Consumption, Income and Wealth

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Private consumption accounts for a considerable share of domestic demand in most countries in the western world. In Denmark, private consumption accounts for around half of domestic demand and has a strong impact on the business cycle. Consequently, it is important to have good insight into the determinants of private consumption, e.g. in connection with business cycle analyses of the Danish economy.

Over the last 10-15 years, Danish households have increased their net wealth as a ratio of income. At the same time, they have also expanded their balance sheets, i.e. both assets and liabilities. As a result, their gross debt ratio is now among the highest in the world even though their net wealth ratio is on a par with comparable countries. The high gross debt has attracted considerable attention both nationally and internationally.

This article examines how net wealth and its composition have influenced growth and fluctuations in private consumption, first in a wider international perspective, followed by a separate analysis for Denmark. We also investigate the effects of financial flows from household wealth on household income and hence the scope for consumption.

Rising wealth entails more scope for consumption, and the consumption and wealth ratios are expected to show similar patterns under normal circumstances. However, a number of countries have seen an increase in the net wealth ratio without the consumption ratio following suit. Growth in net wealth covers in particular rising housing wealth and in some countries – including Denmark – rising pension wealth. There are a number of possible explanations of why the higher wealth ratio has not increased the consumption ratio, such as the widespread use of savings-based pension schemes.

As regards fluctuations in consumption, Denmark stands out from most other comparable countries. The fluctuations in consumption seem to be attributable especially to housing wealth and income.

The focus is on Denmark in the second half of the article. In order to throw light on the significance of wealth to consumption, we construct and estimate a consumption model with special focus on the short and medium run. The short-run and medium-run properties of the consumption function are to a high degree determined by the choice of defin-

ition of income (consumption-determining income), while the definition of wealth plays a smaller role.

The choice of income definition concerns, in particular, the treatment of investment income from pension wealth. We choose a description where investment income from pension wealth only affects household disposable income with a lag via future pension payouts. Consequently, interest-rate changes will be passed through to household interest expenses immediately, while interest income from pension wealth will only slowly affect income. In the short and medium run, interest-rate increases will thus lead to higher net interest expenses for households.

Alternatively, interest income from pension wealth can be included directly in consumption-determining income, e.g. by using the disposable income of the private sector. However, this approach will not necessarily change the pass-through of a change in interest rates to net interest expenses, since pension wealth to a high degree has a fixed return as a result of guarantees and interest-rate hedging. Hence, interest-rate changes will, also in this case, principally impact household interest expenses and only to a limited extent on their interest income.

The identification of consumption-determining wealth is difficult and associated with uncertainty, but as mentioned, the choice of definition of wealth has only a minor impact on the properties of the consumption function in the short and medium run. The wealth ratio of Danish households has risen considerably over the last 30 years without the consumption ratio following suit. An increasing wealth ratio in conjunction with a stable consumption ratio poses challenges in the construction of a stable consumption function. It is not possible to identify clearly, on the basis of macroeconomic data, which components of wealth have risen without influencing consumption. However, there are some empirical and theoretical clues.

The various types of household assets, such as pension schemes, equities, bank deposits and housing, are very different, implying varying influence on consumption.

Pension savings, for instance, are tied up until retirement, cannot be pledged and are typically paid out over a number of years. Moreover, payouts from household pension wealth in part reduce public pension payouts by decreasing the pension premium, among other channels. This indicates a small impact on the consumption ratio from pension wealth, especially in the short and medium run. For some households, e.g. those that are close to retirement, pension wealth no doubt plays a larger role. An in-depth analysis of the long-run effects of increased private pension wealth is beyond the scope of this analysis, however.

Equity wealth is typically also found to have a relatively small impact on consumption, *inter alia* because the distribution of this wealth is very uneven, as it is held by high-income families in particular. Moreover, in Denmark any capital gains are taxable.

Real house prices have risen over the last 20 years, e.g. due to falling interest rates and the introduction of new loan types. Housing wealth can only be translated into consumption by the households borrowing against home equity or selling the home. The Danish mortgage-credit system provides ample room for borrowing against home equity, thus translating house price increases into consumption, but there are limits to how much the households can and will increase the loan-to-value, LTV, ratio. This implies that the last 20 years' house price increases have only partially been translated into consumption.

The above discussion indicates that increasing pension and equity wealth has played a substantial role in the divergence of the consumption and wealth ratios over the last 30 years, but that higher housing wealth may also have been a factor. Specifically, this means that the weights of pension, equity and housing wealth are reduced accordingly, ensuring that the consumption-determining wealth ratio has, by and large, fluctuated around a historical average. The weights reflect an empirical choice, but formal estimations confirm that the weighting chosen strengthens the long-run relationship between consumption, income and wealth compared with the choice of total household net wealth.

As mentioned already, the information content of data is not sufficient to provide clear identification of the correct weights, but a robustness check shows that changes of the weights have only a small impact on the model properties in the short and medium run.

In the short run, a number of factors may cause consumption to deviate from the estimated long-run model. We construct an aggregate model in which the quarterly changes in consumption are explained by deviations from the long-run model and a number of variables that may influence consumption in the short run, such as unemployment and real interest rates.

The properties of the consumption function are then examined within the framework of Danmarks Nationalbank's macroeconomic model, MONA. This makes it possible to take into account dynamic effects of shocks to the consumption function, e.g. how increased consumption stimulates income, which in turn boosts consumption. In order to link the consumption function to MONA we construct a financial submodel to manage the relationship between household income, consumption and savings on the one hand and wealth on the other.

Fluctuations in housing wealth play a large role in the aggregate model. During the boom in 2004-07, house prices rose by approximately 60 per cent, whereas they fell by around 15 per cent from end-2007 to end-2009. According to the model, this was the most important factor behind the surge in consumption during the boom and the subsequent sharp falls. The key role of housing wealth in consumption fluctuations ties in well with the observations from the international comparison.

Moreover, the model demonstrates that the falling interest rates in recent years – in response to the marked international economic slowdown – have contributed substantially to cushioning private consumption. The decline in interest rates has both reduced net interest expenses and supported house prices.

The key role of interest rates can be attributed, among other factors, to the households' accumulation of a high gross debt ratio over the last 15 years without correspondingly increasing interest-bearing assets. At the same time, a far larger share of the debt is now variable-rate debt. All in all, this implies higher interest-rate sensitivity for household disposable income and thus private consumption today, compared with previously.

As a result of the more pronounced interest-rate sensitivity, the transmission mechanism of monetary-policy has strengthened and, viewed in isolation, normalisation of monetary-policy interest rates will have a stronger dampening effect on consumption today than a corresponding interest-rate increase would have had 10 years ago. The higher interest-rate sensitivity emphasises how important it is that financial markets have confidence in the Danish economy.

RELATIONSHIP BETWEEN CONSUMPTION, INCOME AND WEALTH

A budget constraint is the point of departure for economic models of private consumption. A person's consumption at a given time depends on the volume of available resources and on how large a share of the resources the person chooses to consume. Total available resources consist of the sum of existing wealth, W_t, and life-cycle income less taxes and other mandatory expenses, e.g. interest expenses, I_t. The assumption here is that it is possible to borrow against future income.

A normal assumption in economic theory is that individuals will seek to have relatively stable consumption over time, i.e. they currently wish to consume a virtually constant share of their total resources.[1] This share

[1] This corresponds to the original "Life-Cycle Hypothesis", cf. Modigliani & Brumberg (1979).

may vary over time, e.g. if the price of consumption varies over time.[1] Moreover, it is assumed that individuals spend all of their income over their life cycle.

Consumption at a given time, C_t, can thus be determined as:

(1) $$C_t = m_t * (I_t + W_t)$$

where m_t is the share of total resources consumed at time t.

A number of consequences can be drawn from this simple model:

- Predicted changes in income and wealth will not affect consumption. Consequently, changes in wealth as a result of planned savings will have no impact on consumption.
- Unpredicted capital gains and losses, e.g. as a result of unexpected house price increases or falls, have an impact on consumption, but only in so far as these changes in value are found to be permanent.
- Unpredicted temporary changes in income will only have a limited impact on consumption, since the temporary change in income will be distributed over the remaining lifetime (consumption smoothing).

The simple model can be expanded in several areas, e.g. by[2]

- introducing uncertainty about income. Wealth will thus also act as a buffer to be used in connection with temporary loss of income, e.g. due to a short period of unemployment;
- introducing uncertainty about life expectancy. This means that wealth is often not consumed in full, resulting in inheritance. There could also be an explicit wish to leave an inheritance;
- introducing credit constraints, e.g. only limited access to borrow against future income.

The first two expansions do not change the model properties to any substantial extent. For example, predicted changes in income still have no impact on consumption. Changed uncertainty may, however, influence the preference of wealth size. For a certain period – while the buffer is accumulated – increased uncertainty can thus entail lower consumption.

Credit constraints, on the other hand, will have an impact on the properties of the consumption model. If households do not have access to credit, some will be forced to spend less than what they ideally would like to. Hence an increase in income, even if it was predicted, will lead to higher consumption. Thus, one consequence of introducing credit con-

1 The price of consumption is determined by real interest rates. See Box 1 for more details.
2 See Muellbauer and Lattimore (1995) for a thorough discussion of a large number of expansions of the simple model.

straints into the model is that current income will play a larger role as regards consumption.

Empirical considerations

The above model is based on how an individual makes consumption decisions. Adding up all individuals is necessary in order to determine an aggregate consumption function for private consumption as a whole. Aggregate consumption is thus a function of aggregate wealth and income (current and future).[1]

The present value of future income is difficult to calculate in practice. A simple solution, which is often used in the empirical literature, is to use current income as a measure of future income, e.g. by assuming that future income is proportional to current income, Y_t, so $I_t = k*Y_t$.

Hence, aggregate consumption can be written as:[2]

$$(2) \qquad C_t = m_t * (k*Y_t + W_t) = \alpha_1 Y_t + \alpha_2 W_t,$$

where α_1 expresses the consumption share of one extra krone of income (the marginal propensity to consume income), and α_2 expresses the consumption share of one extra krone of wealth (the marginal propensity to consume wealth).

If equation (2) is rewritten, then:

$$(2') \qquad C_t/Y_t = \alpha_1 + \alpha_2 W_t/Y_t,$$

meaning that, according to the model, the consumption ratio (C_t/Y_t) and the wealth ratio (W_t/Y_t) show the same pattern over time. According to this relationship, consumption will fall – even though income remains unchanged – if the wealth ratio decreases e.g. as a result of a drop in house prices (capital loss). Lower consumption at unchanged income will entail higher savings and hence a higher wealth ratio. This process will continue until the households have restored their wealth ratio to the desired level. The opposite applies in the event of capital gains.

Given the assumption that future income is proportional to current income, household expectations of future income are not affected by

[1] This coresponds to the existence of one representative consumer. If the sum of many individuals' consumption is to be represented by one representative consumer, consumption must not be influenced by the distribution of income and wealth across individuals, cf. Mas-Colell, Whinston and Green (1995), Chapter 4.

[2] The parameter m_t is assumed to be constant over time, corresponding to constant real interest rates. Real interest rates are included in the estimations of the short-run dynamics of consumption below, corresponding to allowing m_t to vary.

structural changes. Hence, it is difficult to use his model framework to describe how consumption is influenced by household expectations. A possible interpretation of this assumption is that households do not form explicit expectations about the future (myopic expectations) – or that households are subject to credit rationing, so it is difficult for them to respond to e.g. expectations about higher future income.

A widespread alternative to the model type discussed above is dynamic stochastic general equilibrium (DSGE) models. In a DSGE model, household expectations of the future play a key role in consumption, cf. Box 1, so this type of model is better suited to analysing the significance of e.g. structural changes that can be expected to influence household behaviour.

However, the DSGE model framework entails the challenge of explicit modelling of formation of expectations. It is typically assumed that households have rational expectations and can comprehend the conse-

THE CONSUMPTION FUNCTION IN DSGE MODELS Box 1

In DSGE models consumers choose the consumption and savings levels which will maximise their wellbeing within their budget constraint, i.e. they maximise utility. Moreover, consumers are forward-looking, basing today's consumption on expectations of future income and wealth.

Implications of the consumption function

Given that consumption in a typical DSGE model is a forward-looking variable, formation of expectations may potentially play a key role. These expectations are typically assumed to be formed rationally. If consumers have fully rational expectations, they use all available information (i.e. all information on relationships in the model) to form expectations regarding future income. For example, this means that consumer expectations of future income and wealth will be based on information on how the other economic agents are expected to act in the future, including the central bank and the public sector.

Consumers are assumed to be able to identify all shocks, e.g. whether higher income can be attributed to higher wages as a result of stronger productivity growth, or whether higher income is attributable to higher tax-funded transfers. Given forward-looking and rational expectations, the first case will entail consumption growth, since it implies higher future income for the consumers. In the second case, the consumption effect will be zero, since life-cycle income is unchanged (tax-funded transfers are to be financed via higher taxes in the future).

Since consumers optimise their consumption taking future income into account, real interest rates will play a key role in consumption development, because today's consumption depends on expectations regarding all future real interest rates. If monetary policy can influence real interest rates, e.g. because of price stickiness, monetary policy will not only be passed through via today's real interest rates, but also via expectations regarding the future monetary-policy stance.

CONTINUED Box 1

The DSGE model framework was constructed, *inter alia*, in response to the Lucas critique.[1] Lucas criticised macroeconometric models for not being structural and thus not taking into account that the model parameters depend on the economic policy pursued. The coefficients in the traditional economic models, e.g. equation (2) above, are estimated on the basis of historical data and thus the relationships in the economy that applied under past economic policy. Changed economic policy can change consumer behaviour and hence the model coefficients.

The DSGE model's relations are based on maximising rational behaviour in households and firms, whereby the relations are, in principle, unchanged over time and hence robust to the Lucas critique.

[1] The Lucas critique was formulated by Robert E. Lucas Jr., who was awarded the Nobel Prize for Economics in 1995 for, *inter alia*, this work.

quences of all changes and shocks to the economy. This is a strict assumption that does not always hold true in practice. No matter which model framework is chosen, it is therefore necessary to include simplified assumptions that are not necessarily met in the real world.

CONSUMPTION, INCOME AND WEALTH IN AN INTERNATIONAL CONTEXT

This section first examines whether developments in consumption and wealth ratios across a number of countries are in accordance with the simple model described above. Differences in consumption fluctuations across countries are then examined.

