Danmarks Nationalbank

Monetary Review 3rd Quarter Part 2

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The small picture on the front cover shows the "Banker's" clock, which was designed by Arne Jacobsen for the Danmarks Nationalbank building.

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Contents

Price Formation in Denmark

Ester Hansen, Morten Hedegaard Rasmussen and Jonas Staghøj, Economics

1. INTRODUCTION AND SUMMARY

The development in Danish consumer prices has been stable for many years. Consumer prices summarise price developments for thousands of goods and services into an annual rate of increase, which has only temporarily deviated from a level around 2 per cent.

Price formation in Denmark is analysed using several different approaches with a view to assessment of ongoing developments and identification of potential threats to the stable inflation regime.

Price stability is a key prerequisite for a well-functioning market economy, and in both Denmark and other countries high-inflation periods have been associated with serious economic consequences, not least because high inflation is typically accompanied by greater variability. Inflation – meaning a sustained increase in the general price level – in excess of more than a few per cent annually has numerous negative implications for a market economy. They include unintended reallocations between various groups in society as well as greater uncertainty in connection with the financial decisions of households and firms regarding savings, consumption and investment, cf. Pedersen and Wagener (2000).

The primary risk of undesirable price developments is that various types of price shocks can trigger a self-reinforcing process whereby stronger price increases lead to higher wage demands, which in turn accelerate price increases through higher costs for firms. This is a vicious circle with higher-than-wanted price inflation. Spange (2011) previously examined the spillover from strong commodity price inflation to other Danish consumer prices in the period 2000-11. This analysis showed no signs of considerable second-round effects via influence on wage formation.

An analysis of price and wage formation in the years 1975-2013 confirms interdependency between wages and prices, which may potentially lead to a wage-price spiral. The model analysed can be regarded as an extension of the wage relation previously estimated for the period 1975-2007 using a vector autoregressive (VAR) model in Storgaard

(2011). Here, the estimation period is extended to the 1st quarter of 2013, and the model is expanded with a price relation based on corporate price setting behaviour.

Since 1990, price formation has generally been characterised by low price increases, which have continuously contributed to ensuring stable inflation expectations. This is a central element of price formation, *inter alia* because firmly anchored expectations reduce the risk of a self-reinforcing process resulting in substantial wage and price increases. The analysis shows that inflation expectations have been firmly anchored for many years, regardless of whether they are compiled by means of consumer or analyst questionnaires or by deriving expected inflation from the financial markets.

An analysis of microdata on consumer prices shows very marked differences in price setting for various types of goods and services. The analysis confirms the overall findings of Hansen and Hansen (2006), whose analysis covered the period up to the end of 2005. The new analysis uses data up to April 2013, which enables a closer look at the price setting behaviour during a period of strong economic instability and marked price fluctuations especially in the energy and commodity markets.

In addition to providing detailed insights into the pronounced heterogeneity across products and industries, the analysis of microdata also shows that fluctuations in inflation are first and foremost determined by the frequency of price changes. Excessive price increases are normally the result of more price increases rather than higher average price increases. This indicates that – besides the overall inflation rate – it may also be relevant to examine whether more prices are adjusted upwards. Moreover, the findings point to price formation in Denmark being state-dependent. Both the timing and the extent of price changes are chosen by the firms. It is otherwise often assumed that, under a stable inflation regime, many firms can make the necessary price adjustments by changing prices regularly, e.g. annually.

The studies that have analysed microdata do not all agree on this. Klenow and Malin (2010) summarise a number of decomposition analyses of inflation rates for both the USA and the euro area based on microdata. Their conclusion is that most of the variance in inflation can be attributed to changes in the intensive margin, while frequency plays only a minor role. As in our analysis, Nakamura and Steinsson (2008) find that the frequency of price increases determines the course of inflation in the USA, while both the frequency of price decreases and the size of price increases and decreases play a minor role. Dhyne et al. (2006) summarise the results for 10 euro area member states, concluding that both

the frequency and size of price changes influence price developments. Gagnon, López-Salido and Vincent (2013) use a slightly different methodology in that they examine firms' price setting behaviour in the event of considerable shocks to the economy. They find that frequency plays an important role.

