – reflected in a change in the fraction B_1 / B_0 – will result in a proportionate change in the house price. For example, a 10 per cent increase in income which entails $B_1 / B_0 = 1,1$, will also cause a 10 per cent increase in house prices if interest and tax rates remain unchanged.

Now assume instead that there is a tax freeze which fixes the nominal property value tax payment at level E. Following the change in home buyers' willingness to pay, the house price must then satisfy the following relation:

$$\frac{B_1}{B_0} = \frac{\left[r(1-t) + as^g + d\right]P_1 + E}{\left[r(1-t) + as^g + d\right]P_0 + E}. \tag{2}$$

If $s_o^e \equiv E / P_0$ is defined as the effective property value tax rate applying at the outset, we find by rearrangement of (2) that

$$\frac{P_1}{P_0} = \frac{B_1}{B_0} + \left(\frac{B_1}{B_0} - 1\right)\left(\frac{s_o^e}{r(1-t) + as^g + d}\right). \tag{3}$$

Comparing (1) and (3) we see that in the situation with a tax freeze, fluctuations in the willingness to pay – i.e. fluctuations in the fraction B_1 / B_0 – will always result in larger house-price fluctuations measured as fluctuations in the fraction P_1 / P_0. It can also be inferred from (3) that the larger the part of the property value that exceeds the progression limit of the property value tax, the larger will be house-price volatility during a tax freeze, since s_o^e increases the more severely the property is affected by the progression.

The quantitative implications of the above formulas may be explained by a couple of numerical examples. Consider e.g. an owner-occupied home which has a value of kr. 1,000,000 from the outset, without a freeze on the property value tax, and for which the current maintenance costs amount to 1 per cent of the property value. At the plausible values of interest and tax rates assumed in the main text, the current annual housing cost of this property (or to be more precise: the user cost) will include interest expenditure after tax of 0.04 x (1-0.335) x 1,000,000 = kr. 26,600. To this should

CONTINUED Box 4.2

be added property value tax costs of 0.0085 x 1,000,000 = kr. 8,500, a land tax payment of 0.02592 x 0.29 x 1,000,000 = kr. 7,517, and maintenance costs of 0.01 x 1,000,000 = kr. 10,000. This generates annual housing costs after tax of kr. 52,617 in total.

Now assume that home buyers' willingness to pay increases by 10 per cent, e.g. as a result of increasing incomes, so that a buyer is willing to pay total current housing costs of 1.1 x 52,617 = kr. 57,879 kr. for the home concerned. In the absence of a nominal tax freeze, the property value tax and the other elements of the housing cost will vary proportionately with the current value of the home (possibly with a short delay in respect of the taxes and maintenance costs). As a consequence, a 10 per cent increase in the willingness to pay will also result in a 10 per cent increase in the value of the property, since the increase in the total housing cost will also be 10 per cent.

In case of a tax freeze, however, the property value tax will be fixed irrespective of any increase in the property value. Accordingly, a larger increase in the property price is required to generate a specific increase in the housing cost. In our example where the marginal home buyer is willing to increase his total annual housing cost by 10 per cent from kr. 52,617 to kr. 57,879, and where the property value tax is frozen at kr. 8,500 because of the tax freeze, the property price must therefore increase to the extent that the cost of interest, land tax and maintenance increases to kr. 57,879 - 8,500 = 49,379. Hence, the property price must increase from kr. 1,000,000 to about kr. 1,119,700, or just under 12 per cent. In comparison, the price would only have to increase by 10 per cent in the situation without a tax freeze. In the example, the freeze on property value tax consequently increases house-price volatility by just under one fifth, or almost 20 per cent. This estimate is almost identical with the estimate based on the regression equation (2) in the main text.

For properties with a value that exceeds the progression limit for property value tax, the nominal tax freeze has had a stronger effect on house-price volatility according to formula (3). If e.g. 25 per cent of the property value exceeds the limit of kr. 3,040,000 where the property value tax constitutes 3 per cent of the marginal property value, and if we stick to the previous assumptions concerning interest and other tax rates, etc., formula (3) shows that the freeze on property value tax has increased the price volatility for such a property by just over 30 per cent.

confirm this. As demonstrated by Dam et al. (2011), the last decade has shown a clear tendency for larger house-price fluctuations in the "expensive" parts of Denmark where, prior to the introduction of the tax freeze, a considerable number of properties were taxed at 3 per cent of the value increase due to the progressive element of the property value tax.

Stability-oriented property value taxation

Econometric analyses as well as simple reflections on the link between housing costs and house prices support the impression that for property value tax the nominal principle of the tax freeze has contributed signi-

ficantly to increasing house-price fluctuations. So the introduction of the nominal principle has dismantled an important automatic tax stabiliser, cf. also the discussion in connection with Chart 4.3 and Table 4.1.