Many countries have seen a general increase in the wealth ratio over the last 30 years, cf. Chart 1. In most countries, rising housing wealth has accounted for a considerable share of the increase, e.g. in Denmark and Sweden, where housing wealth rose by 150 and 110 per cent, respectively, relative to disposable income in the period 1990-2010.[1]

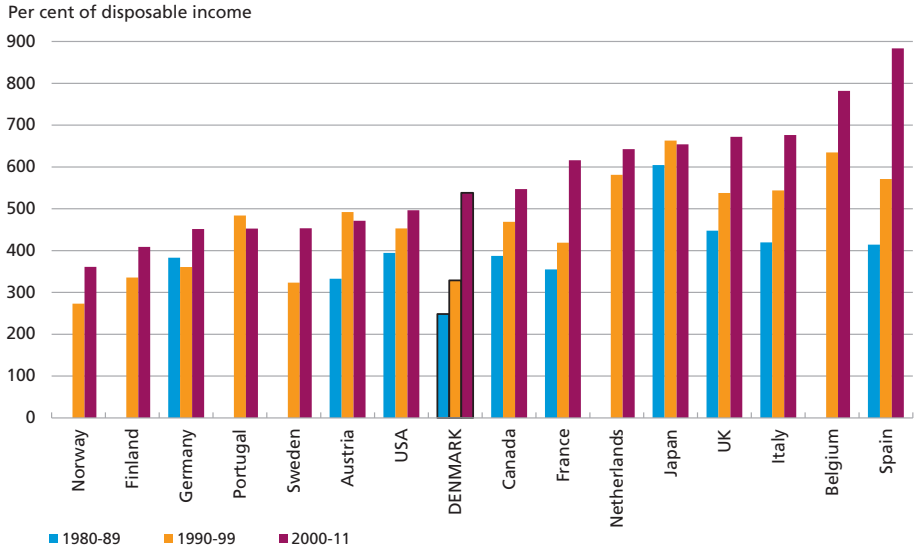
Higher pension savings have also contributed substantially to rising net wealth in some countries, such as Denmark and the Netherlands. Since 1995, pension wealth in Denmark and the Netherlands has grown by approximately 140 and 170 per cent of disposable income, cf. Chart 2.

Development in consumption and wealth ratios

Given the increase in the wealth ratio over the last 30 years, the consumption ratio could also be expected to have risen. However, not many

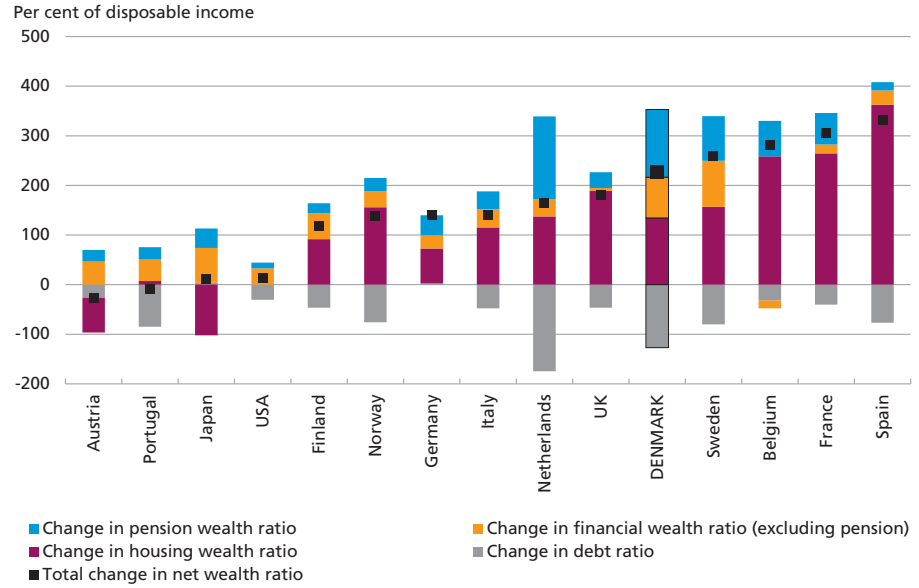
[1] Properties owned by non-residents are included in housing wealth in the country where the property is located. This may have considerable influence on the calculation of e.g. housing wealth in Spain.

AVERAGE NET WEALTH RATIO FOR HOUSEHOLDS — Chart 1



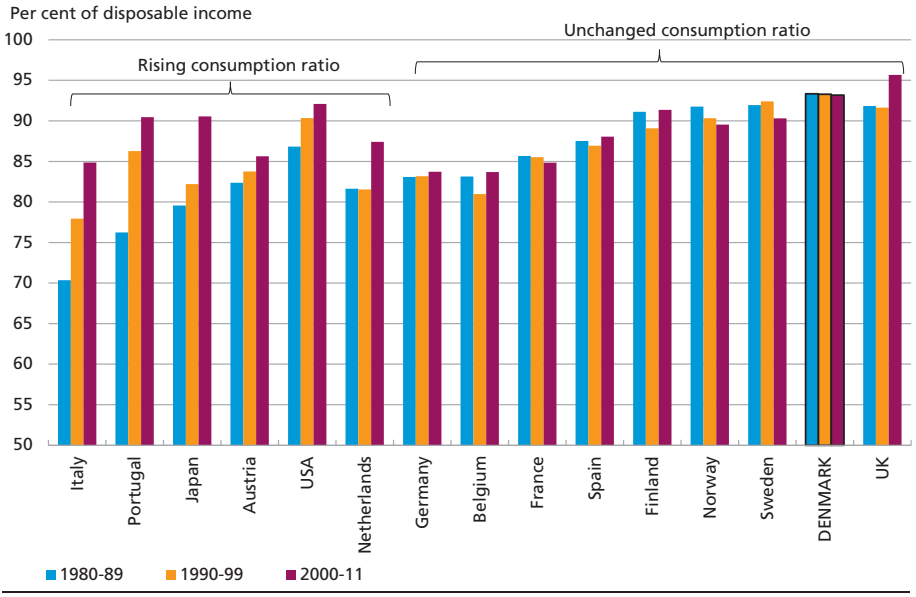
Note: Including pension wealth before tax.
Source: Own calculations based on data from OECD, Statistics Denmark, Isaksen et al. (2011) and De Bonis, Fano and Sbano (2007).

CHANGE IN WEALTH RATIO IN THE PERIOD 1995-2010 — Chart 2



Note: Including pension wealth before tax.
Source: OECD, Statistics Denmark and Isaksen et al. (2011).

AVERAGE CONSUMPTION RATIO FOR HOUSEHOLDS Chart 3



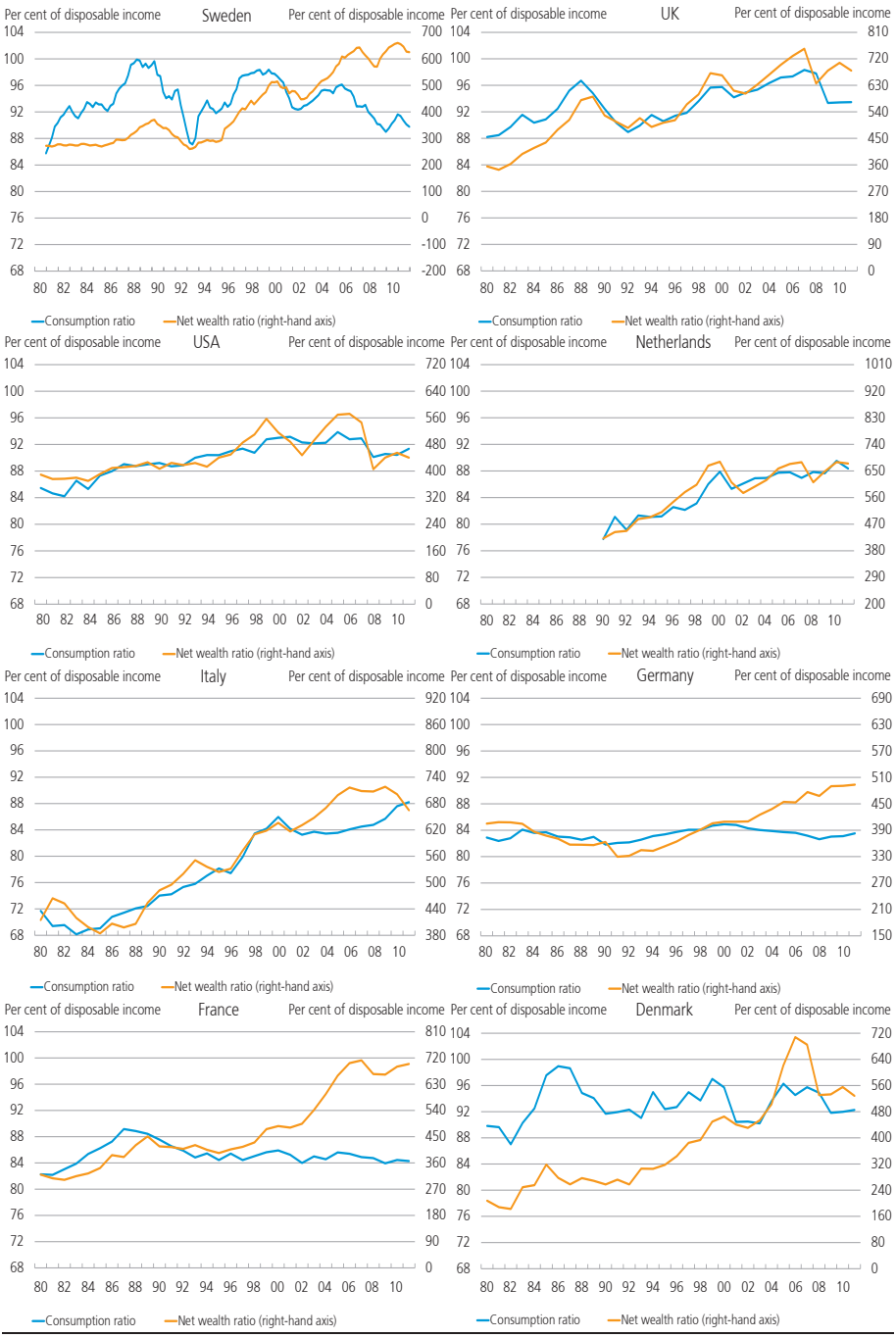
Note: It has been attempted to adjust for data breaks. For Austria and Belgium the average in the 1980s covers only 1985-89.
Source: OECD and Isaksen et al. (2011).

countries have seen such an increase. Instead, average consumption ratios have been virtually stable over the last three decades, cf. Chart 3. Only Italy, Portugal and Japan have seen a considerable increase in the consumption ratio, which should be viewed in light of such factors as the initially very low consumption ratios in these countries relative to other OECD countries.

However, the ratio of consumption to disposable income varies substantially across countries. For example, the Danish consumption ratio has been around 10 percentage points higher, on average, than the German ratio over the last three decades. The variation in consumption ratios can be attributed to several factors, such as differences in the size of the public sector, demographics, financial development, corporate savings, interest-rate levels and tax structures, cf. Isaksen et al. (2011).

Chart 4 compares consumption patterns and wealth ratios for a number of countries since 1980. In the UK, the USA, Italy and the Netherlands, the consumption ratio follows the same pattern as the wealth ratio over time. For the remaining countries – including Denmark – the wealth ratio tends to have increased considerably more than the consumption ratio. In the years up to the financial crisis, Denmark and the USA, in particular, saw considerable growth in housing wealth, which

WEALTH AND CONSUMPTION RATIOS, SELECTED COUNTRIES — Chart 4



Note: The net wealth ratio includes net financial assets and housing wealth. Income has been calculated including net pension contributions, cf. Box 2.

Source: OECD, Statistics Denmark, Isaksen et al. (2011) and De Bonis, Fano and Sbano (2007) and Sveriges Riksbank.

contributed to the substantial rise in the consumption ratio. In the post-crisis years, both the wealth ratio and the consumption ratio have fallen back.

The literature has identified several factors that may have contributed to the rise in net wealth over time without the consumption ratio following suit. Demographics, for instance, may have affected the consumption ratio over time. More widespread use of savings-based pension schemes may also have played a role, e.g. if public pension payouts are partially replaced by private pension payouts. Financial constraints or lack of response to higher pension savings among households may also lead to pension savings increasing net wealth without the consumption ratio following suit. Moreover, falling interest rates have presumably increased wealth; a case in point is the strong growth in house prices in most countries. Over the last 20 years, house price gains have probably only partially been translated into consumption. Possible reasons are credit constraints – for instance, it is not possible to borrow against home equity in a number of countries – or households' aversion to increasing their LTV ratios.

Consequently, the pattern in Denmark over the last three decades with an increasing wealth ratio and a stable consumption ratio is not unique; it is also found in other countries such as Sweden, France and to a lesser extent Germany. However, this development may not necessarily have the same determinants across countries. In Denmark, the LTV ratio for homes has increased over the last 20-30 years, presumably due to both the Danish mortgage-credit system and to the fact that high pension wealth reduces the need for having redeemed all debt by the time of retirement. This makes it possible that a larger share of house price increases in Denmark over the last 20 years has been translated into consumption compared with other countries. Moreover, a further distinguishing feature of private consumption in Denmark relative to comparable countries is the high degree of volatility, which is analysed in more detail in the following section.

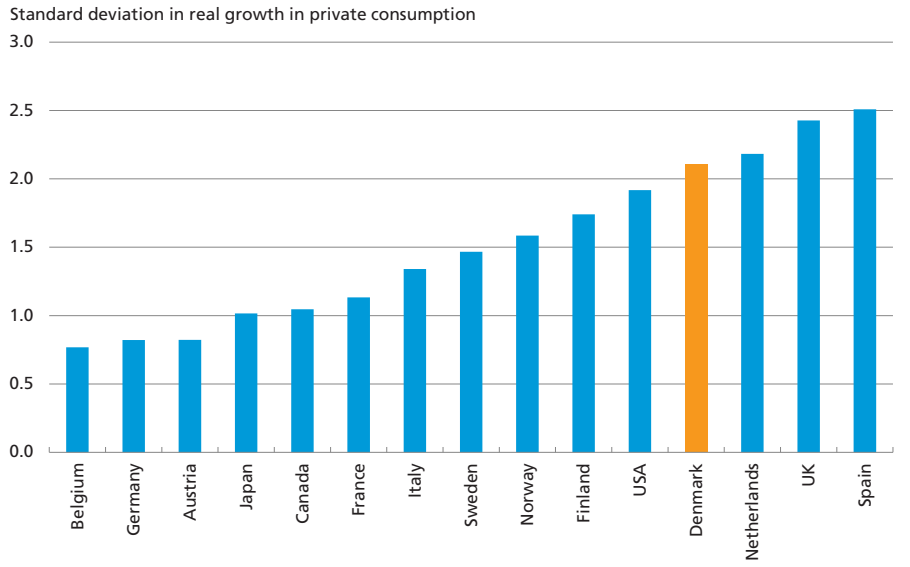
Volatility in consumption

From the 1980s until the present crisis, many countries have seen a decrease in the volatility of growth in real private consumption, which is typically explained by enhanced economic policy and/or smaller shocks to the economy. This development has been called the great moderation.[1] Despite the decrease over time, volatility still varies considerably across countries. For example, fluctuations in private consumption are

[1] For more details, see Galí and Gambetti (2009).

FLUCTUATIONS IN REAL GROWTH IN PRIVATE CONSUMPTION ACROSS COUNTRIES

Chart 5



Note: 1996-2011. The standard deviation is based on annual national accounts data.
Source: OECD.

more than twice as strong in Denmark as in Germany (measured in terms of standard deviations), cf. Chart 5. Consumption growth volatility is generally stronger in Denmark than in most other comparable countries.[1]

The variation of consumption volatility across countries may be attributable to several factors. The differences may e.g. be attributable to the composition of consumption or differences in the volatility of the factors determining consumption, i.e. income and wealth.