As regards the ongoing assessment of whether the current price development implies a risk of unwanted inflation, it is relevant to distinguish between the underlying factors causing price increases.

One element here is to use core inflation to distinguish between temporary and permanent price changes. Temporary price changes affect inflation expectations to a lesser degree, while permanent price fluctuations can change the formation of expectations. On the basis of an analysis of price developments in Denmark – including the microdata underlying the compilation of consumer prices – different core inflation measures are constructed. The preferred version is constructed as the development in the overall consumer price index, excluding energy and unprocessed food, which are characterised by more frequent and more pronounced price fluctuations than most other goods and services at both micro and macro levels. An analysis shows that HICP inflation typically adjusts to core inflation in the long term – not the other way around. This supports its use as an indicator of the underlying price trend.

Another element is to identify how much of the price pressure stems from abroad. Energy prices stand out by being determined mainly in global markets, just as most of the fluctuations in import prices are determined internationally. Consequently, with a view to examining domestic price pressures, Danmarks Nationalbank has been calculating a price index for domestic market-determined inflation, IMI, since 1984, cf. Hansen and Knudsen (2005, 2006). This enables better assessment of the part of inflation that is attributable to domestic price pressures. Since domestic price pressures are linked to current capacity utilisation in the economy, the IMI can be included in an assessment of whether inflation is moving so far away from equilibrium that economic-policy measures are required to prevent costly subsequent adaptation. Furthermore, the analysis shows that the IMI index can contribute to predicting future consumer prices.

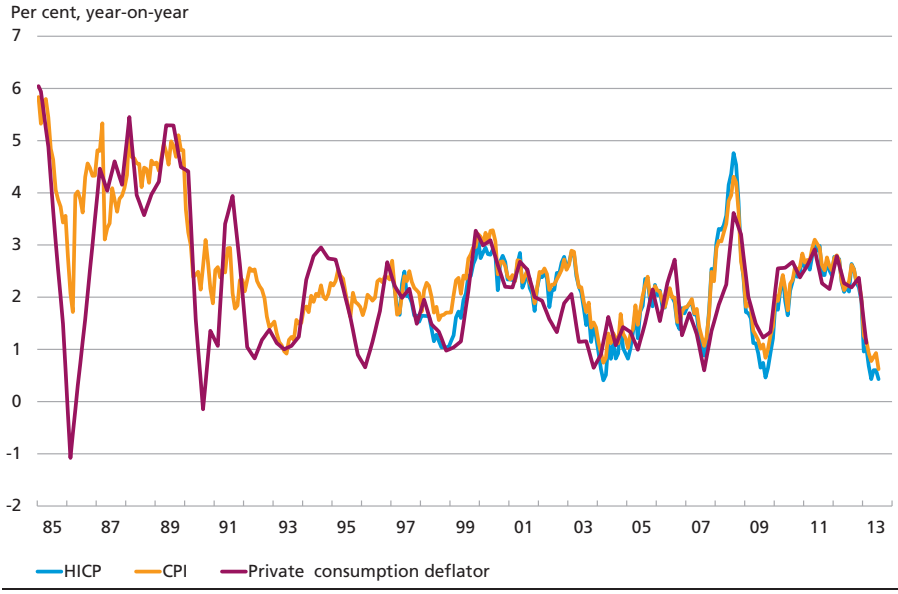
Denmark's fixed-exchange-rate policy – combined with the stability-oriented fiscal policy – has resulted in a prolonged period of low and stable inflation. This has created a credible framework for stable socio-economic development. Experience from previous periods and other countries shows that deviations from a stable inflation regime are associated with costly adaptation.