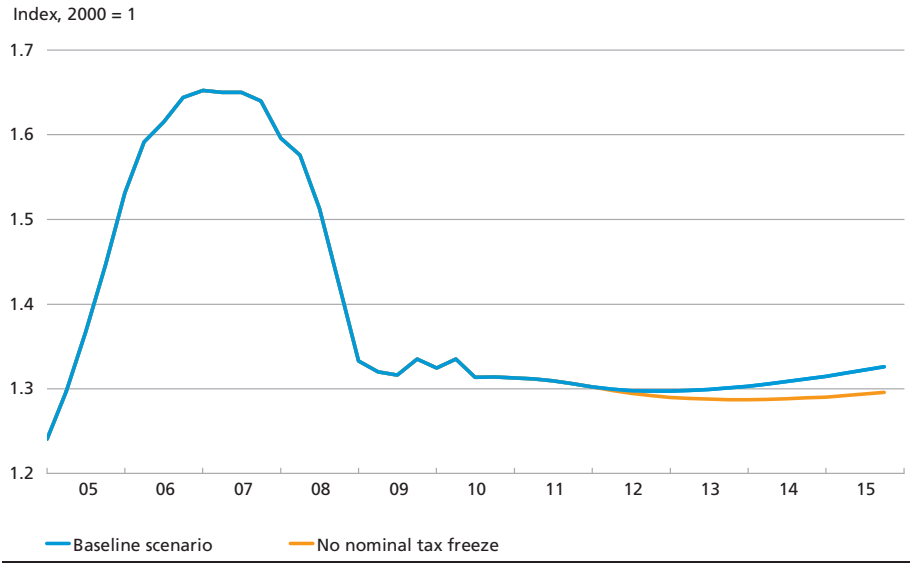
Due to these inexpedient and presumably unintended effects it is natural to consider abolishing the nominal principle. This may be done without raising the current property taxation, provided that a downward adjustment of the formal property value tax rate is made at the same time so total revenue remains unchanged in the short term. If the nominal principle were abolished, the nominal property value tax would again mirror the development in property valuations. This would contribute to stabilising the future development in house prices. However, at the time of reform, a certain dampening of house prices may be expected in as much as home buyers today calculate with lower real tax payments in future as a result of the nominal principle. If the reform is implemented during an upswing, however, the negative short-term effect on the housing market will be offset by the increase in housing demand resulting from rising incomes.

A temporary problem will arise if the principle of charging property value tax on the most recent property valuation is reintroduced. The problem is due to the fact that since the introduction of the tax freeze in early 2002, property values have risen much more steeply in and around the large cities than in the rest of the country. If the new downward-adjusted property value tax rate is fixed in such a way as to ensure that the total revenue at the time of reform remains unchanged, this may result in a significant tax increase for homeowners in the areas that have seen the highest increases during the last decade, while homeowners in other parts of the country will obtain tax cuts. This problem might be addressed by a transitional arrangement entailing a gradual adjustment to the new level of property value tax. When designing the transitional arrangement it is important to ensure that individual homeowners' tax payments mirror house-price developments from the start to immediately achieve the desired stabilising effect on house prices and economic development.

Lifting the freeze on property value tax would prevent tax revenue from being gradually eroded by inflation. Using the calculation method presented in Box 3.3 in Dam et al. (2011), it is possible to estimate with some uncertainty that a permanent freeze on the nominal property value tax would result in a loss of government revenue corresponding to a permanent fall in annual government revenue of just under kr. 8 billion in present current value terms. Preventing such loss of revenue would thus prevent significant deterioration of fiscal sustainability in the long term. At the same time, reducing the tax subsidy for owner-

SHORT-TERM EFFECT ON HOUSE PRICES OF LIFTING THE NOMINAL FREEZE ON PROPERTY VALUE TAX

Chart 4.4



Note: Own estimates based on MONA with new relations for house price and residential investment, cf. Dam et al. (2011). The baseline scenario is based on the forecast published in this Monetary Review, Part 1, supplemented with a technical projection for 2014-15, cf. Dam et al. (2011).
Source: Danmarks Nationalbank.

occupied housing consumption would lead to economic efficiency gains, cf. Sørensen (2011).

Chart 4.4 illustrates how lifting the freeze on nominal property value tax with effect from the beginning of 2012 may be expected to impact house prices in the short to medium term. The estimates in the Chart were achieved by incorporating the house price and residential investment relations as established and estimated by Dam et al. (2011) into Danmarks Nationalbank's macroeconometric model, MONA. The baseline scenario in Chart 4.4 assumes that the current tax rules remain unchanged and resembles the medium-term projection of the Danish economy in Chart 2.4. The alternative scenario in Chart 4.4 assumes that households will to some extent take account of the fact that they will miss out on future real tax cuts when the freeze on property value tax is lifted.[1] Accordingly, a certain negative impact on house prices can already be seen in 2012 when the nominal principle will be abolished. Even so, the effect on house prices will be relatively limited. In the longer term, the price effect will gradually disappear, because the supply of housing will be reduced as a result of a decline in new construction.

[1] To be more precise, 40 per cent of households are assumed to show such forward-looking behaviour. This corresponds to the proportion of home buyers who, according the analysis in Dam et al., do not act short-sightedly by attaching importance to the housing payment in the first year only.

Alternatively, it may be assumed that home buyers focus solely on the amount of real property value tax at the time of purchase,[1] i.e. they do not allow for the fact that in case the freeze is lifted they will miss out on lower real tax payments in future. Based on this assumption, there will be no significant effect on house prices within the time horizon under review, the reason being that the real property value tax will remain unchanged when the freeze is lifted.

Reducing the tax value of the mortgage tax relief: An alternative to lifting the freeze on property value tax?

The user cost of owner-occupied housing consumption includes interest after tax. Hence, an alternative to higher property taxation may be to reduce the tax subsidy of owner-occupied housing by lowering the rate of tax on investment income. Higher interest after tax would increase the change in the price of housing consumption resulting from a given change in the house price. According to the analysis in Box 4.1, this would dampen house-price fluctuations when housing demand is exposed to shocks.

For persons with negative net capital income, the current capital income tax rate is 33.5 per cent in an average local-government district, but pursuant to the latest tax reform this rate will be gradually reduced to 25.5 per cent up to 2019 for negative net capital income exceeding kr. 50,000 per person. As this nominal threshold is not subject to indexation, an increasing proportion of households' net interest costs will gradually acquire a tax value of 25.5 per cent.

A further reduction of the tax rate on negative net capital income is proposed in the public debate from time to time. This would further reduce tax subsidies of owner-occupied housing for the majority of homeowners who have net financial debt, but not for those with positive net capital income. For the latter group, the opportunity cost of investing in owner-occupied housing is the interest after tax that may alternatively be obtained by investing in interest-bearing assets. Accordingly, the user cost of owner-occupied housing consumption for persons with positive net capital income would not be affected by a lowering of the tax value of the mortgage tax relief.