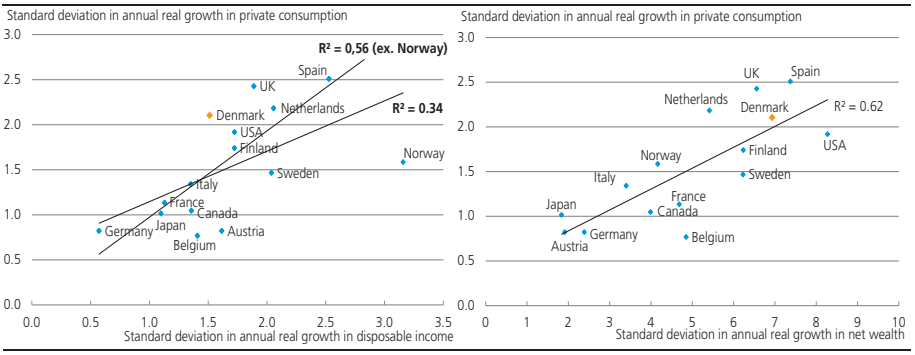
Composition of consumption

In countries with a large public sector, such as Denmark, healthcare services and education, among other things, are paid by the government (individual public consumption). As a result, these consumer goods are not included in private consumption in Denmark. Since many of these services are necessities, they will tend to fluctuate less over a business cycle than the remainder of consumption. This indicates a higher degree of volatility in private consumption in countries with a large public sector. In the period from 1995 to 2007, there was a clear link between

[1] There is a positive relationship between GDP per capita and the volatility of consumption growth. In order to ensure a more comparable basis this section focuses on countries with almost the same level of welfare.

CORRELATION BETWEEN FLUCTUATIONS IN CONSUMPTION, INCOME AND WEALTH

Chart 6



Note: 1996-2011.
Source: OECD, Statistics Denmark and Isaksen et al. (2011).

higher individual public consumption and more pronounced volatility in private consumption. In the period after the financial crisis this link has been less characteristic.

Changes in income and wealth

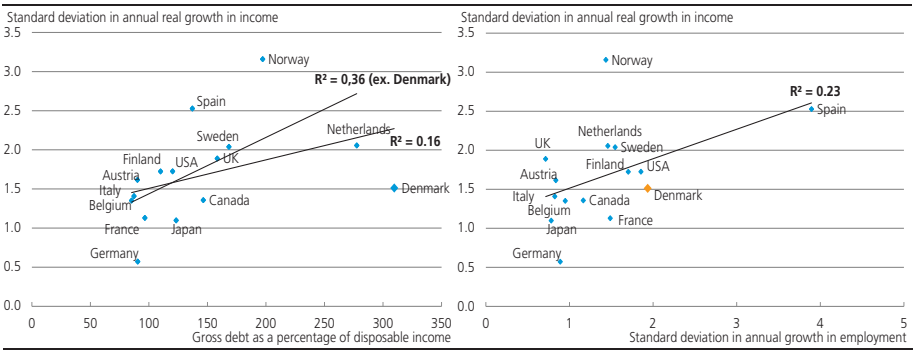
A key factor contributing to varying volatility in consumption growth is differences in volatility in income and wealth across countries, cf. Chart 6.

There may be several reasons why incomes fluctuate. For example, fluctuations in employment will entail stronger fluctuations in income and thus consumption, cf. Chart 7 (right). A generous unemployment benefit system, on the other hand, will dampen fluctuations in income.

In addition, the household debt ratio may influence disposable income via interest payments, cf. Chart 7 (left). Interest-rate fluctuations tend to

CORRELATION BETWEEN FLUCTUATIONS IN INCOME, GROSS DEBT AND EMPLOYMENT

Chart 7



Note: 1996-2011.
Source: OECD, Statistics Denmark and Isaksen et al. (2011).

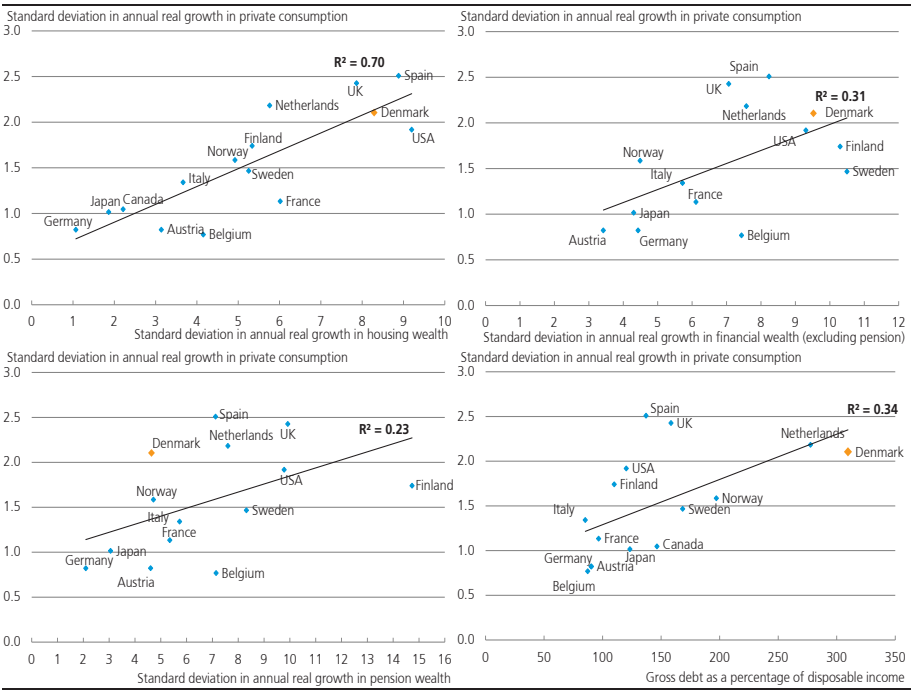
affect income more for households with a high debt ratio than for households with a low debt ratio. Moreover, households with high debt and a high LTV ratio will find it difficult to smooth out consumption by increasing borrowing in the event of a temporary decrease in income due to e.g. unemployment. The Danish and partially the Dutch households differ from households in other countries in that their incomes tend to fluctuate far less than could have been expected, viewed in isolation, on the basis of their gross debt ratios. One possible explanation is that the underlying structural factors that contribute to the high gross debt ratios in Denmark and the Netherlands, such as developed financial markets, large private pension wealth and sound public finances, tend to dampen fluctuations in income at the same time.

Change in wealth

There is also a clear relationship between fluctuations in wealth and consumption, cf. Chart 6 (right). Wealth consists of several components. Volatility in housing wealth is the component that has shown the strongest correlation with volatility in private consumption since 1996, cf. Chart 8 (top left). Denmark is one of the countries that have seen the

CORRELATION BETWEEN FLUCTUATIONS IN CONSUMPTION GROWTH AND GROWTH IN WEALTH COMPONENTS

Chart 8



Note: 1996-2011.
Source: OECD, Danmarks Statistik and Isaksen mfl. (2011).

strongest volatility in housing wealth and private consumption in recent years. However, the reasons for the correlation cannot be determined on the basis of these simple graphs. One possibility is that falling interest rates or a fiscal easing increases both consumption and house prices. Another possible explanation is that fluctuations in housing wealth affect credit constraints and thus volatility in consumption.

In the period from 1996, fluctuations in pension wealth have been only weakly correlated with private consumption, cf. Chart 8 (bottom left), especially if the focus is on countries where households hold substantial pension wealth (Denmark, the Netherlands, Sweden, the UK and the USA). This is probably related to the fact that capital gains on pension wealth cannot be realised immediately, but are instead paid out over a number of years with a considerable lag. On the other hand, fluctuations in non-pension financial wealth have been more strongly correlated with consumption, cf. Chart 8 (top right).

Initially, the size of household gross debt also plays a role with regard to fluctuations in private consumption. As mentioned previously, this may be attributable to both the direct effect on income from interest-rate fluctuations and to the fact that it is more difficult for households with high debt and high LTV ratios to smooth out consumption in the event of a temporary fall in income.

CONSUMPTION IN DENMARK

Average annual growth in consumption in Denmark has been almost 2 per cent over the last 30 years. But this masks substantial fluctuations. For example, private consumption increased strongly in the period up to the financial crisis and then dropped by almost 6 per cent from the 2nd quarter of 2008 to the 1st quarter of 2009. In order to analyse the reasons for this development, we construct and estimate a model that explains consumption by income, wealth and several other factors.

While there is extensive empirical literature on aggregate consumption functions, especially on US data, there are also a number of studies based on Danish data.[1]

The short-run and medium-run properties of the consumption function are to a high degree determined by the choice of consumption-determining income, while the choice of definition of wealth plays a smaller role. In order to explain the empirical choices in this article in the best possible way, we begin by discussing a number of definitions of income

[1] See, *inter alia*, Davis and Palumbo (2009) for analyses of US data, Macklem (1994), for analyses of Canadian data or Olesen (2008) and Dam, Hansen and Olesen (2004) for analyses of Danish data.

and wealth. We then proceed to test formally whether our choices of income and wealth definitions provide a robust long-run relationship between consumption, income and wealth.

Income definition

Only households account for private consumption. Consequently, it is most natural in the first instance to focus on household income, which is indeed the approach in this article. While the major part of household income is wage income, households also have other income, such as investment income and public transfers in the form of old age pension, unemployment benefits, social benefits, leave allowances, etc. Moreover, income is taxable. Total household income after tax is called household disposable income in the national accounts.

The calculation of household disposable income is not entirely unambiguous. In the national accounts, mandatory pension savings, i.e. labour-market pensions, are included as a mandatory expense that reduces disposable income. Investment income from labour-market pensions does not impact the disposable income in the national accounts either, as investment income is assumed to accumulate in the pension accounts. Pension payouts, on the other hand, are regarded as income contributing to disposable income. It is also possible to calculate an adjusted disposable income where pension savings are treated as all other wealth, cf. Box 2.

It can be argued that a more broad-based income concept covering income in the private sector overall, i.e. including pension funds, can be an alternative to household disposable income.[1] Corporate income will normally be paid out to the owners sooner or later via dividend and thus be included in household disposable income.

However, parts of corporate income may end up in the households without being included in household income. This is because corporate income can be transferred to households via firms buying back their own shares from the households. This will be posted in the national accounts as if the households have realised a capital gain (retained profits lead to higher equity prices). Hence, a household's income will not capture the development in earnings in the firms owned by the household. This supports the argument that income in the private sector overall may be a better measure of consumption opportunities in the long run.

[1] Most estimations on Danish data are based on income and wealth for the private sector overall, cf. Olesen (2008).

TREATMENT OF PENSION SAVINGS IN THE NATIONAL ACCOUNTS Box 2

Pension savings in collective schemes are treated differently from other savings in the national accounts. Since wage earners have to pay a part of their salary to collective schemes, these pension savings are regarded as a mandatory expense, i.e. money not at the households' disposal. Contributions to these schemes are thus deducted from the calculation of disposable income, while payouts from the schemes are added to disposable income. Pension contributions are, however, included in gross savings in the national accounts (here called adjusted gross savings). As a result, disposable income less consumption does not equal adjusted gross savings.

In order to make developments in income, consumption and adjusted savings fit, the national accounts contain an adjustment variable (D8). The D8 item is calculated as net contributions to collective pension schemes plus associated capital gains less pension yield tax. Adding D8 to the national accounts definition of disposable income results in adjusted disposable income, where pension savings in collective schemes are treated as all other savings. Adjusted disposable income less consumption equals adjusted gross savings (savings including D8).

Given the pension yield tax on capital gains, adjusted disposable income will fall when e.g. equity prices rise (equity price gains are regarded as capital gains and not capital returns). Hence, the consumption ratio based on adjusted disposable income will rise when equity prices go up, but this relationship is purely mechanical and does not reflect a wealth effect on consumption.

However, parts of corporate income are paid to foreign owners and to the central government, which supports using household income as a measure. It is, however, possible to adjust private-sector income accordingly. For the consumption function in Danmarks Nationalbank's macroeconomic model, MONA, private-sector income is adjusted for energy-sector income, among other factors.

But other factors go against the use of a broad-based income concept, *inter alia* in connection with analyses of e.g. interest-rate shocks. Rising interest rates will increase private-sector disposable income, since the private sector, including the pension funds, has interest-bearing net wealth. If the household sector is viewed in isolation, rising interest rates will, on the other hand, reduce income in the short and medium run, because the household sector has interest-bearing net debt, disregarding pension wealth.

In the slightly longer term, changed investment income in the pension funds will, however, affect household disposable income. The reason is that the accumulation of investment income from pension wealth affects household disposable income with a lag via future pension payouts.[1] Thus, changes in interest rates will immediately be passed through

[1] The treatment of investment income from pension wealth correponds to the disposable income concept in the national accounts. Other macro models, such as ADAM, have the same approach in the short run.

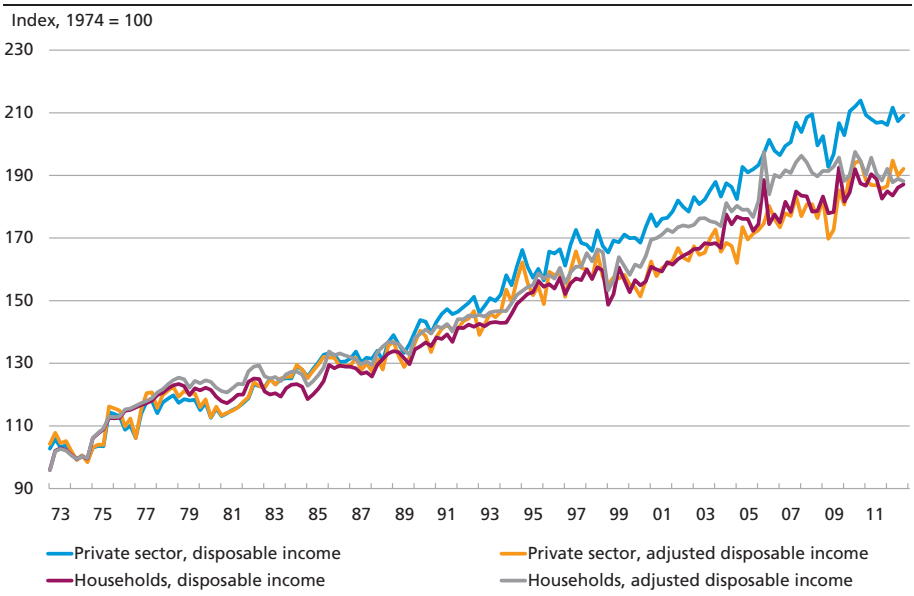
to household interest expenses, while the interest income from pension wealth will only slowly affect income.