Section 2 reviews general price developments in Denmark and the euro area. Section 3 analyses different methods of calculating inflation expectations, which constitute a key element of wage and price formation. The underlying reasons for changes in consumer prices are examined in section 4. Various expressions of core inflation are constructed, as well as a price index for measuring domestic price pressures. Section 5 contains an analysis of the microdata on which the Danish CPI is based. Section 6 concludes with an analysis of the interaction between prices and wage formation.

2. PRICE DEVELOPMENTS IN DENMARK AND THE EURO AREA

The most frequently used measure of price developments in Denmark is the consumer price index, CPI, compiled by Statistics Denmark. It measures the prices of a basket of goods and services reflecting the average consumption of a Danish household. The current national CPI was introduced in 1965, and since 1996 Statistics Denmark has also compiled an EU Harmonised Index of Consumer Prices, HICP. The HICP is comparable to other countries and is used by the European Central Bank, ECB, as a measure of price developments. Since 1990, annual consumer price inflation has been around 2 per cent, cf. Chart 2.1.

DEVELOPMENT IN CONSUMER PRICES IN DENMARK — Chart 2.1



Note: Monthly frequency for the HICP and the national CPI and quarterly frequency for the private consumption deflator. The HICP is not available before January 1996, so the annual rate of increase can be calculated as from January 1997. The most recent observations are from July 2013.
Source: Statistics Denmark.

The development in the two consumer price indices attracts considerable attention, and the annual increase is usually referred to as inflation. Box 2.1 discusses a number of caveats to bear in mind when interpreting consumer price developments.

CALCULATION OF THE CONSUMER PRICE INDEX Box 2.1

The consumer price index measures the price of household consumption in Danish territory, cf. Statistics Denmark (2009). Statistics Denmark calculates consumer prices on the basis of a monthly sample of around 25,000 prices collected from approximately 1,800 retailers, firms and institutions across Denmark. These prices are aggregated into one figure, i.e. the consumer price index. This is done by weighting all prices, so that the index shows the development in the cost of a fixed basket of goods and services over time. For this purpose, Statistics Denmark uses a Young price index for the development from period 0 to t,

$$I_{0:t}^{Young} = \sum_j w_b^j \frac{p_t^j}{p_0^j}$$

w_b^j denotes the budget share of product j in period b, which is typically before period 0.[1] Strictly speaking, a Young price index does not measure the price development of a fixed basket of goods, since the budget share, not the quantity, is fixed. p_0^j and p_t^j denote the price of product j in periods 0 and t, respectively. The budget share is calculated on the basis of the national accounts and the consumer survey, which contain detailed information on household consumption.

Although the consumer price index is the most widely used index for measuring price developments and has been used for many years and in most countries, using the index as a measure of the costs of living for consumers is problematic in some respects. Firstly, the basket of goods does not change continuously over time, even though prices or consumer preferences change. When prices change, households tend to buy more relatively cheap products and fewer relatively expensive products. When a fixed basket of goods based on historical weights is used, the consumer price index will not capture the change in the composition of consumption, entailing that the price development will be overestimated. The weights are therefore updated regularly. Budget shares based on the national accounts and the consumer survey are typically updated every three years. In addition, the weights in the consumer price index are currently updated annually on the basis of price developments, whereby the budget shares remain fixed between the actual updates of the weights. This approach reduces the risk of overestimating the price development. In this connection, a balance must be achieved between, on the one hand, ensuring a representative basket of goods by frequently updating it, and, on the other, the wish to measure price movements for a fixed basket of goods.

Another related issue concerns changes in quality, which should not impact a price index. However, the value of changed quality is not known and is difficult to calculate and adjust. For computers, for example, it is possible to adjust the value for quality improvements using physical criteria such as computing power, memory and battery life. For other goods and services, quality improvements are of a more intangible nature, which makes adjustment difficult. This contributes to uncertainty about price developments.

CONTINUED Box 2.1

In practice, quality adjustments are made by Statistics Denmark assessing whether the same product is involved from month to month. If the quality has changed to such an extent that the product cannot be regarded as the same product, the price change is excluded in that month, whereby the price change is attributed to changed quality. The price development of the product in question is included as usual in the subsequent months.