A reduction of the negative net capital income tax rate entails a jump in marginal taxation of yields on financial savings when the net capital income is above zero. This will give asset owners an incentive to place their assets in owner-occupied housing rather than in financial

[1] This assumption would correspond to method I for modelling the impact of the freeze on property value tax in the calculations and discussion in Dam et al. (2011, section 3). The assumptions of the calculation that forms the basis of Chart 4.4 correspond to method II.

assets, thereby distorting the composition of savings. This inappropriate effect may be prevented by symmetrically reducing the tax on both positive and negative net capital income, thus ensuring a higher level of neutrality in total taxation of capital returns. However, lowering the tax on capital income would lead to greater wealth redistribution across generations than raising the property value tax, as members of the younger generations typically have net financial debt, while members of the older generations often have positive financial net worth. The vertical distribution of income will also be affected as a lowering of the capital income tax will exacerbate income inequality, because positive net capital income is concentrated particularly in the highest income brackets.

For these reasons, we focus on abolishing the nominal principle of the tax freeze as the most obvious method of reducing house-price fluctuations. Higher current property taxation is also recommended by OECD (2011) as the most effective and neutral method of reducing tax subsidies for owner-occupied housing.

5. HOME FINANCING AND HOUSE-PRICE FLUCTUATIONS

Based on international experience, the above-mentioned OECD study and the recent study by Andrews (2010) emphasise that in addition to tax rules, house-price volatility is also dependent on the terms and conditions for home financing. In Dam et al. (2011) we also find that the emergence of new types of home financing contributed to the soaring Danish house prices in the middle of the last decade. This raises the question of whether it is possible to reduce house-price fluctuations through appropriate home financing regulation. This issue will be discussed in the following.

Deferred-amortisation loans and house-price fluctuations

According to the analysis in Box 4.1, a lower normalised user cost (the user cost as a ratio of the house price) will cause house prices to react more strongly to housing demand shocks. At the same time, the empirical analysis in Dam et al. (2011) indicates that in addition to the "classical" user cost defined in equation (1) in Box 4.1, housing demand in Denmark is also dependent on the minimum first-year payments on mortgage loans offered by the loan types available at the time of purchase. To be more precise, the analysis shows that housing demand reacts to a modified user cost, bp^m, which can be expressed as follows

$$bp^m = r(1-t) + s + d + \alpha \cdot A, \qquad 0 < \alpha < 1, \tag{4}$$

where, as in previous equations, *s* is housing-related taxes, while *r* should be interpreted as a weighted average of the interest rates on long-term loans and 1-year adjustable-rate loans, respectively. The parameter *A* is the first-year (minimum) repayments on the loan as a proportion of the purchase price, and α is the proportion of such repayments that home buyers regard as a cost. In traditional economic theory α is assumed to be zero, i.e. repayments on loans are not regarded as a cost as they are offset by an equivalent wealth increase. However, if home buyers are liquidity constrained, wishing to increase their consumption in relation to the consumption level permitted by the credit facilities available, it may be rational for them to regard (part) of the repayments on loans as a cost, since the repayments constitute compulsory savings. To the extent that home buyers are short-sighted and consequently do not allow for the fact that larger repayments now result in lower interest costs later, they may also regard the repayments as a cost. The parameter α can be interpreted as the proportion of home buyers who are liquidity constrained or apply a short-sighted approach. Dam et al. (2011) estimate that in a Danish context α amounts to approximately 0.6.

We see from (4) that the repayment element $\alpha \cdot A$ affects the modified user cost and thus housing demand in the exact same way as the tax subsidy $t \cdot r - s$, only in reverse. As previously seen, there is empirical evidence that an increase in the tax subsidy will increase house-price volatility, cf. regression equation (2). The obvious assumption is therefore that a decrease in the repayment element $\alpha \cdot A$ will have a similar effect on house-price fluctuations. In Denmark it is estimated that the introduction of deferred-amortisation mortgage loans at the end of 2003 caused the parameter *A* in equation (4) to decrease from approximately 1.75 per cent to approximately 0.25 per cent when calculated as an average over a longer time period. At an estimated value of α of 0.6 this meant that the deferred-amortisation loans lowered the modified user cost by approximately 0.9 percentage points. If the user cost fell in parallel with an increase in the tax subsidy, this increased house-price volatility by approximately 0.9 x 2.07 = 1.9 percentage points according to equation (2).

As mentioned in section 4, the more sophisticated analysis in Andrews (2010) indicates that equation (2) overestimates the effect of the tax subsidy (and probably also of the deferred-amortisation loans) on house-price volatility by a factor of just under 1.8.[1] Adjusting for this effect, we find that the introduction of deferred-amortisation loans may have

[1] The factor is achieved as the estimated effect on volatility according to (2) in relation to the estimated effect according to Andrews' regression analysis.

amplified house-price fluctuations by just over 1 percentage point, i.e. a stronger effect than the estimated impact of the nominal principle of the tax freeze.