Even including the return on pension wealth in consumption-determining income, there is reason to believe that interest-rate increases entail higher net interest payments for the households. This is because return on pensions is to a great extent fixed-rate return, either due to a guaranteed minimum return or to the widespread hedging of interest-rate risk among the pension funds. Pension wealth can thus be regarded as fixed-rate wealth.

On the basis of the above discussions, we opt for the household disposable income concept from the national accounts, i.e. an income concept where investment income from pension funds only slowly increases consumption-determining wealth. The model properties – especially interest-rate sensitivity – are strongly influenced by this income definition in the short and medium run.

In the period from 1973 until the end of the 1990s, the different income concepts showed almost identical patterns, cf. Chart 9, but since then the overlap between the income concepts has been slightly less clear.

DEVELOPMENT IN DISPOSABLE INCOME — Chart 9



Note: All indices are based on nominal, seasonally adjusted quarterly developments deflated by the development in consumer prices. Private sector, adjusted: disposable income adjusted for income in the energy sector and depreciation. The different developments in private-sector income and household income in 1999 are especially attributable to strong growth in income in the energy sector.

Source: Own calculations based on data from Statistics Denmark, Danmarks Nationalbank and MONA.

Wealth definition

Household wealth consists of various assets less debt. Housing accounts for the largest share of wealth, but the households also hold a number of financial assets, such as equities, bank deposits and pension savings. Fluctuations in wealth are attributable to fluctuations in housing and equity wealth in particular, cf. Chart 10.

The value of parts of the assets is associated with some uncertainty. This is because the market value of rarely traded assets is not known. In the national accounts, the market value of these assets is instead based on the market value of comparable traded assets.

While, as regards income, there are both pros and cons of using household or private-sector income, respectively, to explain private consumption, it is difficult, as regards wealth, to identify advantages of using private-sector wealth.

The most important difference between private-sector and household wealth is how the value of firms is calculated. For households, it is calculated as the market value of their equity wealth, while for the private sector overall it is calculated as the value of firms' capital stock at replacement cost.[1] However, the value of a firm is influenced by factors other than just the value of the capital stock, e.g. the value of patents and goodwill.

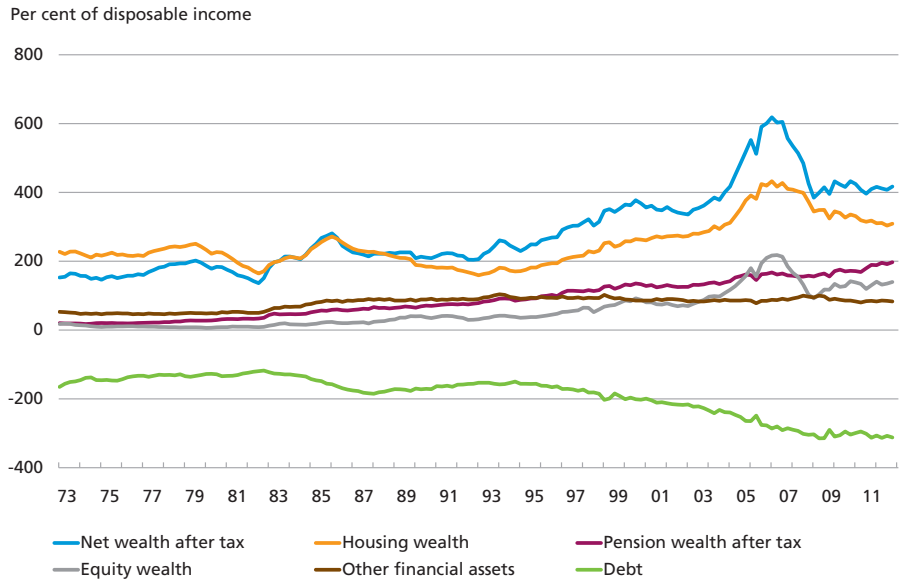
In theory, equity prices should capture the market value of all these factors. Moreover, equities are far more liquid than the capital stock of firms. Equity wealth should thus be assumed to be more relevant to households' consumption and savings decisions than the value of firms' capital stock.

Household wealth and private-sector wealth have differed considerably since 1970. Both growth and volatility have been stronger for household net wealth than for private-sector wealth, cf. Chart 11.

Although it seems obvious to use household net wealth rather than private-sector net wealth, the final choice of consumption-determining wealth is a challenge and associated with uncertainty. The reason is that the wealth ratio for households has risen substantially without the consumption ratio following suit. An increasing wealth ratio in conjunction with a stable consumption ratio poses challenges when constructing a stable consumption function, as this requires identical development patterns for the two ratios. It is not possible to identify clearly, on the basis of macroeconomic data, which components of wealth have risen

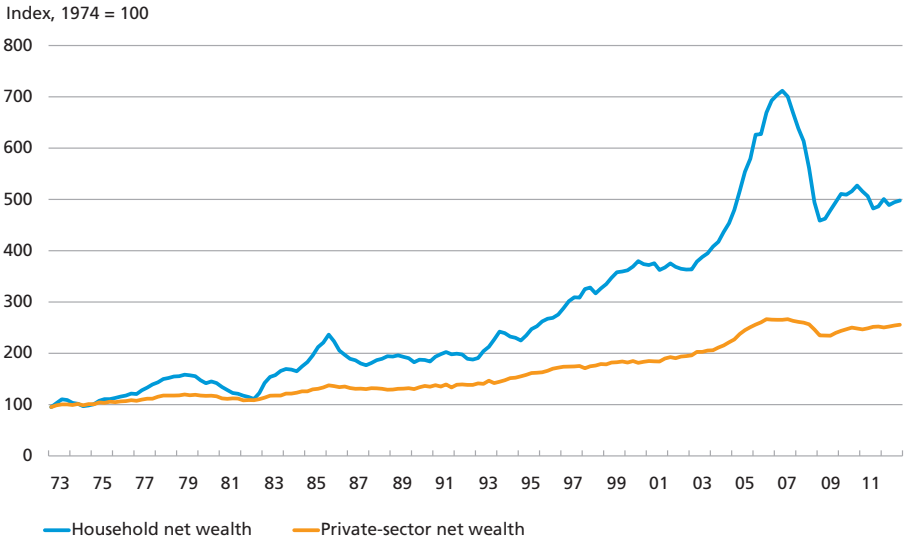
[1] Replacement cost is used in the absence of market value of the capital stock. For the private sector overall, equity wealth is practically negligible, because it constitutes an asset for households, but a liability for firms. Hence, net equity wealth for the private sector overall is by and large zero.

HOUSEHOLD BALANCE SHEET BY COMPONENTS — Chart 10



Source: Danmarks Nationalbank.

WEALTH DEVELOPMENTS — Chart 11



Note: All indices are based on nominal, seasonally adjusted quarterly developments deflated by the development in consumer prices. Private-sector wealth consists of commercial plant and equipment, building and construction capital, housing wealth and net financial wealth (based on quarterly financial accounts) for the private sector overall, including financial corporations. The calculation of private-sector wealth in MONA is slightly different as regards calculation of financial wealth, but the pattern is almost the same.

Source: Own calculations based on data from Statistics Denmark, Danmarks Nationalbank and MONA.

without consumption following suit. However, there are some empirical and theoretical clues.

The various household assets differ markedly, and it is possible to identify a number of reasons why their respective impacts on consumption may also vary.

Pension wealth

The use of savings-based pension schemes, which are part of the collective agreements, has increased considerably over the last 30 years. At the same time, the contribution margins for these pension schemes have also risen. From 1980 to 2011, household pension wealth before tax has grown from approximately 50 per cent to more than 300 per cent of disposable income.[1] The large pension wealth is estimated to entail higher income for future pensioners, but pension payouts are regarded as income, which will reduce a number of income-related allowances, such as the pension premium. The widespread use of labour-market pensions for civil servants and corresponding phasing-out of civil servant pensions may also have increased pension wealth without increasing these people's income as pensioners. For some households, higher pension savings will thus only to a minor degree increase their income as pensioners.

According to the simple consumption model presented above, the households decide their level of saving on the basis of their preference for even consumption. If a household is forced to save up more in a pension scheme than it wishes, it will just reduce other savings accordingly. Consumption and savings will thus remain unchanged, while disposable income will fall (the pension contributions erode disposable income). Overall, this entails a slight increase in the consumption and wealth ratios as a result of lower disposable income.

There are a number of studies – both at individual and macro level – of how mandatory pension savings affect other savings. Their general conclusion is that higher mandatory savings only leads to a reduction of other savings by 15-40 per cent for households, where studies based on individual data are generally at the low end of the interval.[2] A reduction of other savings by e.g. 20 per cent entails, viewed in isolation, a higher wealth ratio, but a limited effect on the consumption ratio (calculated as consumption over disposable income in the national accounts) since both consumption and disposable income are reduced as a result of higher mandatory savings. However, it is not possible to transfer these

1 Pension payouts are liable for income tax.
2 See e.g. Isaksen et al. (2011), Economic Council (2008) and Arnberg and Barslund (2012).

estimates for household savings behaviour directly to a specific weight of pension wealth in the macro analysis.

The relatively small estimated reduction of other savings may be attributable to, *inter alia*, the households factoring in the reduction of parts of public pensions due to pension payouts. An additional possible explanation is that the households are not fully able or willing to reduce other savings, e.g. by increasing borrowing or that they are not fully able to perceive the consequences of the higher mandatory pension savings.

When labour-market pensions are fully phased in, payouts will exceed contributions, resulting in higher disposable income (the consumption ratio will remain largely unaffected).[1] However, the large payouts will put a stop to growth in the pension wealth ratio.

The discussion above indicates a small impact on the consumption ratio from pension wealth, especially in the short and medium run. For some households, e.g. those that are close to retirement, pension wealth no doubt plays a larger role. An in-depth analysis of the long-run effects of increased private pension wealth is beyond the scope of this analysis, however.

Housing and equity wealth

From a theoretical perspective, it is by no means obvious that housing wealth should have an impact on consumption. The reason is that housing wealth – as opposed to other wealth – does not constitute a claim on another sector. Rising house prices will thus result especially in a shift of wealth from new to existing homeowners. Nevertheless, empirical analyses typically find that the consumption effect of housing wealth is more pronounced than the consumption effect of financial wealth (which tends to fluctuate as a result of variations in equity prices), cf. Altissimo et al. (2005). The following factors, among others, can be mentioned:

- Rising house prices reduce credit constraints and improve the access to raise loans against the home as collateral.
- Households regard house price fluctuations as more permanent than equity price fluctuations. Hence, households will be more inclined to adjust their consumption as a result of changes in house prices than as a result of changes in equity prices. This applies particularly in countries where it is easy to borrow against home equity.
- Purchase of a home is typically financed partially with borrowed funds, i.e. residential investment is leveraged. This means that increasing

[1] Payouts exceed contributions as pension wealth accrues interest.

house prices result in a higher net return on equity, compared with non-leveraged investment. Accordingly, rising house prices have a stronger impact on consumption compared with other assets.

- Housing wealth is more evenly distributed across households than financial wealth. Only 9 per cent of Danish families hold equity for more than kr. 100,000, cf. Table 1, while approximately half of all families own a home. Moreover, families with substantial equity wealth tend to have considerably higher income than the average income (2.6 times higher for families with equity wealth exceeding kr. 1 million). If the propensity to consume is lower among the families in the highest income brackets, changes in equity prices will have a smaller effect on consumption, compared to house price increases.
- Capital gains on equities are regarded, for tax purposes, as capital income at the time of realisation of the capital gain. The payment of tax reduces the gain from equity price increases. Conversely, capital gains from housing are not taxable.
- A large part of the equity wealth consists of unlisted shares typically issued by small firms, e.g. a doctor's practice or a small firm of builders. Unlisted equity securities should be expected to be illiquid, i.e. they are difficult to sell quickly without a considerable loss. At the same time, it will often not be possible to sell only parts of the portfolio. Moreover, it may also be difficult to borrow against them. Consequently, any capital gains will be very difficult to realise. All of these factors indicate a low propensity to consume out of unlisted equity securities. In addition, the calculation of the value of household portfolios of unlisted equity securities is associated with far greater uncertainty than other wealth components, due to a combination of no available market prices and inadequate source data.[1]

However, there may be factors indicating a dampening of the effect of changed house prices on consumption. House prices have risen strongly over the last 20 years, due to, *inter alia*, falling interest rates and introduction of new loan types. Higher housing wealth can only be realised by the households – either by borrowing against home equity or by selling the home. The Danish mortgage-credit system provides ample room for borrowing against home equity and thus translating house price increases into consumption, but there are limits to how much the households can and will increase the LTV ratio. This means that the last 20 years' house price increases have only partially been translated into

[1] Source data for portfolios of unlisted equities stems from accounts statistics databases, but the coverage ratio of these databases is uncertain and may have changed considerably over time.

AVERAGE FAMILY INCOME Table 1

Share of average income/per cent	Income	Share of families
Equity wealth 0-10,000	0.9	76 per cent
Equity wealth 10,000-50,000	1.2	9 per cent
Equity wealth 50,000-100,000	1.3	4 per cent
Equity wealth 100,000-250,000	1.4	5 per cent
Equity wealth 250,000-500,000	1.5	2 per cent
Equity wealth 500,000-1,000,000	1.6	1 per cent
Equity wealth over 1,000,000	2.6	1 per cent

Note: Data is based on custody bank statistics, which are not exhaustive. The data does not include e.g. equity securities in safety deposit boxes or similar.
Source: Statistics Denmark and own calculations.

consumption. This is in line with analyses of inheritance at individual level. According to these analyses, the Danes, especially homeowners, have left increasing amounts of inheritance, cf. Juul (2012).[1]

The above discussion indicates that increasing pension and equity wealth has played a substantial role in the different patterns of the consumption and wealth ratios, but that higher housing wealth may also have been a factor. This is confirmed by a simple estimation explaining the consumption ratio by the pension, equity and housing wealth ratios and the remainder of the net wealth ratio. The estimated weights of the pension and wealth ratios become small and not statistically significant, while the weight of the housing wealth becomes slightly smaller than the weight of the remaining net wealth ratio. Hence, it seems obvious to reduce the weights of these wealth components in a model context.

Long-run models: Estimation results

In order to obtain the best possible illustration of the consequences of various income and wealth definitions, we estimate four different consumption relations based on different income and wealth definitions:

- M1: Private-sector wealth and private-sector disposable income adjusted for income in the energy sector and depreciation.[2]
- M2: Total household wealth, including pension wealth and adjusted household disposable income.[3]
- M3: Total household wealth excluding pension and unlisted equities and household disposable income.

1 The calculations of inheritance are associated with considerable uncertainty. Juul (2012) finds that inheritance averaged around kr. 500,000 in 1997, while Economic Council (2004) finds that inheritance averaged around kr. 300,000 in 2000 (both in 2010-prices).

2 M1 roughly coresponds to the present model in MONA, but with a slightly different wealth concept. However, the two wealth concepts show almost identical development patterns.

3 In M2, pension wealth is treated like all other wealth as regards both wealth and income. Pension contributions should therefore not reduce disposable income, so adjusted disposable income is used, cf. Box 2.