Goods that are only sold during part of the year also present a challenge when applying a fixed basket of goods, since no price can be observed for such goods during the rest of the year. Statistics Denmark compensates for this in different ways, e.g. by assuming that the price follows the price development for similar goods in the periods without observations.

Besides the practical challenges discussed above, it is sometimes argued that a wider definition of price development should be applied, which would enable it to be used as a deflator of nominal income over the course of a lifetime. This means that the price index should measure the purchasing power of money for all products, for which money can be used as a means of payment. In that case, the measure should also include the price of future consumption, which can be achieved by including asset prices.

[1] If $b = 0$ this is also known as a Laspeyres index.

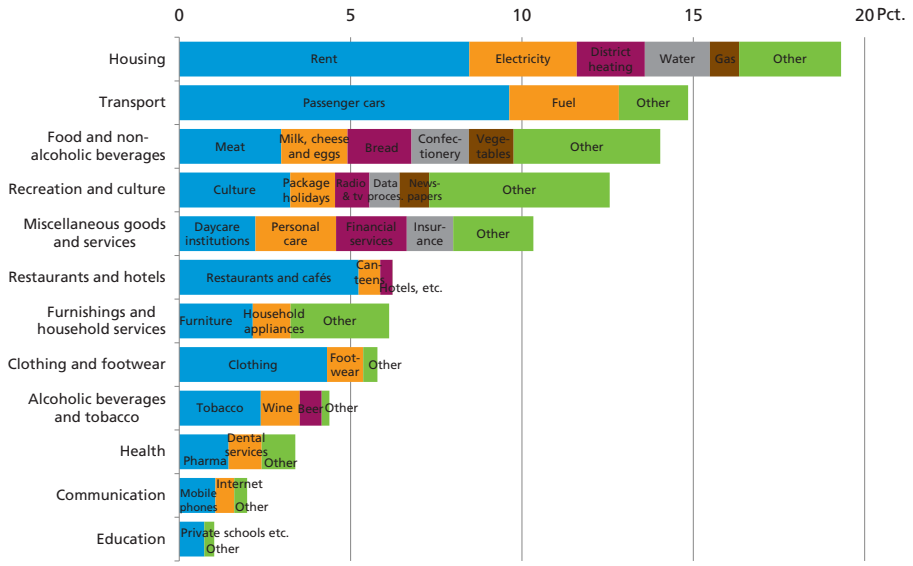
The two consumer price indices are generally closely mirrored by the development in consumer prices as calculated in the quarterly national accounts (the implicit consumption deflator). Consequently, an overall assessment of consumer price developments in Denmark is not dependent on the chosen price index, despite considerable differences in the methodology behind the various price indices. For example, the consumption deflator measures price developments in terms of total household consumption, i.e. including consumption abroad. Moreover, the implicit consumption deflator – as opposed to the consumer price indices – takes account of household substitution towards cheaper products, since it is constructed on the basis of the actual composition of consumption. On the other hand, this also means that the consumption deflator does not measure price developments of the same goods over time.

Composition of the consumer price index

In Denmark, the consumer price index is normally classified according to the international COICOP[1] classification, which is based on use. Chart 2.2 gives an impression of the weight composition in the HICP, detailing the key products in each COICOP category.

[1] Classification of individual consumption by purpose.

WEIGHTS IN THE HICP Chart 2.2



Note: Weight basis for the HICP as per December 2012.
Source: Statistics Denmark.

A fairly wide range of goods and services is included, some of which are goods frequently bought by consumers, whereas others are bought less frequently. In the event of considerable deviation from the average composition of consumption, the individual consumer may experience a development in prices that is different from that indicated by the consumer price index. In addition, consumers may also perceive price developments as different if, in practice, they are more aware of the prices of certain products. For example, the weights of rent and expenditure for acquisition and maintenance of passenger cars are higher than those of food and beverages in total. However, in everyday life the individual consumer is confronted with the prices of food and beverages far more frequently than with the price of a new passenger car, so they may attach greater importance to groceries in their assessments of price developments.