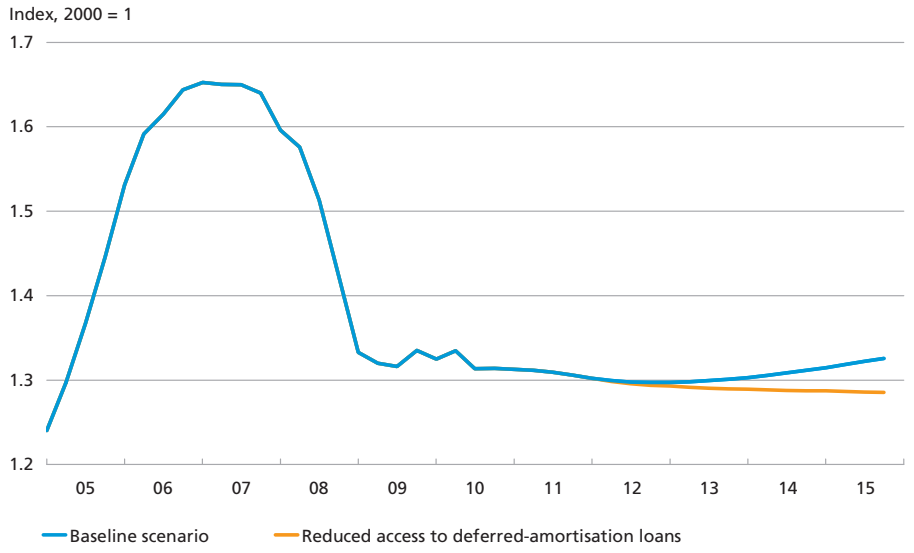
Besides, the increasing use of deferred-amortisation loans also makes homeowners and thus the economy as a whole more vulnerable to unexpected drops in house prices because the deferred amortisation reduces the build-up of home equity. Widespread use of deferred-amortisation loans will increase the number of homeowners who become technically insolvent in the event of a plunge in house prices. This is not just a problem for the households concerned but also for society at large. Technical insolvency may thus encourage homeowners to save up extraordinarily in periods of economic slowdown and decreasing house prices where the downturn would be amplified by consumption restraint. Furthermore, technically insolvent homeowners may not be able to afford to move. This will impede labour mobility, thus making it difficult to reduce unemployment in a downturn.

This speaks in favour of future mortgage loans for owner-occupied housing being granted solely with amortisation. Like lifting the freeze on property value tax, such a reform would reduce long-term fluctuations in the housing market. By ensuring the build-up of larger home equity, phasing out deferred-amortisation mortgage loans would also reduce the vulnerability of homeowners and society at large to unexpected negative shocks to the housing market. To avoid putting too much pressure on the housing market in the short term, access to deferred-amortisation loans should be phased out slowly, e.g. by reducing over a period of time the credit limit for new deferred-amortisation mortgage loans by 10 percentage points annually.

Chart 5.1 illustrates how such a gradual limitation of access to deferred-amortisation loans may be expected to impact house prices in the short to medium term. As in Chart 4.4, the estimate was achieved by incorporating the house price and residential investment relations as established and estimated by Dam et al. (2011) into Danmarks Nationalbank's macroeconometric model, MONA. The baseline scenario shown, in which the current access to deferred-amortisation loans is fully maintained, corresponds to the baseline scenario behind Chart 2.4. In the alternative scenario in Chart 5.1 it is assumed that from 2012 the upper limit for use of new deferred-amortisation mortgage loans will be reduced by 10 percentage points annually, starting from the current 80 per cent of the value of the property. Our analysis shows that this will only dampen house prices to a limited extent in the next few years.

As previously mentioned, average annual house-price fluctuations will be reduced by 1-2 percentage points in the long term if deferred-amort-

SHORT-TERM EFFECT ON HOUSE PRICES OF A GRADUAL PHASE-OUT OF DEFERRED-AMORTISATION LOANS — Chart 5.1



Note: Own estimates based on MONA with new relations for house price and residential investment, cf. Dam et al. (2011). The baseline scenario is based on the forecast published in this Monetary Review, Part 1, supplemented with a technical projection for 2014-15, cf. Dam et al. (2011). In the alternative scenario the credit limit for deferred-amortisation mortgage loans is gradually reduced by 10 percentage points annually, starting from 2012.
Source: Danmarks Nationalbank.

isation mortgage loans are phased out completely. In connection with the preparation of a specific proposal, maintaining limited access to this type of loan might be considered if it can be done without compromising the above objectives of the measure.

Cyclical regulation of home financing?

Another possible reform of home financing might be to regulate access to deferred-amortisation mortgage loans and adjustable-rate loans in relation to the cyclical position in the housing market. To illustrate this, we investigate the expected effects of three different types of restrictions on home buyers' access to credit facilities:

Mild cyclical brake: In periods of substantial house-price increases (real price increases of 5 per cent year-on-year or more), access to adjustable-rate mortgage loans and deferred-amortisation loans is restricted as from the start of the following year from the present 80 per cent to 60 per cent of the value of the home. In periods of dramatic real price increases (10 per cent year-on-year or more) access to adjustable-rate loans and deferred-amortisation loans is further restricted to 40 per cent of the value of the home. Access to fixed-rate bond loans is not affected, meaning that such loans may still constitute up to 80 per cent of the value of the home.

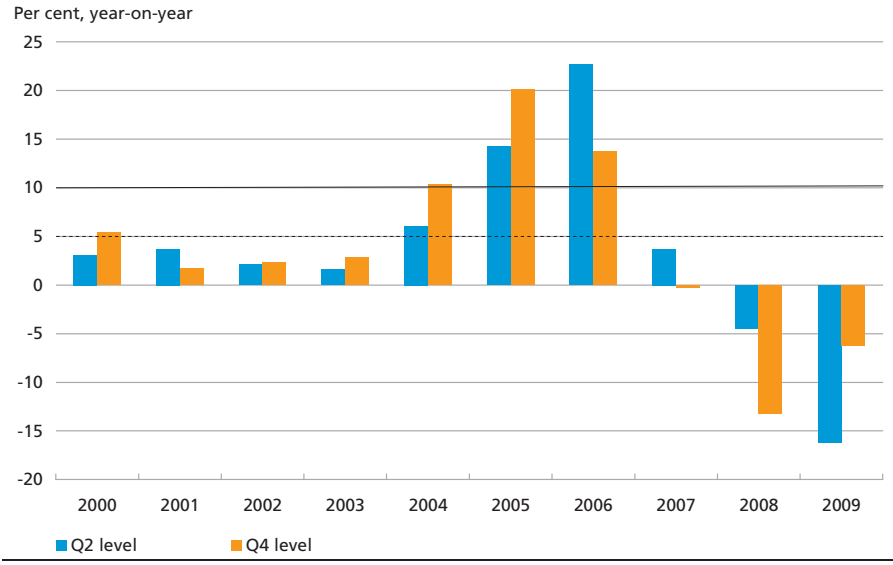
Severe cyclical brake: Here, access to adjustable-rate mortgage loans and/or deferred-amortisation loans is restricted from the present 80 per cent to 40 per cent of the value of the home in the event of real house-price increases of 5 per cent year-on-year, while access will be eliminated if the real price increases exceed 10 per cent year-on-year. Access to fixed-rate loans remains unchanged.