- M4: Net household wealth, including housing wealth at a weight of 0.8, pension wealth at 0.2 and equity wealth at approximately 0.4, and household disposable income.

Model 3 excludes unlisted equities, corresponding to setting the weight at approximately 0.5, while also reducing the fluctuations in total equity wealth, since the calculated value of unlisted equities in the national accounts has tended to fluctuate more than the value of listed equities. In model 4, the weight is adjusted further downwards to around 0.4.

The choice of functional form is described in Box 3. Given the chosen functional form, the logarithms of the consumption and wealth ratios should move in parallel. Looking at the consumption and wealth ratios together thus provides an indication of the stability and properties of the four models, cf. Chart 12.

CHOICE OF FUNCTIONAL FORM OF THE CONSUMPTION FUNCTION Box 3

The basis for the consumption function is the simple model described above, where consumption is described as a linear function of income and wealth, cf. equation (2).

(2) $C_t = m_t * (k*Y_t + W_t) = \alpha_1 Y_t + \alpha_2 W_t$

In the empirical literature, estimation is only rarely made directly on an equation like (2), because growth in consumption, income and wealth is typically regarded as relatively steady in the long run (i.e. exponential growth). It is difficult to estimate the relationship between time series with exponential growth. Instead, the time series are transformed in a way that ensures a stable long-run relationship (i.e. cointegration).

We choose to transform all variables by compiling them as logarithms, resulting in linear development. In equation (2) above, the estimated parameters α_1 and α_2 can be interpreted as propensities to consume, i.e. by how many kroner consumption increases when income or wealth, respectively, increases by one krone. When the variables are compiled as logarithms, the estimated parameters become elasticities, i.e. they denote the percentage increase in consumption on a 1 per cent rise in income or wealth, respectively.

Comparison of elasticities is difficult, since they depend on the relative sizes of the estimated components. A 1 per cent rise in house prices e.g. tends to increase total household wealth more than would have been the case with a 1 per cent rise in bond prices, because housing wealth is larger than bond wealth. Hence, a 1 per cent increase in house prices should be expected to have a stronger impact on consumption, compared with a 1 per cent increase in bond prices, i.e. the elasticity of housing wealth becomes more pronounced than the elasticity of bond wealth.

In addition, the elasticities are only relevant in the short term, since wealth is, in the long run, endogenous and determined by income. In the very long run, the elasticity of income will be 1, and an increase by 1 per cent in income will boost wealth by 1 per cent.

CONTINUED Box 3

Despite the different elasticities for the individual wealth components, the propensities to consume may be the same. The transition between consumption elasticities and propensities to consume are given as $MPC_Y=(C/Y)*\varepsilon_Y$ and $MPC_W=(C/W)*\varepsilon_W$, where *MPC* is the marginal propensity to consume and ε the marginal consumption elasticity from income (*Y*) and wealth (*W*).

In connection with modelling of consumption in macroeconomic models such as MONA, a homogeneity constraint is imposed on the consumption function. The constraint implies that in the event of a 1 per cent increase in both income and wealth, consumption also grows by 1 per cent. The constraint corresponds to the requirement that the sum of α_1 and α_2 must be 1. This gives:

(3) $\log(C_t) = \alpha_1\log(Y_t)+ \alpha_2 log(W_t)$, *where* $\alpha_1+ \alpha_2=1$

(4) $\log(C_t/Y_t) =(1- \alpha_1)\log(W_t/Y_t)$

so that the constraint forces the consumption ratio, $\log(C_t/Y_t)$, and the net wealth ratio, $\log(W_t/Y_t)$, to show the same pattern in the longer run. A strong increase in the wealth ratio will increase the consumption ratio, resulting in declining savings. The wealth ratio will thus decline until equilibrium is restored. This is an attractive property ensuring balanced growth in consumption, income and net wealth in the longer run.

The consumption and wealth ratios based on private-sector income and wealth, M1, follow each other closely until the late 1990s, after which time the wealth ratio begins to show an upward trend. Consequently, in the model estimation, the parameter estimate of wealth will decline after 1995, and estimated consumption will tend to be too low in the beginning of the period and too high at the end.

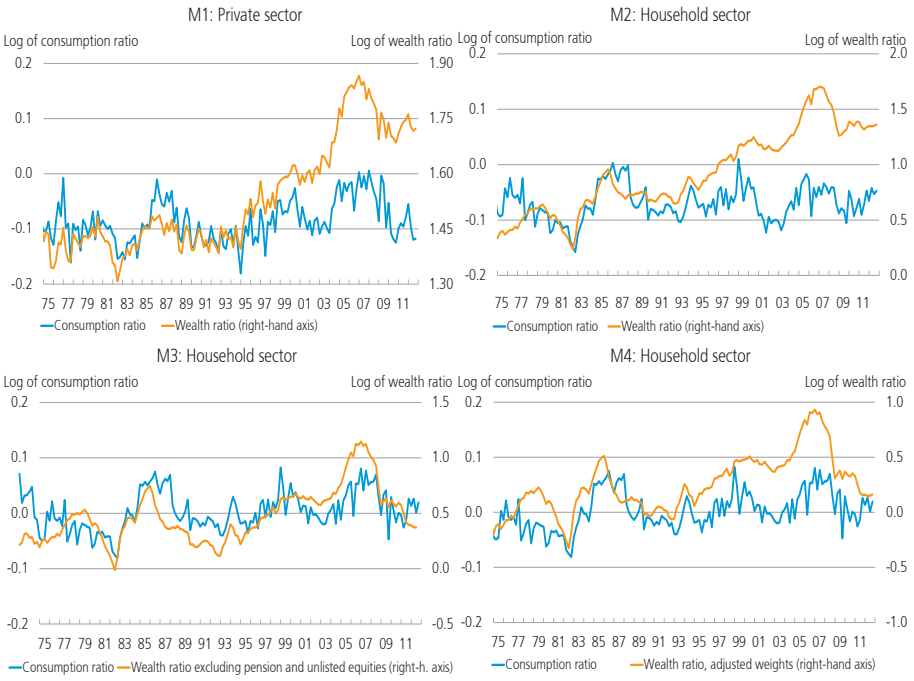
M2, which is based on total household wealth, including pension wealth and adjusted household disposable income, has the same problem as M1, in view of the upward trend of the wealth ratio throughout the period.

In M3, which excludes both pension wealth and unlisted equities, the result is an almost stable wealth ratio. However, the increase in the consumption ratio during the boom in 2004-07 was initially somewhat smaller than what the consumption ratio would have warranted, viewed in isolation.

If pension wealth is included at a small weight and the weight of housing wealth correspondingly reduced as in M4, the result is again an almost stable wealth ratio. The comparison of M4 and M3 illustrates that it is difficult to determine the correct weights on the basis of data alone.

The models are estimated formally below. In the first step, a long-run relation is estimated between consumption, income and wealth corres-

CONSUMPTION AND WEALTH RATIOS IN LOGARITHMS Chart 12



Note: Top left: curves based on disposable income for the private sector adjusted for income in the energy sector and depreciation of the total capital stock. Wealth is based on the calculation of net private-sector wealth, cf. the note to Chart 11. Top right: curves based on adjusted household disposable income (i.e. including D8, cf. Box 2). Wealth is total net household wealth including pension wealth after tax. Bottom left: curves based on household disposable income (i.e. excluding D8). Wealth is total net household wealth excluding pension wealth and unlisted equities. Bottom right: curves based on household disposable income (i.e. excluding D8). Wealth is net household wealth based on adjusted weights.

Source: Own calculations based on data from Statistics Denmark, Danmarks Nationalbank and MONA.

ponding to the curves in Chart 12. The four models are estimated using an Engle-Granger 2-step procedure, cf. Box 4.

According to the estimations, all four models can be used as empirical long-run equilibrium models, cf. Table 2. The tests of a model as an empirical long-run equilibrium model are, however, weak, so they should not stand alone. Recursive parameter estimates and compliance with the imposed homogeneity constraint can give a better view of the properties and stability.

The homogeneity constraint can clearly be rejected for M1 and M2 (based on a Wald test). This is indicated by the parameter estimates not being stable. In M3, on the other hand, the homogeneity constraint is not rejected, resulting in far more stable parameter estimates. In model M4 it is only just rejected, but the result is sensitive to small changes, e.g. in the estimation period.

On the basis of the above considerations, we opt for model M4. This is an empirical choice. As discussed previously, the information content of

ESTIMATION METHOD Box 4

The consumption function is estimated by means of an Engle-Granger 2-step procedure.

The first step is a test of whether a stable long-run relation exists between consumption, income and wealth (i.e. whether cointegration exists). This is achieved by testing whether the residuals from an estimated long-run relation are stationary (critical values from MacKinnon (2010)).

The long-run relation is estimated by means of dynamic OLS, cf. Stock and Watson (1993). The advantage of using dynamic rather than ordinary OLS is that it provides for calculation of asymptotically valid standard deviations, e.g. using HAC Newey-West. Dynamic OLS includes a number, *p*, of leads and lags. We determine *p* by first setting *p* at 5 and subsequently eliminating insignificant variables, cf. e.g. Gagnon et al. (2011).

In the second step, the short-run dynamics are estimated using an error correction model (estimated by means of simple OLS), where the quarterly change in consumption is explained by the error correction term (excluding the *p* leads and lags), which captures the adjustment to the long-run equilibrium 1st lag of the deviation from the long-run model) and a number of short-run variables.

LONG-RUN MODEL FOR PRIVATE CONSUMPTION Table 2

Left-hand side variable: consumption	M1	M2	M3	M4
Income	0.83***	0.98***	0.90***	0.92***
Net wealth, beginning of period	0.17***	0.02***	0.10***	0.08***
Constant	-0.33***	-0.10***	-0.05***	-0.01**
R^2 adj.	0.98	0.98	0.98	0.98
AIC	-4.21	-4.28	-4.58	-4.44
Durbin-Watson	0.93	0.44	0.51	0.44
Test for cointegration:				
DF test value	-6.78***	-4.78***	-6.06***	-6.16***
ADF(1) test value	-4.54***	-3.87**	-4.43***	-4.56***
ADF(2) test value	-3.97**	-3.71**	-3.73**	-3.90**
Critical test values:				
10 per cent	-3.07	-3.07	-3.07	-3.07
5 per cent	-3.38	-3.38	-3.38	-3.38
1 per cent	-3.97	-3.97	-3.97	-3.97
Wald test for homogeneity	0.00	0.00	0.48	0.03

Note: All variables are in logarithms and are deflated by consumer prices. Estimation period: M1: 1974q1-2011q1, M2: 1974q1-2011q1, M3: and M4: 1973q2-2011q1. Estimated using dynamic OLS, cf. Box 3. Newey-West-calculated standard deviations. * 10 per cent significance level, ** 5 per cent significance level and *** 1 per cent significance level.

Source: Own calculations based on data from Statistics Denmark, Danmarks Nationalbank and MONA.

data is not sufficient for clear identification of the correct weights of wealth. For example, the weight of pension wealth could be reduced, while the weight of equity and/or housing wealth is increased equivalently, corresponding to M3.[1]

As a robustness check we have tried to apply M3 as a long-run relation. According to the analysis, such changes of the weights have only limited effect on the model properties in the short and medium run.

From a long-run to a short-run perspective

In the above model, a long-run relation has been estimated between consumption, income and wealth. In the short run, however, consump could deviate from the long-run relation, as indicated by a number of factors. We specifically examine the significance of changes in the following variables: unemployment, expected loss of income due to unemployment, inflation, corporate income and real interest rates. In addition, we include five financial variables, which attempt to capture fluctuations in the credit supply, among other things, and three dummy variables, which capture changes in VAT and indirect taxes in the 1970s.

A rise in the unemployment rate increases the risk of being hit by unemployment, which may induce the households to reduce their consumption – applying a precautionary approach – and increase their savings. In order to capture fluctuations in consumer savings resulting from the precautionary approach, the expected loss of income due to unemployment is also included. *A priori*, both variables are expected to have a negative sign.

Inflation may also influence consumption in the short term, e.g. if rising energy prices result in lower fuel consumption beyond the potential effect of falling real income. The sign is expected to be negative *a priori*.

Corporate income is ultimately a gain for households (and foreign owners). The households may thus react to changes in corporate income, meaning that higher corporate income leads to higher consumption.

In the short term, real interest rates may affect consumption via several channels, i.e. the substitution, income and wealth channels. According to the substitution channel, consumption should rise when real interest rates fall, since lower real interest rates make it less attractive to save. The income channel influences consumption via changes in household interest

[1] Although pension wealth is included with a small weight in consumption-determining wealth in the long-run relation, investment income from pension wealth is not included in income in the short and medium run. The reason is that it is presumably very difficult in the short run to borrow against investment income from pension wealth. Even if it was possible to borrow against it, it is still to a high degree subject to a fixed interest rate and hence not influenced by interest-rate developments. Consequently, the effect on consumption is expected to be very small.

income and expenses and pension payouts when real interest rates change. Finally, via the wealth channel, changes in real interest rates affect the value of wealth (e.g. via changes in house or equity prices).

The estimations capture the income and wealth channels by including income and wealth in the short-run dynamics. Consequently, only the substitution channel is not captured via other variables in the short-run dynamics. The sign of real interest rates in the short-run dynamics should thus be expected to be negative.

Finally, a number of financial variables are examined, which are to capture fluctuations in credit supply, financial innovation and financial liberalisation. According to the life-cycle hypothesis, households will seek to smooth out their consumption over time, but in reality, the households' scope for smoothing consumption is limited. For a household under a liquidity constraint, i.e. without access to borrow as much as it wants to, current income tends to play a larger role in consumption.

Credit constraints arise as a natural result of asymmetrical information between borrower and lender, among other factors. For instance, the borrower knows his or her own abilities better than the lender. Consequently, the borrower may wish to borrow more than the lender is willing to lend, given the limited information available to the lender. The extent of credit constraints depends on both financial regulation and innovation and the willingness and/or ability of the financial institutions to lend. With a view to identification of the short-run effects of these factors on private consumption we have constructed five financial variables: interest margin, credit mix, loan impairment charges and nominal and real costs of home financing, cf. Box 5.

Short-run model: estimation results

In the short-run model, the quarterly change in consumption is explained by the error correction term from the long-run model and by the variables described above. In addition, changes in household income and housing wealth are included, bringing the total number of variables to 15, besides the error correction term. The error correction term is included as the deviation from the long-run model lagged one period, thus capturing the adjustment to the long-run equilibrium, while the short-run variables are included with a lag of up to four periods.[1]

In the short term, the following model is estimated:

$$\Delta log(consumption) = \alpha_1 ECM_{t-1} + \sum_i \alpha_i SR_{i,t} + \varepsilon_t$$

[1] A potential simultaneity bias may exist between changes in consumption and income. However, this bias is assessed to be small, so no adjustment has been made accordingly.