In some contexts, a drawback of the COICOP classification is that each of the 12 main categories contains very different goods and services. Moreover, the same type of goods can be included in several sub-indices. A case in point is that energy prices are included in both housing and transport.

An alternative approach is classification according to product type, i.e. goods and services that are typically influenced by the same type of economic events. The ECB mostly uses such classification of the HICP into

five main components. For example, energy prices are grouped together, because they are closely related to oil prices, and a distinction is made between processed and unprocessed food, because the latter category is more sensitive to e.g. weather conditions and seasonal fluctuations. This classification is used in section 5, which contains a more detailed analysis of price developments of individual goods and services. In section 4, the consumer price index is decomposed using a more analytical approach, focusing on identification of prices that can be regarded as exogenous and prices that show strong temporary fluctuations and therefore contain a large element of noise in relation to measuring underlying price developments.

Normally, there is only a slight deviation between the national CPI and the HICP, cf. Chart 2.1. Previously, the statistics showed several minor differences in methodology, but since 2001 the only difference worth mentioning has been the treatment of owner-occupied housing. Owner-occupied housing is difficult to tackle, since the consumption value of owner-occupied housing is to be included in a consumer price index – not the development in house prices. The consumption value is given by the return on living in your own home. Theoretically, the price of a home should be the discounted value of the expected future return on living in it, which means that the calculation of the consumption value could be based on house prices.

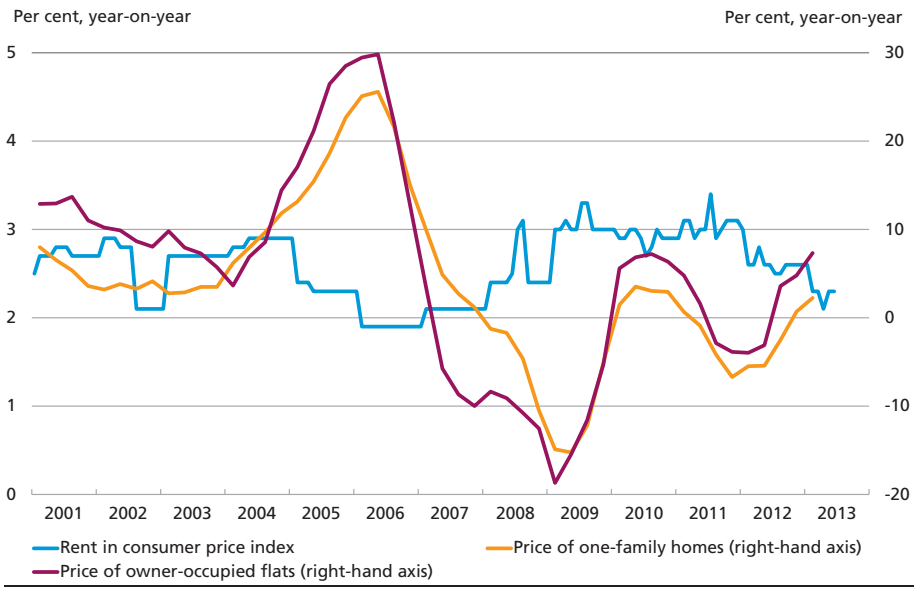
In practice, the national CPI instead operates with a housing cost determined on the basis of rent for a rental property (both permanent residences and holiday homes). Owner-occupied housing is thus included in the index by weighting the price development of this housing cost using the share of household expenditure that goes to owner-occupied housing according to the consumer survey, currently around 14 per cent.

In the short term, house prices and rent are not very closely related in the consumer price index, cf. Chart 2.3. Consequently, the method applied does not provide an answer to the impact of e.g. a housing bubble, so the soaring house prices in 2005-06 were not directly passed through to the consumer price index.