General restriction: In this scenario access to adjustable-rate loans and deferred-amortisation loans is generally restricted to 60 per cent of the value of the home, irrespective of the situation in the housing market. The analysis below assumes that the restriction is introduced as from the 4th quarter of 2003, i.e. at about the same time as the introduction of deferred-amortisation mortgage loans. The restriction does not change the 80 per cent LTV (loan to value) limit for fixed-rate loans.

As previously mentioned, the two former credit restrictions are assumed to be implemented from the end of the calendar year in which the unacceptably high rate of increase in house prices occurs, and it is assumed that they will be eliminated from the end of the calendar year in which the rate of increase in house prices has fallen below the acceptable limits stated. The analysis below allows for the fact that the official house-price indices from Statistics Denmark are published almost six months after the underlying home purchases/sales took place. The decision to change the mortgaging rules as from 1 January in the following year would thus have to be made on the basis of the rate of increase in house prices observed in the 2nd quarter of the preceding year.

Chart 5.2 illustrates the significance of the lag in available house-price information. It shows the observed annual rate of increase in real house prices in the 2nd and 4th quarters of every calendar year in the last decade. It is seen that the annual rate of increase in the real house price exceeded 5 per cent in the 4th quarter of 2000, even though the rate of increase in the 2nd quarter was somewhat below that level. As a consequence of the lag in access to information about house prices, a "cyclical brake" on credit access would not have been activated from 1 January 2001. This can almost be said to be an advantage as the years 2001, 2002 and 2003 were characterised by limited real house-price increases and relatively weak general economic activity throughout most of the period. But in the course of 2004 house-price increases began to escalate. In the 2nd quarter of 2004, the real annual rate of increase was just over 6 per cent, and in the 4th quarter it exceeded 10 per cent. If the latter information had been available at the end of 2004, access to the new loan types should, according to the above rules on "cyclical brakes", have been further restricted as from 1 January 2005 than actually warranted by the information available. From early 2006, when the rate of

RATES OF INCREASE IN THE REAL HOUSE PRICE Chart 5.2



Note: Based on quarterly house-price observations divided by the implied deflator for private consumption. The annual rate of increase is calculated as growth in the 2nd and 4th quarter, respectively, compared with the same quarters in the preceding year. The horizontal lines represent the mild cyclical brake (dashed), and the severe cyclical brake (full) in the model of cyclical credit facilities outlined in the text.

Source: Statistics Denmark.

increase in house prices peaked, the most extensive credit restriction would have been introduced, despite the lag in available house-price statistics, if the above rules on cyclical brakes had been followed.[1]

The potential problems ensuing from the unavoidable time lag in implementing cyclical credit restrictions are best illustrated by experience gained in the period 2006-07. Due to the high rate of increase in house prices observed in the 2nd quarter of 2006, the tight credit restrictions would have been maintained throughout 2007, even if the rate of increase in real prices became negative at the end of 2007. In an ideal world with perfect foresight of house prices, the credit restrictions would, however, have been removed in early 2007 to prevent the downturn in the housing market.

In Table 5.1 and Chart 5.3 we have used the house-price relation estimated in Dam et al. (2011) to simulate the effects of the three above types of credit restrictions while allowing for the lag in available house-price information mentioned. As appears, the two "cyclical brakes" would not have had any significant effect on house prices in 2005, as prices, according to the empirical analysis, react to changes in the finan-

[1] This assumes that the credit restriction introduced as from 1 January 2005 would not have pushed the annual rate of price increase in the 2nd quarter of 2005 below 10 per cent. But if this had been the case then such a strong cyclical brake would probably not have been needed in 2006.

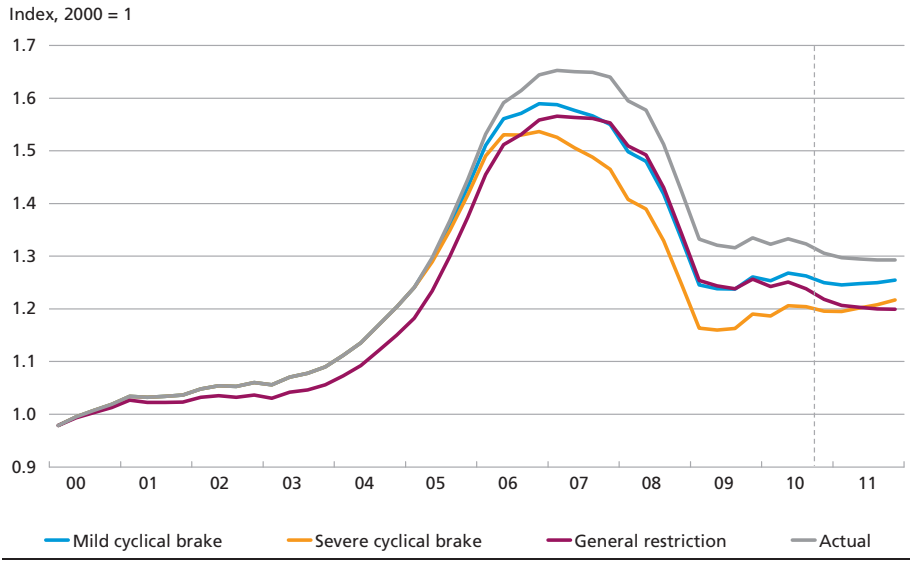
DEVELOPMENT IN THE REAL HOUSE PRICE UNDER DIFFERENT CREDIT RESTRICTIONS — Table 5.1