CONSTRUCTION OF FOUR CREDIT VARIABLES Box 5

Interest margin (measure of credit supply)
The first variable is the banks' interest margin, i.e. the difference between their lending and deposit rates. The interest margin reflects, *inter alia*, the banks' earnings, their credit ratings of customers and statutory capital requirements, which makes it an indicator of the banks' lending capacity. However, the interest margin is also affected by structural factors. For example, as a result of the banks' restructuring of their interest and fee policies, fees account for a larger share of earnings. This indicates a generally narrowing interest margin. Structural changes are removed by means of an HP filter. The coefficient on the interest margin in the estimated consumption function is expected to have a negative sign.

Credit mix (measure of credit supply)
The second variable is a credit mix, defined as the banks' share of total lending to households by banks and mortgage banks. The idea is that changes in the credit supply will typically increase the banks' share of total lending. The reason is that lending by banks is affected by the supply side to a higher degree than lending by mortgage banks. Over time, the credit mix has been influenced by structural changes. A case in point is that it became possible in the late 1980s to borrow against home equity, which has presumably increased lending by mortgage banks relative to lending by banks, while the introduction of mortgage loans in 2004 had the opposite effect. The estimated coefficient on the credit mix is expected to be positive.

Loan impairment charges (measure of credit supply)
The third financial variable is the banks' impairment charges on outstanding loans and guarantees. The banks' loan impairment charge ratios affect their ability to meet statutory capital requirements, which has an impact on the banks' wish to lend and their lending opportunities. The coefficient on the loan impairment charge ratio is expected to have a negative sign.

Cost of home financing (measure of financial liberalisation and innovation)
The fourth and last variable denotes the minimum first-year instalment for financing kr. 100 with an owner-occupied home as collateral. The instalment is very much influenced by financial liberalisation and innovation. Cases in point are statutory requirements regarding mixed loans in the mid-1980s or the introduction of variable-rate loans in 1996. We calculate two variants, i.e. a nominal and a real variant, i.e. adjusted for inflation. The sign of the home financing variables is expected to be negative.

where *ECM* is the error correction term from the long-run model, and SR_i denotes the 15 short-run variables.

In the model shown (M4 baseline model), the most insignificant lags have been removed, whereby each variable is only included once, cf. Table 3. The model without insignificant variables is shown as model M4. In general, all variables have the expected sign, although there are a few problems with some of the financial variables. The model is well-specified overall, assessed on the basis of common misspecification tests.

SHORT-RUN MODEL FOR PRIVATE CONSUMPTION Table 3

Left-hand side variable: Δlog(consumption)	M4 Baseline model	M4	Propensity to consume
ECM_{t-1}	-0.25***	-0.19***	0.92[1]/0.07[1]
$\Delta\log(income_t$, households)	0.15***	0.13**	0.13
$\Delta\log(income_t$, private sector)	0.01	---	
$\Delta\log(housing\ wealth_t$, beginning of period)	0.14***	0.09**	0.04
$Inflation\ term_t$	-0.70***	-0.71***	
$\Delta unemployment\ rate_{t-2}$	-0.01***	---	
$Expected\ loss\ of\ income_t$	-3.11***	-2.25**	
$\Delta real\ interest\ rate_{t-2}$	-0.42**	-0.55***	
$Interest\ margin_{t-2}$	-0.01***	---	
$Credit\ mix_{t-2}$	0.00	---	
$Loan\ impairment\ charges_{t-2}$	0.01	---	
$Home\ financing,\ real_{t-2}$	-0.04	---	
$Home\ financing,\ nominal_{t-2}$	0.14***	---	
Dummy (75, Q4 and '76, Q1)	0.03***	0.03***	
Dummy (77, Q3 and Q4)	0.05***	0.05***	
Dummy (78, Q4)	-0.06***	-0.05***	
Constant	-0.00*	0.00***	
R^2 adj.	0.57	0.54	
AIC	-5.97	-5.97	
Normality[2]	0.21	0.07	
Heteroskedasticity[2]	0.43	0.75	
Autocorrelation[2]	0.20	0.50	
Durbin-Watson	2.27	2.18	

Note: Estimation period: 1973q4-2011q2. Estimated using simple OLS. Newey-West standard deviations. * 10 per cent significance level, ** 5 per cent significance level and *** 1 per cent significance level. Normality test: (Jarque-Bera). Heteroskedasticity test: Breusch-Pagan-Godfrey, autocorrelation test: LM-test with 4 lags.

Source: Own calculations.

[1] Long-run propensity to consume is 0.92 for income and 0.07 for consumption-determining wealth.

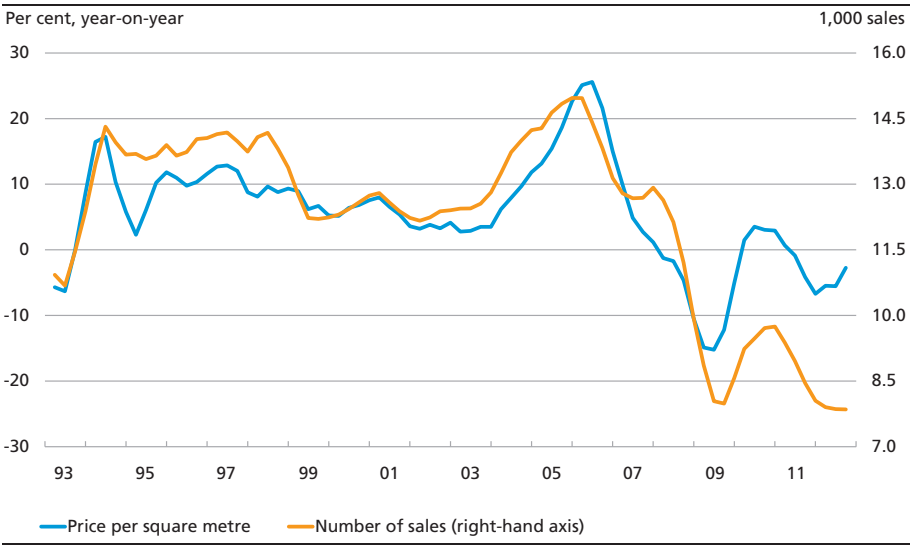
[2] P values for misspecification tests.

The coefficient on the error correction term is highly significant, and around half of a deviation from the equilibrium is eliminated within 3 quarters.

Changes in private-sector income are insignificant, whereas household income is significant. The estimate of the income effect in the short run is, however, relatively small (a short-run propensity to consume of around 0.13, against 0.92 in the long run).

The housing wealth estimate, on the other hand, is relatively large. Hence, a 1 per cent increase in house prices will immediately cause consumption to rise by 0.10-0.14 per cent, i.e. one additional krone of housing wealth will increase consumption in the short run by around kr. 0.04. Part of this short-run effect is due to the fact that rising house prices normally coincide with growing activity in the housing market, cf. Chart 13. A house trade is typically associated with considerable private con-

HOUSE PRICES AND NUMBER OF HOME SALES — Chart 13



Note: The number of sales is a 4-quarter moving average. Both prices and the number of sales relate to one-family houses.
Source: Statistics Denmark.

sumption, e.g. in the form of removal costs, purchase of furniture and refurbishing. Higher turnover in the housing market may thus lead to higher private consumption.

Moreover, changed house prices may influence credit constraints, since higher house prices increase the value of the collateral.

The inflation term is highly significant, but this is due, among other factors, to the inclusion of inflation – measured as the implied deflator for private consumption in the national accounts – on both the left and the right sides of the regression.[1] However, inflation may actually have an impact on real consumption beyond the effect that may be attributable to the fall in real income, so we have chosen to include the inflation term in the consumption function.

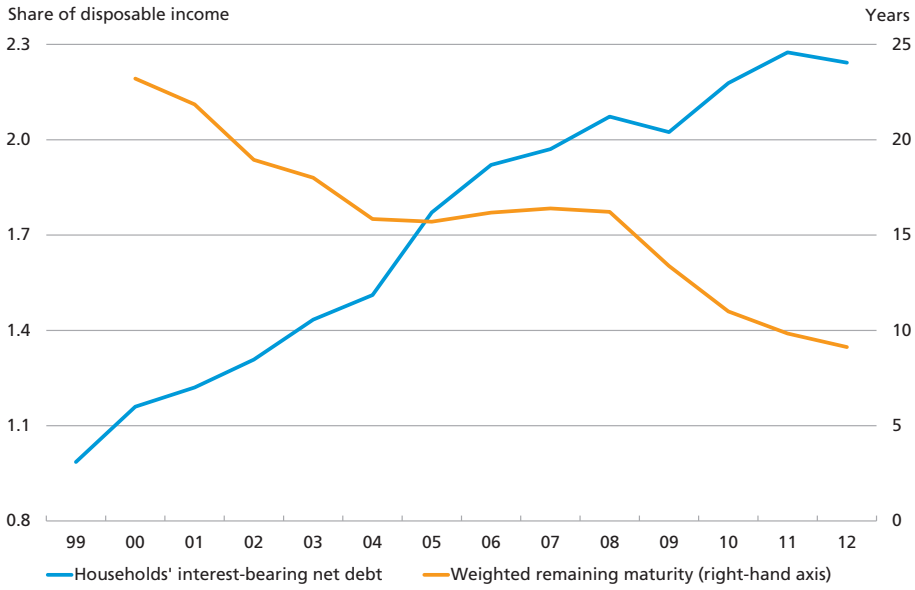
Changes in unemployment are not significant, but the expected loss of income is significant. In the short term, households thus increase their savings for precautionary purposes in connection with higher unemployment.

In general, the financial variables have only a negligible impact on consumption, although the interest margin is significant and has the expected sign. Nominal home financing is also significant, but has the wrong sign. However, the weak explanatory power does not mean that financial conditions have no impact on consumption. Instead, it means

[1] Consumption in volumes, *fcp*, is compiled as consumption at current prices, *cp*, divided by the consumption deflator, *pcp*, which gives: $\Delta log(fcp) = \Delta log(cp) - \Delta log(pcp)$.

HOUSEHOLDS' INTEREST-BEARING NET DEBT AND AVERAGE REMAINING MATURITY OF MORTGAGE BONDS

Chart 14



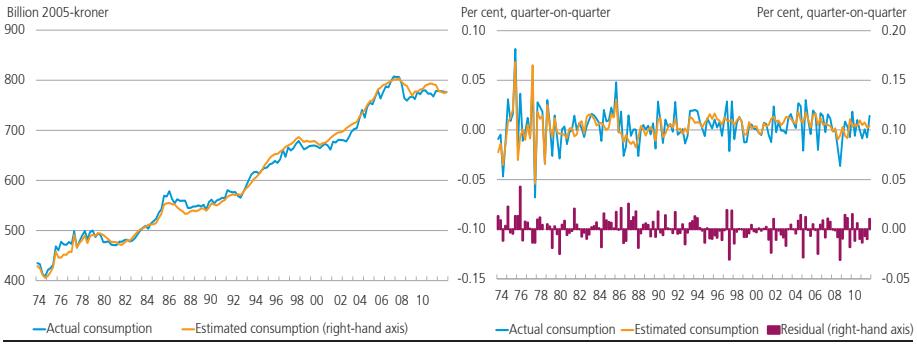
Note: Annual averages based on monthly data.
Source: Danmarks Nationalbank.

that the financial conditions influence consumption particularly through income, wealth and interest rates, e.g. via higher house prices or lower interest rates. For example, the introduction of variable-rate loans led to a lower average interest rate payable by the households, while the introduction of deferred amortisation reduced the average housing burden, which may have contributed to rising house prices, cf. Dam et al. (2011).[1]

Changes in real interest rates are strongly significant. A drop in real interest rates by 1 percentage point entails an immediate increase in consumption by around 0.5 per cent in addition to the effect of wealth and income. The household debt ratio has risen strongly over the last 20 years, while the average remaining maturity of outstanding mortgage debt has decreased, cf. Chart 14. As a result, the households have become more sensitive to changes in interest-rates. Nevertheless, recursive coefficient estimates show that the elasticity of interest rates has been very stable over time, meaning that the increased interest-rate sensitivity stems from interest payments in particular, and thus via disposable income and wealth, since house prices have probably become more sensitive to interest rates, cf. Dam et al. (2011).

[1] Changes in financial conditions – including the credit supply – may also affect firms, e.g. small and medium-sized enterprises, whereby the financial conditions may influence household income.

ACTUAL AND ESTIMATED CONSUMPTION Chart 15



Note: Left-hand chart: dynamic simulation, i.e. the error correction term is based on the difference between the simulated short-run and long-run models. Start in the 1st quarter of 1974. Right-hand chart: static simulation.
Source: Own calculations.

The model has generally performed well in predicting consumption both before and after the financial crisis. Overall, the estimated model captures the fluctuations in consumption since 1974, cf. Chart 15 (right). Estimated consumption closely followed actual consumption throughout the boom years before the financial crisis. As a result of stickiness in the adjustment to the estimated long-run relation, the estimated consumption function is not fully able to capture the sharp fall in late 2008, so estimated consumption was higher than actual consumption during most of 2009, cf. Chart 15 (left). Rising house and equity prices in 2009 and 2010 meant that estimated consumption in 2011 and the beginning of 2012 was also higher than actual consumption. The weak development in consumption over the period may reflect that the considerable uncertainty, which characterised the period, caused households to increase their savings for precautionary purposes.

However, as a result of the subsequent house price falls, estimated consumption based on current income, wealth and interest-rate levels is close to actual consumption at end-2012.

MODEL PROPERTIES

In this section, the properties of the consumption function are presented by means of two experiments. In one experiment, all interest rates are raised permanently by 1 percentage point, while the second experiment operates with a temporary increase in house prices by 10 per cent. The experiments are carried out within the framework of a macroeconomic model, i.e. Danmarks Nationalbank's existing macroeconomic model, MONA. Dynamic effects of shocks to the consumption function can thus be captured, e.g. how higher consumption stimulates income, which in turn increases consumption.

Linking the consumption function to MONA requires construction of a financial submodel for the relations between household income, consumption and savings on the one hand and household wealth on the other hand. The financial submodel is described in Appendix A.

Interest-rate shocks

In the interest-rate experiment, all interest rates are assumed to rise by 1 percentage point permanently, compared with the baseline scenario. The assumption that all interest rates rise immediately implies overestimation of the effect of changes in market interest rates, since the assumption entails immediately higher interest rates also for households with fixed-rate loans. Conversely, over the estimation period, changes in market interest rates are passed through to average interest rates only with a certain lag.

The interest-rate increase reduces private consumption by around 1 per cent relative to the baseline scenario after a few quarters, cf. Chart 16 (top left). Consumption then continues to fall relative to the baseline scenario and is approximately 3.5 per cent lower after five years, compared with the baseline scenario. The decrease in private consumption stems from three channels. Firstly, the substitution channel means that households reduce consumption and increase savings, because the interest-rate increase makes it more attractive to save.