Prices of owner-occupied housing are not included in the HICP, since the available methods are contrary to the general HICP approach of calculating monetary transactions, i.e. the prices actually paid by consumers. Thus it is not possible to use imputed housing costs that are not formed on the basis of actual costs for owner-occupied housing.

Whether or not imputed housing costs are included, the issue of how to treat owner-occupied housing contributes to greater uncertainty about the actual development in the costs of living for consumers, because the costs of owner-occupied housing constitute a considerable

RENT AND HOUSE PRICES Chart 2.3



Note: The Chart shows monthly figures for the sub-index for rent, which is included in the calculation of the consumer price index, as well as quarterly year-on-year changes in house prices for one-family homes and owner-occupied flats. The most recent observations are from July 2013 for the rent index and the 1st quarter of 2013 for house prices.
Source: Statistics Denmark.

share of the total household budget. House price developments are therefore relevant for households. The EU is working on a harmonised method of including prices for owner-occupied housing in the HICP, cf. Eurostat (2012 and 2013).

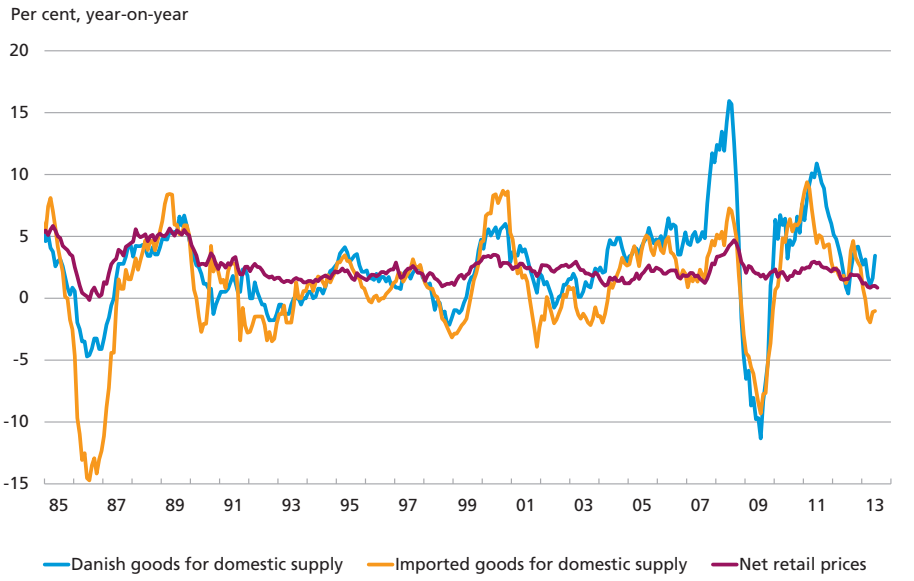
Consumer and producer prices

Since 1990, the annual rates of increase in consumer prices have not deviated by more than 2 percentage points from an annual rate of increase of 2 per cent, except for a short period in 2008. This may seem remarkable, considering the fluctuations in firms' input prices during the same period, cf. Chart 2.4.

The price index for the domestic supply is based on the sales prices of Danish firms and the purchase prices of importers, both calculated excluding indirect taxes. Consequently, they are compared with the index of net retail prices, in which consumer prices are also adjusted for the effect of indirect taxes and duties. The input prices for both Danish and imported goods fluctuate considerably more than net retail prices. One reason is divergence in weights due to differences in the product composition in Danish firms' production and household consumption. The volatile energy and commodity prices have a particular impact on

DEVELOPMENT IN NET RETAIL PRICES AND PRICES FOR THE DOMESTIC SUPPLY OF GOODS

Chart 2.4



Note: The most recent observations are from July 2013.
Source: Statistics Denmark.