Percentage deviation from actual development	2005	2007	2009	2011
Mild cyclical brake	-0.5	-4.7	-6.1	-3.5
Severe cyclical brake	-1.0	-9.2	-11.8	-6.9
General restriction	-4.9	-5.3	-5.9	-7.1

Note: Counterfactual scenarios based on estimated house-price relation. The counterfactual scenarios are described in the main text above. The effect of adjustable-rate loans is not introduced until the 1st quarter of 2000. The estimates for 2011 are based on Danmarks Nationalbank's forecast from the 4th quarter.
Source: The MONA data bank and own estimates.

cing conditions with a certain lag. On the other hand, the general credit restriction, which is unrelated to cyclical conditions, would have had a certain (albeit limited) dampening effect on prices in 2005, as we assume it was introduced at the end of 2003 at the same time as deferred-amortisation loans. From 2006 onwards, all three types of credit restrictions (especially the "severe cyclical brake") have clearly dampened house prices. But it is also evident that the three different measures would only have taken the top off the price increases. So even the severe cyclical brake would not have prevented a significant increase in house prices in the middle of the last decade. However, the simulations in Table 5.1 and Chart 5.3 assume that the unexplained house-price "bubble element" during that period would not have been affected by

SIMULATED SCENARIOS FOR THE REAL HOUSE PRICE — Chart 5.3



Note: Counterfactual scenarios based on estimated demand relation. The counterfactual scenarios are described in the main text above. The effect of adjustable-rate loans is not introduced until the 1st quarter of 2000. Observations after the 3rd quarter of 2010 are based on Danmarks Nationalbank's forecast from the 4th quarter.
Source: The MONA data bank and own estimates.

the credit restrictions. In practice, the bubble element would probably have been dampened by the fact that a lower observed rate of price increase would have lowered expectations of large capital gains on housing. Accordingly, Table 5.1 and Chart 5.3 probably underestimate the dampening effect that the credit restrictions would have had on prices.

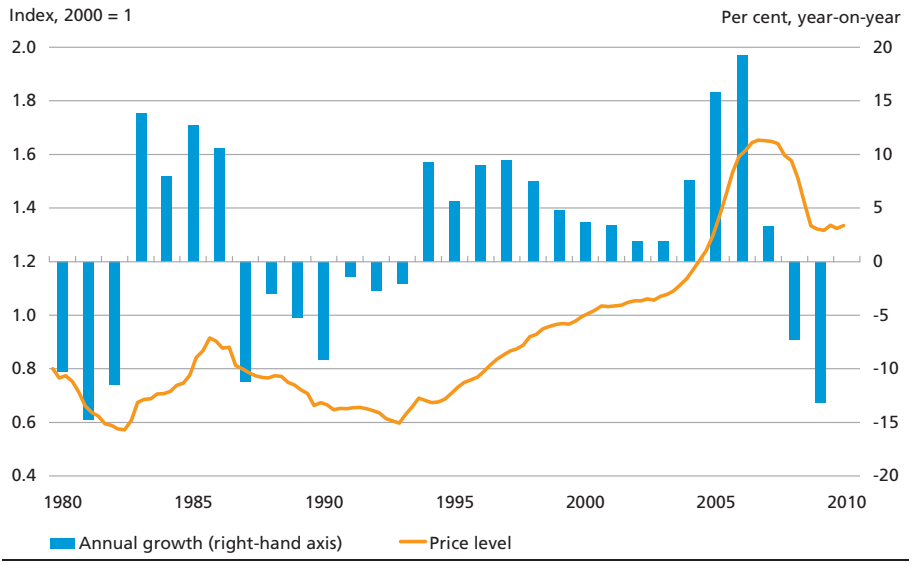
While restrictions on the use of the new loan types might have dampened the upswing in the housing market during the boom years in the middle of the last decade, they would have resulted in lower house prices and thus had a certain dampening effect during the downturn that occurred in the years following the financial crisis. However, our previous analysis in Chart 2.4 clearly indicates that a dampening of the house-price boom in the mid-2000s would have been likely to result in lower unemployment in the coming years due to Denmark's reduced spare production capacity and improved international competitiveness.

As indicated in Chart 5.3, there is an important difference between cyclical and general credit restrictions in as much as the dampening effect a general restriction would have on prices will increase over a number of years, irrespective of the development in the housing market, whereas the dampening effect of a cyclical loan brake will decrease as house prices stabilise. The desire to limit fluctuations in the housing market therefore points to a cyclical rather than a general credit restriction.

However, the two "cyclical brakes" in Table 5.1 are based on very simple rules depending solely on the *change* in house prices, irrespective of their starting level. Such simple rules may be sufficient if they are implemented in a situation where real house prices are not too far from their long-term equilibrium level. If, on the other hand, house prices are far from their long-term equilibrium, this should be taken into account when amending home financing regulations. As shown in Chart 5.4, house prices increased significantly in the period 1994-97, but the starting point was the trough in 1993 following a period of low growth in 1987-93. Against that background, it would hardly have been expedient to tighten the conditions for home financing in the first years after 1993.

This example illustrates the potential risk of simplistic and rigid rules governing cyclical regulation of credit. On the other hand, using a cyclical loan brake which is dependent on the rate of increase in house prices as well as their deviation from the long-term equilibrium level is difficult, as there is considerable uncertainty about the equilibrium level of house prices.

REAL HOUSE PRICE 1980-2010 Chart 5.4



Note: The price of single-family houses divided by the implied deflator for private consumption according to the national accounts.
Source: Statistics Denmark and the MONA data bank.

6. CONCLUSION

The analysis in this article has pointed out that large house-price fluctuations entail significant economic costs. The analysis also shows that fluctuations are amplified by the nominal principle for property value tax under the tax freeze and by the access to deferred-amortisation loans.