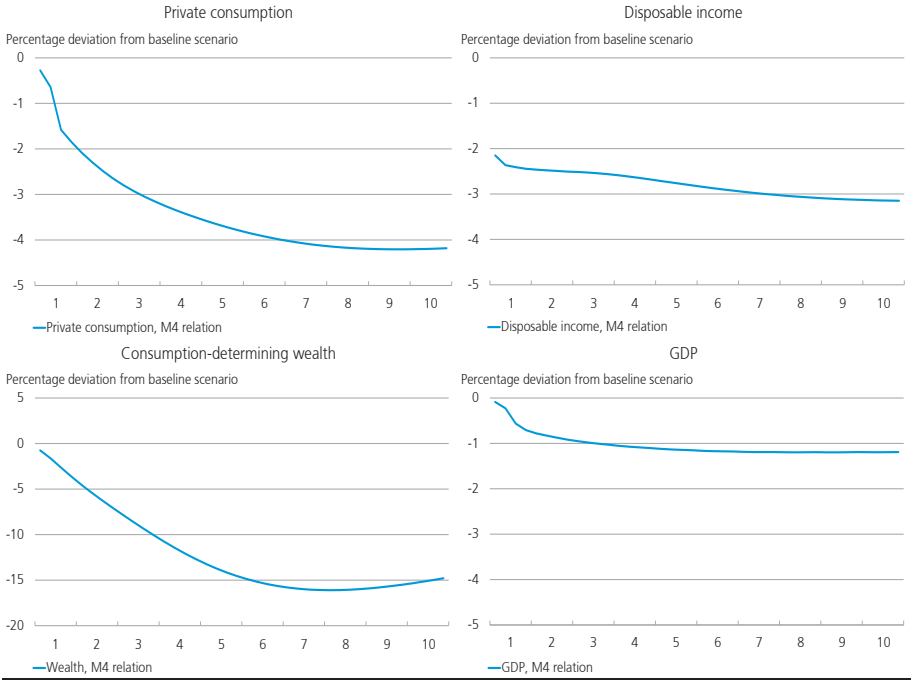
Secondly, private consumption declines as a result of lower consumption-determining wealth for the households (the wealth channel), cf. Chart 16 (bottom left). The drop in wealth is primarily attributable to lower housing wealth, particularly due to lower house prices and to a lesser extent a lower level of gross fixed investment. The interest-rate increase also reduces household borrowing as a result of falling house prices. However, debt is reduced less than housing wealth, resulting in an overall decline in consumption-determining wealth. In the long run wealth will approach the level in the baseline scenario due to lower consumption and higher savings.

Thirdly, household net interest expenses will rise (the income channel), reducing disposable income in the first years after the drop in interest rates, cf. Chart 16 (top right).[1]

After 10 years, GDP declines by approximately 1.4 per cent relative to the baseline scenario, cf. Chart 16 (bottom right). GDP is affected less than consumption, due to the strong increase in net exports, particularly as a result of falling imports and to a lesser extent rising exports.

[1] Net interest expenses rise, because the return on pension wealth is not included. The higher interest rates will entail a higher return on pension wealth. This increases pension wealth, which in the long run will lead to higher disposable income, cf. the discussions above.

EFFECTS OF INTEREST-RATE INCREASE OF 1 PERCENTAGE POINT Chart 16



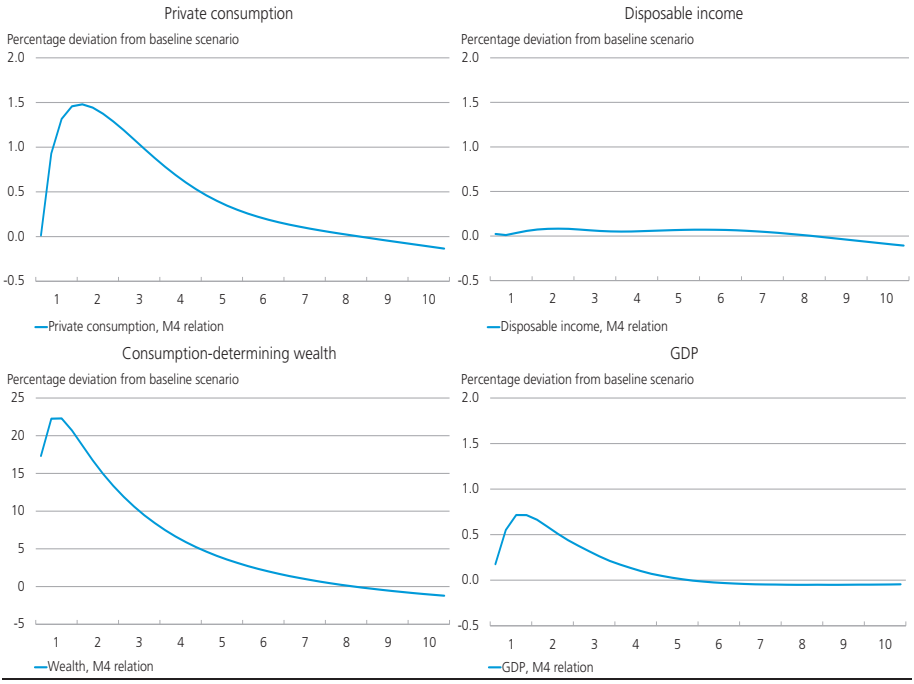
Note: The time axis shows the number of years after the initial shock.
Source: Own calculations.

As mentioned above, an alternative consumption function based on a slightly different weighting of the wealth components will give almost identical empirical properties. Moreover, the model properties also remain virtually unchanged, meaning that the interest-rate experiment will have a near-identical effect on the economy. But the use of private-sector income instead of household income will give markedly different results, unless pension wealth is assumed to be subject to a fixed interest rate. The reason is that higher interest income in the pension funds leads to higher consumption-determining income. However, it seems most natural to let investment income for pension funds impact on households via higher pension payouts, i.e. with a considerable lag and over a longer period, or alternatively to assume that pension wealth is subject to a fixed interest rate.

Shocks to house prices

In the housing experiment, house prices rise unexpectedly and temporarily by 10 per cent relative to the baseline scenario. After the initial shock, the development in house prices is determined by the model, whereby prices fall back to their long-run equilibrium.

EFFECTS OF A 10 PER CENT INCREASE IN HOUSE PRICES Chart 17



Note: The time axis shows the number of years after the initial shock.
Source: Own calculations.

Immediately after the increase in house prices, household consumption-determining wealth has risen by around 15 per cent, cf. Chart 17 (bottom left), i.e. consumption-determining wealth tends to grow more than the initial increase in housing wealth. This is because housing wealth is larger than consumption-determining wealth, which is calculated net of household financial liabilities.

House prices continue to rise in the first year after the shock, when consumption-determining wealth becomes more than 20 per cent higher than the level in the baseline scenario. As a result of the increase in wealth, 2 years after the house-price rise households will expand consumption by approximately 1.5 per cent relative to the baseline scenario, cf. Chart 17 (top left). The growth in household consumption reduces savings, while borrowing increases as a result of higher house prices. This causes wealth to fall back over time, even to a lower level than in the baseline scenario.

Disposable income will grow a little in the first years after the increase in house prices, cf. Chart 17 (top right), due to stronger economic activity, cf. Chart 17 (bottom right). However, the increase in income is somewhat lower than the increases in both private consumption and GDP,

which can be attributed to higher interest payments due to stronger borrowing.

Around 5 years after the shock to house prices, disposable income starts to fall. Falling to a level below the baseline scenario, it contributes, together with the decrease in wealth, to reducing consumption to a lower level than in the baseline scenario.

In the very long run, household disposable income as well as consumption-determining wealth and private consumption fall back to the level in the baseline scenario, bringing the real economic effect in the very long run of a temporary increase in house prices to zero.

The presented effects on consumption of both the rise in interest rates and the hike in house prices are stronger than in the existing consumption function in MONA, cf. Appendix B.

DEVELOPMENT IN CONSUMPTION BEFORE AND AFTER THE FINANCIAL CRISIS

Consumption before the financial crisis – the role of housing wealth

In the period from end-2003 until end-2007, private consumption rose by almost 4 per cent annually, which is far more than the historical average of around 1.8 per cent in the period 1975-2010. In the same period, house prices rose by approximately 60 per cent, which contributed to the consumption boom. In order to assess the role of house price developments in consumption we have calculated the counterfactual development in consumption, given steady growth in housing wealth from the beginning of 2004 until the beginning of 2010.[1]

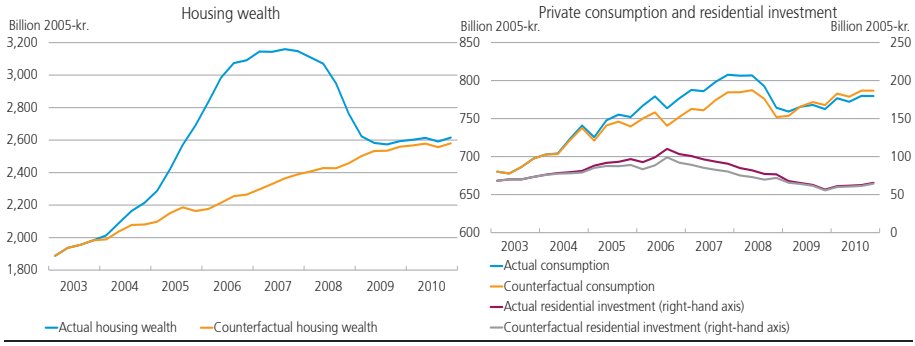
The consumption effect of the strong increases in house prices was quite pronounced. Steady growth in housing wealth in 2004-09 would have entailed approximately kr. 25 billion lower private consumption by end-2007, cf. Chart 18 (right), corresponding to almost 1.5 per cent of GDP, while residential investment would have been around kr. 11 billion lower, equivalent to 0.75 per cent of GDP.

Private consumption after the financial crisis – the role of lower interest rates

In the wake of the burst house-price bubble, consumption contracted by almost 6 per cent from the 2nd quarter of 2008 to the 1st quarter of 2009. Since then, private consumption has shown weak development des-

[1] A fixed growth rate has been calculated for the period from the 1st quarter of 2004 to the 4th quarter of 2009, so that actual house prices are hit in the 1st quarter of 2010. This removes the strong house-price increases and subsequent falls.

IMPACT OF HOUSING WEALTH ON CONSUMPTION Chart 18



Note: Left-hand chart: house prices in the counterfactual scenario are identical to actual house prices in the 4th quarter of 2003 and the 1st quarter of 2010. Counterfactual housing wealth is slightly lower than actual housing wealth at the end of the period as a result of a lower level of investment in the counterfactual scenario. Right-hand chart: counterfactual scenario: start in the 1st quarter of 2004.
Source: Own calculations.

despite the easing of both fiscal and monetary policies and the strong drop in market interest rates.

In addition to the effects of the strong house price fluctuations, it is interesting to examine the effects on consumption of the interest-rate falls in recent years. From the 2nd quarter of 2009 to end-2012, the 1-year mortgage yield decreased by approximately 2.4 percentage points, cf. Chart 19 (top left). During the same period, household net interest expenses, calculated as the difference between interest paid and interest received, fell from 10.7 per cent to 5.9 per cent of disposable income.[1] From mid-2011, however, net interest expenses did not fall at the same pace as interest rates. One reason is that the higher credit risk premia were not reflected in mortgage yields, which are based on mortgages with homes as collateral.

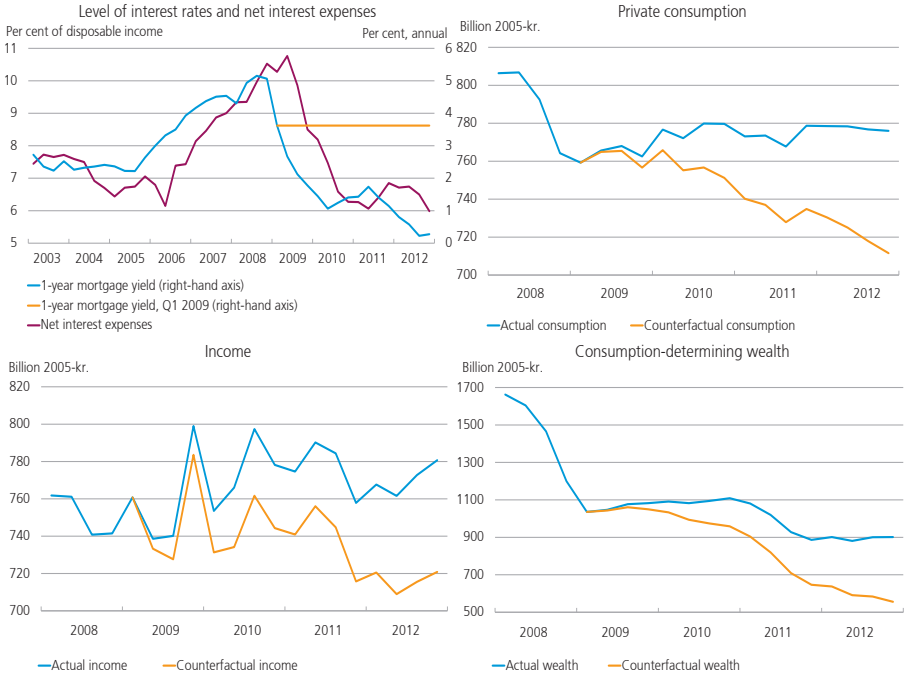
In order to assess the significance of the drop in interest rates to consumption, the counterfactual development in consumption according to our model is calculated, assuming that all interest rates were constant at the level from the 1st quarter of 2009 to end-2012, cf. Chart 19 (top left), but if the international economic situation remained unchanged.[2] Thus, the counterfactual experiment shows the development in consumption given a combination of high interest rates and a very weak international economic position.

[1] Interest payments in the national accounts have been calculated according to FISIM, which is an estimate of the share of the interest margin that can be regarded as payment for a service. Consequently, the net expenses shown are slightly lower than the actual net interest expenses. But the development is presumably largely unaffected by FISIM.

[2] The level of e.g. the 1-year mortgage yield in the 1st quarter of 2009 roughly corresponds to its average level since 2000.

LEVEL OF INTEREST RATES, NET INTEREST EXPENSES AND COUNTERFACTUAL DEVELOPMENT IN CONSUMPTION, INCOME AND WEALTH

Chart 19



Note: Top left: Net interest expenses are based on the national accounts, i.e. according to FISIM. Bottom right: Consumption-determining wealth is both less and more volatile than actual net household wealth.

Source: Top left: own calculations based on data from Statistics Denmark and Danmarks Nationalbank. Remaining charts: own calculations.

A higher level of interest rates would have led to lower disposable income (higher net interest expenditure) and lower house prices. The calculations show that as a result of the lower interest rates, household disposable income at end-2012 was 7.7 per cent higher than it would otherwise have been, cf. Chart 19 (bottom left), while consumption-determining wealth was almost kr. 350 billion higher than it would otherwise have been.

Hence, via lower interest-rate expenses and higher wealth, the drop in interest rates since 2009 has contributed to cushioning private consumption. Without the drop in interest rates, private consumption at end-2012 would have been approximately kr. 60 billion lower, corresponding to 8.3 per cent, cf. Chart 19 (top right).

The role of household debt

The household debt ratio has risen strongly over the last 15 years. Gross household debt has grown from around 200 per cent of disposable income in 2000 to more than 300 per cent at end-2012. Household inter-

est-bearing assets, on the other hand, have not increased, but have remained relatively stable around 90 per cent of disposable income. As a result, interest-bearing net household debt is currently more than 200 per cent of disposable income. At the same time, a far larger share is variable-rate debt today. Overall, this implies that household disposable income is more sensitive to interest rates now than 10-15 years ago. Alternatively, pension wealth can be regarded as fixed-rate wealth, so interest-rate changes will, also in this case, affect household interest expenses in particular and only to a limited extent their interest income.

In order to examine the increase in the interest-rate sensitivity of consumption, we compare the significance of a 1-percentage-point increase in interest rates in 2000 and 2011, respectively. In addition to a rise in gross household debt by around 100 per cent of disposable income, the share of variable-rate mortgages soared from around 0 in 2000 to more than 60 per cent in 2011. The shorter fixed-interest period has increased the pass-through from market rates to the average interest rate on household debt.

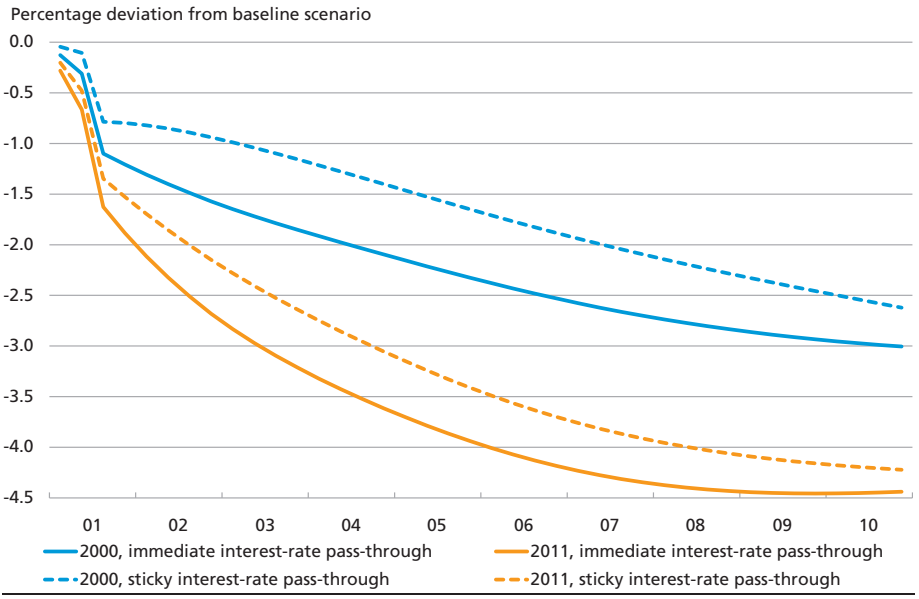
The comparison shows that the pass-through to consumption surged from 2000 to 2011, particularly due to the higher interest-bearing net household debt. An interest-rate shock entailing an immediate increase in all interest rates by 1 percentage point in 2011, would have reduced consumption by approximately 3.75 per cent after five years, while a corresponding interest-rate shock in 2000 would have dampened consumption by around 2.20 per cent, cf. Chart 20.

Taking into account that some loans are fixed-rate loans, whereby interest expenses are partly unaffected in the short run, the consumption effect is dampened somewhat.[1] This applies especially to the interest-rate shock in 2000, when consumption after five years would have been reduced by a little more than 1.5 per cent. In 2011, the share of fixed-rate loans was smaller, entailing a contraction of consumption by approximately 3.25 per cent after five years.

The calculated interest-rate sensitivity shows the effect of an isolated change in interest rates. Under normal circumstances, interest rates would be countercyclical, i.e. they rise during an economic upturn and fall during a slowdown. Hence, rising interest rates would typically coincide with strengthened domestic and foreign demand, including stronger growth in consumption.

[1] Specifically, it is assumed that full pass-through from market interest rates to average interest rates on fixed-rate loans takes 10 years, whereas the effect is instantaneous for variable-rate loans. This reflects that a considerable share of homeowners with fixed-interest loans will redeem their loans prematurely when buying and selling a home or remortgaging.

INTEREST-RATE SENSITIVITY, PRIVATE CONSUMPTION Chart 20



Note: Full interest-rate pass-though: all interest rates rise immediately by 1 percentage point. Reduced interest-rate pass-through: mortgage yields on outstanding fixed-rate loans rise gradually over 10 years by 1 percentage point in total. The experiment shown has been constructed by assuming that the household balance sheet relative to disposable income was the same in 2010 as in 2000 and then solving the model from the 1st quarter of 2011. This isolates the effect of changes in the household balance sheet, since all other data is basically the same. An alternative is a direct comparison of the effects of interest-rate increases in 2000 and 2011, respectively. Such comparison provides almost identical results, however, illustrating that the results are predominantly driven by the difference in the household balance sheet.

Source: Own calculations.

However, the experiment clearly shows that the interest-rate sensitivity of the Danish economy has grown substantially. This has resulted in stronger pass-through from monetary policy and entails that, viewed in isolation, normalisation of the monetary-policy interest rates will have a stronger dampening effect on consumption today than a corresponding increase in interest rates would have had 10 years ago. The higher interest-rate sensitivity emphasises how important it is that financial markets have confidence in the Danish economy.

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APPENDIX A

The financial submodel comprises the household sector only. Consequently, financial flows between the private sector and the other sectors (public sector and rest of the world) are still determined by the existing equations in MONA, and the financial submodel impacts the rest of MONA via private consumption and house prices only. Hence, private-sector investment income will still be determined by private-sector wealth as calculated in MONA. This corresponds to the assumption that households have financial accounts only with the rest of the private sector. However, this is likely to play only a limited role, because in reality the household sector's financial accounts are especially with the rest of the private sector (particularly banks and pension funds).

The principle of the financial submodel is simple; savings influence wealth and wealth influences income via investment income:

Disp. inc. – consumption = savings surplus + inv.
Δnet wealth = savings surplus + revaluations + net inv.

The change in net wealth is thus the savings surplus plus revaluations (capital gains/losses) plus net investment (investment less depreciation).

But the financial submodel is complicated by the variety of components in net financial wealth (equities, other financial assets, pension wealth and debt). Hence, the development in each component cannot be determined on the basis of the savings surplus alone.

The changes in debt are therefore determined on the basis of housing wealth via an error correction model, which ensures that the LTV ratio is constant in the long run. The savings surplus and the changes in debt result in an overall investment need, which determines transactions in financial assets.

A positive investment need entails that households increase their holdings of other financial assets, consisting of bank deposits and bonds, and that they increase pension savings (capital pensions). On the other hand, it is assumed that the households do not invest any of the savings surplus in equities, which is approximately in accordance with data from the financial accounts.

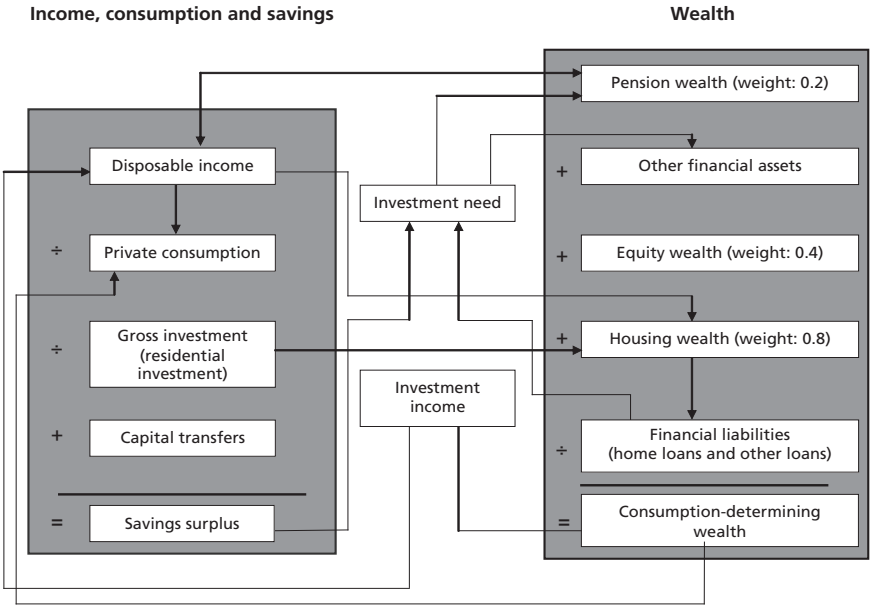
Pension wealth (labour-market pensions) is also affected by wage income, since a fixed share of it is contributed to a pension scheme. Moreover, all investment income from pension wealth (after PAL tax) is expected to be reinvested in pension wealth, whereby investment income from pension wealth is not included directly in disposable income. However, pension wealth influences disposable income via pension payouts.

Consumption-determining wealth consists of the sum of equity wealth, other financial assets, pension wealth and housing wealth less debt. Equity wealth is included with a weight of 0.4, pension wealth with 0.2 and housing wealth with 0.8. Consumption-determining wealth influences consumption via two channels, a direct and an indirect channel. The direct channel is via the wealth effect on consumption, while the indirect channel is via investment income, which increases household disposable income. Investment income is determined by wealth size, the level of interest rates and dividend payments (estimated relationships).

Finally, wealth is affected by revaluations. Revaluations have been estimated for pension wealth (determined by equity prices and interest-rate hedging via derivatives), housing wealth (house prices) and equity wealth (equity prices). On the other hand, other financial assets, particularly bank deposits, and debt are assumed to be affected only by transactions, meaning that bond prices, among others, are assumed to be unaffected by interest rates.

The overall financial submodel is outlined in Chart A1.

FINANCIAL SUBMODEL — Chart A1



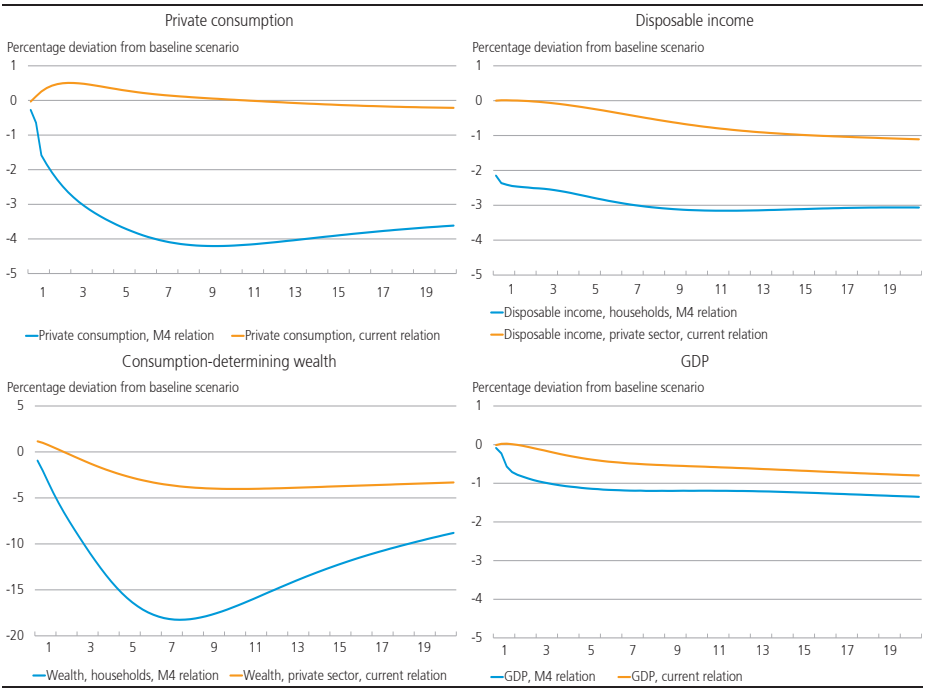
APPENDIX B

In connection with the interest-rate experiment, there are primarily three reasons why our model results in a more pronounced effect on consumption compared with MONA. Firstly, real interest rates are included directly in our consumption function. It thus captures the substitution effect of the fall in interest rates, which MONA does not.

Secondly, the increase in housing wealth due to the lower interest rates has a stronger impact on consumption-determining wealth in our relation. The reason is that the private-sector wealth ratio in MONA shows an upward trend after 1995 after having been almost stable for a prolonged period. This reduces the estimated coefficient on consumption-determining wealth, resulting in a more marked overall effect on consumption in our relation.

Thirdly, the income effect of the increase in interest rates is negative in our consumption function, whereas it is positive in MONA. This is a consequence of the higher interest expenses for the households as a result of their interest-bearing net debt. In MONA, the income effect of an interest-rate increase is positive, because the private sector has interest-bearing net wealth.

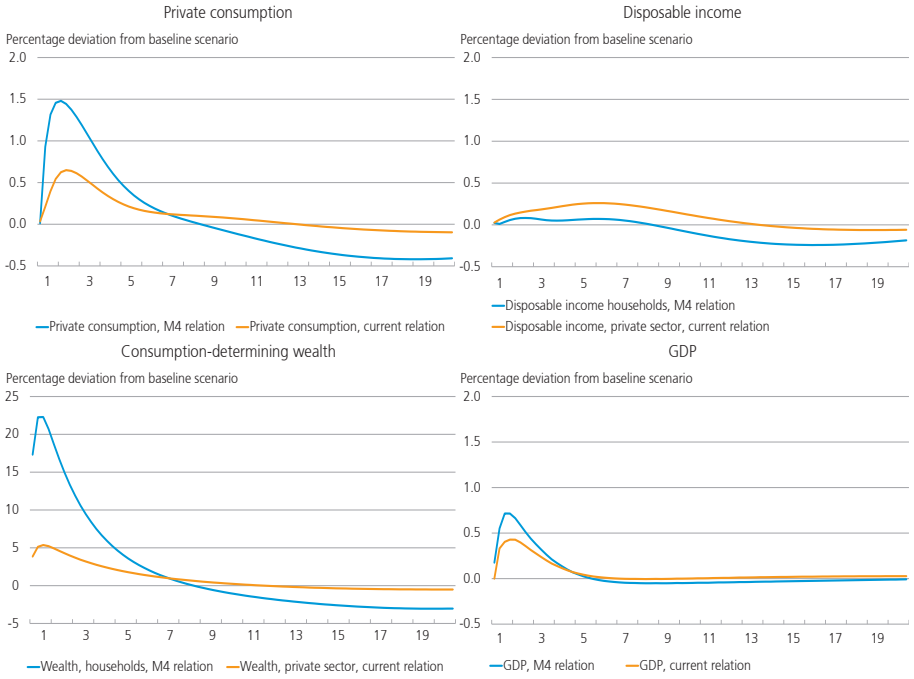
EFFECTS OF INTEREST-RATE INCREASE OF 1 PERCENTAGE POINT — Chart B1



Source: Own calculations.

In connection with the shock to house prices, the stronger consumption effect in our relation can be primarily attributed to the more pronounced wealth effect from housing wealth, compared with MONA.

EFFECTS OF A 10 PER CENT INCREASE IN HOUSE PRICES — Chart B2



Source: Own calculations.