Against this background, we have discussed the possibility of stabilising the housing market by changing the rules on property taxation and home financing. Lifting the nominal principle of the tax freeze concerning property value tax would reduce house-price fluctuations, and as an added bonus it would help solve the fiscal-policy sustainability problem. Subject to an appropriate adjustment of the property value tax rate, it would be possible to eliminate the nominal principle without increasing total housing taxation at the time of transition. Re-introducing the principle that property value tax should be based on the most recent property valuation would contribute to more stable development in the housing market and thus in the economy as a whole. In the short term, such a reform would to some extent dampen house prices, but the effect is assessed to be very limited.

Gradually phasing out the use of deferred-amortisation loans would also contribute to reducing long-term fluctuations in the housing mar-

ket. By ensuring the build-up of larger home equity, phasing out deferred-amortisation loans would also reduce the vulnerability of homeowners and thus the economy to unexpected negative shocks to the housing market.

In principle, cyclical restrictions on access to home financing may reduce fluctuations in the housing market, but there is a significant risk that the timing and dosing of such measures will be wrong because of insufficient information about the current situation in the housing market and uncertainty about the long-term equilibrium level for house prices.

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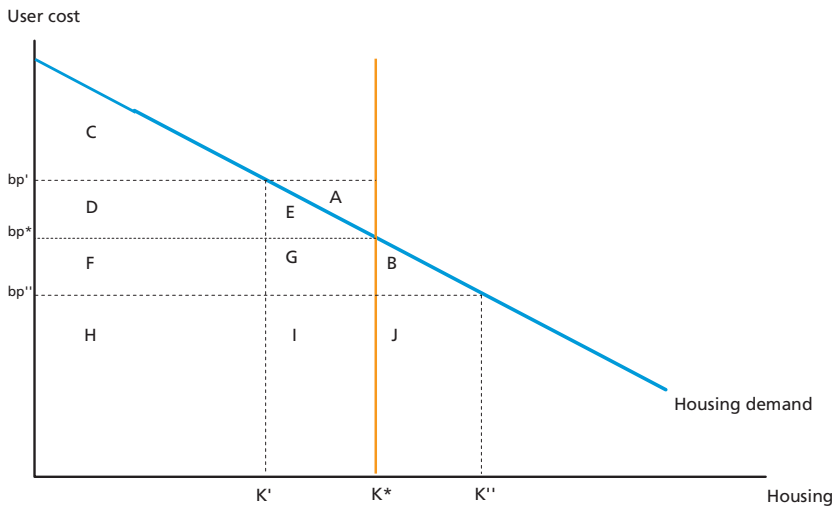
APPENDIX: WELFARE EFFECTS OF HOUSE-PRICE FLUCTUATIONS

This appendix documents the results concerning the welfare effects of house-price fluctuations referred to in the main text.

Chart A1 illustrates how fluctuations in the user cost of owner-occupied housing may inflict a welfare loss on consumers. The premise of the analysis is that large transaction costs may be associated with adjusting housing consumption to a modified user cost (e.g. monetary and psychological costs of moving). The declining curve in the Chart indicates how owner-occupied housing consumption of the representative household is dependent on the user cost in a hypothetical situation where no transaction costs are involved in adjusting housing consumption. For the sake of convenience, the housing demand curve is assumed to be linear, but this should just be seen as a simplified approximation. Each point on the housing demand curve indicates the amount a household is willing to pay to increase housing consumption by one unit (e.g. measured in square metres of a specific quality). Accordingly, the total area under the housing demand curve measures the maximum amount a household would be willing to pay for housing consumption of a specific extent. Chart A1 assumes that the user cost of a home of the quality concerned is bp^* at the time when the household enters the market for owner-occupied housing. So at that time the household chooses a home of size K^*. The area under the housing demand curve to the full vertical line above K^* – i.e. the sum of the areas C, D, E, F, G, H and I – thus indicates the maximum amount the household would pay for housing consumption corresponding to K^*. In comparison, the sum of the areas F, G, H and I – corresponding to the product of bp^* and K^* – indicates the actual economic cost associated

CONSUMER SURPLUS IN CONNECTION WITH OWNER-OCCUPIED HOUSING CONSUMPTION — Chart A1



with housing consumption of this extent. The difference between the two amounts is equivalent to the sum of the areas C, D and E. This quantity is called the consumer surplus and it is used in the theory of welfare economics as a measure of the welfare gains consumers achieve at a specific level of consumption when consumption is optimally adjusted to the current price.

Now assume that the user cost increases to level *bp'* in Chart A1. In the absence of adjustment costs, the household would then choose to reduce its housing consumption to level *K'*, thereby incurring a loss of housing consumption equivalent to the sum of the areas E, G and I, but on the other hand it would save housing costs equivalent to the sum of the areas A, E, G and I. The difference between the two amounts, i.e. the triangular area A, thus constitutes the gain the household would achieve by adjusting its housing consumption to the modified user cost, provided there were no adjustment costs. However, if the adjustment costs exceed an amount equivalent to the triangular area A, it would be better for the household to maintain housing consumption *K** unchanged. Area A would then constitute the welfare loss incurred by the household because it is too expensive to adjust its housing consumption to the modified user cost.

Conversely, if the user cost falls to level *bp"* in Chart A1, the household would want to increase its housing consumption to level *K"* in the absence of adjustment costs. For the household, the value of this additional housing consumption would amount to the sum of areas B and J, while the additional housing cost would only equal area J. The consumer surplus would thus increase by area B, but if the adjustment costs exceed this amount, the household would maintain housing consumption *K** unchanged and thus miss out on the additional consumer surplus B.

Note that this analysis is based on an opportunity cost assumption: If e.g. the user cost increases as a result of a higher house price, a homeowner who has already set up at the lower house price that used to apply, will not experience an increase in direct housing costs. But if housing consumption could be adjusted free of charge, the house-price increase would make it optimal for the homeowner concerned to move to a slightly smaller home and spend the mortgage equity made available on other consumption. The triangular areas A and B measure the welfare loss by not making this type of adjustment to a modified relative price of housing consumption.

Now assume that the real user cost fluctuates around trend level *bp**, and that the associated desired housing is *K** as illustrated in Chart A1. If the actual user cost *bp* deviates from the trend level for a period of time, and if the costs of adjusting housing consumption are sufficiently large, this will result in a welfare loss (*VT*) as seen in the Chart, which can be measured by the triangular area

$$VT = ½ \cdot (bp - bp^*) \cdot (K - K^*), \tag{1}$$

where *K* is the housing the household would prefer, if there were no adjustment costs, i.e. the housing that is reflected in the housing demand curve in Chart A1

next to the user cost *bp*. Given that $\partial K / \partial bp$ indicates the partial derivative of housing demand in terms of the user cost, the welfare loss in (1) can be expressed as follows

$$VT = ½ \cdot (\partial K / \partial bp) \cdot (bp - bp^*)^2. \tag{2}$$

If the welfare loss is compared with the trend value of total owner-occupied housing consumption $bp^* \cdot K^*$, (2) can be converted to

$$\frac{VT}{bp^* \cdot K^*} = \frac{\varepsilon}{2}\left(\frac{bp - bp^*}{bp^*}\right)^2 \approx \frac{\varepsilon}{2}(\ln bp - \ln bp^*), \qquad \varepsilon \equiv -\frac{\partial K}{\partial bp}\frac{bp^*}{K^*}, \tag{3}$$

where ε is the elasticity of owner-occupied housing demand in terms of the user cost, and where ln indicates the natural logarithm function. The average welfare loss per period, expressed as a proportion of private consumption, is shown by the mean value of the expression in (3). Given that $E[\cdot]$ is the mean value operator, the outcome is

$$E\left[\frac{VT}{bp^* \cdot K^*}\right] = \frac{\varepsilon \sigma^2}{2}, \qquad \sigma^2 \equiv E\left[(\ln bp - \ln bp^*)^2\right], \tag{4}$$

where σ^2 is the variance on the logarithm of the real user cost. The real user cost can be expressed as follows

$$bp = p^h \cdot u, \quad u \equiv r(1-t) - \pi + s + d - \pi^h. \tag{5}$$

In (5) p^h indicates the real house price, while *u* is the normalised real user cost consisting of the nominal interest after tax, $r \cdot (1-t)$, less the expected consumer price inflation, π, and the expected rate of increase in the real house price, π^h, plus the rate of depreciation *d* and housing-related taxes *s*, which are both calculated per krone of housing capital. Using the definition in the first equation in (5) and the definition of the variance on the real user cost, the average welfare loss in (4) can be expressed as follows

$$E\left[\frac{VT}{bp^* \cdot K^*}\right] = \frac{\varepsilon}{2}\left[\sigma_p^2 + \sigma_u^2 + 2\,\mathrm{cov}(\ln p^h, \ln u)\right]. \tag{6}$$

The quantity σ_p^2 is the variance on the logarithm of the real house price, σ_u^2 is the variance on the logarithm of the normalised real user cost, and $\mathrm{cov}(\ln p^h, \ln u)$ is the covariance between those two variables. All other things being equal, larger house-price fluctuations will therefore result in a larger loss of welfare. If house-price increases are primarily triggered by a fall in the interest rate, while decreasing house prices are mainly caused by interest-rate increases – i.e. if the covariance $\mathrm{cov}(\ln p^h, \ln u)$ in (6) is negative – the house-price fluctuations will prevent the user-cost fluctuations on owner-occupied housing stemming from interest rate movements, thereby reducing the welfare loss for

homeowners. On the other hand, house-price increases may occur mainly in periods of economic boom where real interest rates are also rising due to increasing demand for credit and/or monetary-policy tightening. Similarly, house prices may fall mainly during downturns during which interest rates will also tend to fall. In that case, house-price fluctuations will amplify the fluctuations in the user cost caused by interest rate movements, thereby increasing the welfare loss caused by fluctuations in the house price. This appears from the fact that a positive value of the covariance $\text{cov}\left(\ln p^h, \ln u\right)$ has a positive impact on the welfare loss in (6).

Equation (6) may be used to provide a quantitative estimate of homeowners' maximum average welfare loss as a result of fluctuations in real house prices. Using the Danish annual data from the ADAM data bank, the following is found for the period 1955-2009 (given that the mean value of the logarithm of the real house price is assumed to follow a linearly increasing trend):

$$\sigma_p^2 = 0.0338, \qquad \sigma_u^2 = 0.0343, \qquad \text{cov}\left(\ln p^h, \ln u\right) = -0.0145.$$

If, based on the discussion in Box 5.2 in Dam et al. (2011), the price elasticity ε is set at 1,[1] inserting those figures in (6) shows that historical house-price fluctuations have caused an average annual welfare loss of just under 2 per cent of the value of owner-occupied housing consumption. According to the national accounts, the imputed value of owner-occupied housing consumption amounted to kr. 127.5 billion in 2009. The average annual welfare loss can then be estimated at about kr. 2.5 billion in 2009 prices. This estimate is on the high side, however, given the assumption in (6) that consumers do not adjust their housing consumption to fluctuations in the user cost. Consumers for whom the area of the "welfare triangles" A and B in Chart A1 exceeds the adjustment costs, will in fact choose to adjust their housing consumption. For such consumers, the welfare loss in connection with fluctuations in the user cost will be given by the adjustment costs, which will be smaller than the measure of welfare stated in (6).

[1] Dam et al. (2011) argue that the uncompensated numerical price elasticity in housing demand is probably less than 1. But according to welfare economic theory, the consumer surplus should be calculated on the basis of the *compensated* price elasticity which exceeds the uncompensated elasticity due to the income effect of a price change. This is why we use an estimated numerical price elasticity of 1 here.