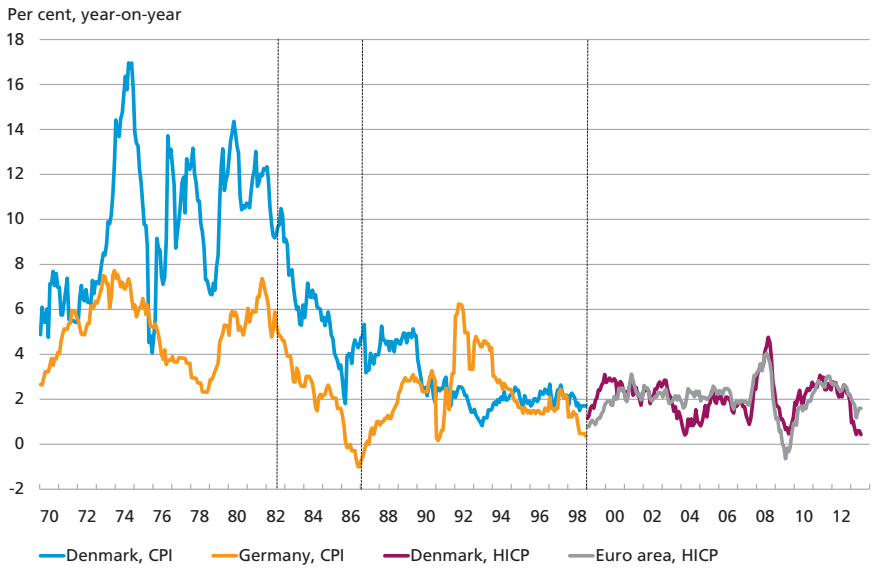
the price index for domestic supply. The smaller fluctuations in consumer prices can also be the result of retailers refraining from passing through temporary changes in the prices of their purchases of goods to their sales prices. Hansen and Storgaard (2011) review more price statistics and their use in more detail. In the remainder of this article, we focus on developments in consumer prices.

Price stability via the fixed-exchange-rate policy

For nearly two decades, Danish consumer price trends have mirrored price developments in Germany/the euro area, cf. Chart 2.5. This was not always the case. The 1970s saw considerably stronger fluctuations in inflation from year to year, and annual price increases of more than 10 per cent were not unusual. Moreover, at that time, inflation in Germany was higher than today, but still considerably lower than in Denmark. Up through the 1980s, the rate of price increase fell substantially in both Denmark and Germany. Since 1990, fluctuations have been more moderate, and the rates of price increase in Denmark and Germany/the euro area have not shown any persistent divergence.

In Denmark, monetary policy aims to deliver price stability by means of a fixed exchange rate of the krone against the euro – and previously against the D-mark, cf. Danmarks Nationalbank (2011). As a result of the

PRICE DEVELOPMENTS IN DENMARK, GERMANY AND THE EURO AREA Chart 2.5



Note: The CPI is the national consumer price index, and the HICP is the EU Harmonised Index of Consumer Prices. The broken lines mark various events related to the fixed-exchange-rate policy. In September 1982, the government coming into office announced that it would refrain from devaluation as seen in previous years. As a consequence of exchange-rate adjustments in the Exchange Rate Mechanism, ERM, in the following years, the value of the krone was maintained relative to the average of the currency basket, entailing minor devaluations against the D-mark. The last devaluation took place in January 1987. In January 1999, the D-mark was replaced by the euro, and the fixed-exchange-rate policy was then conducted against the euro. The most recent observations are from July 2013.

Source: Statistics Denmark, Eurostat and Reuters EcoWin.

fixed-exchange-rate policy, price developments in Denmark in the longer term must be in line with those of the currency anchor. Due to Denmark's substantial trade with the euro area member states, among other factors, cyclical fluctuations in Denmark have been synchronised with fluctuations in the currency anchor since the introduction of the euro in 1999. This contributes to prices and wages moving in tandem with those of the euro area. If the price development deviates from that of the euro area for a certain period of time, a number of economic equilibrium mechanisms will kick in and bring them back together over time. For example, higher price increases in Denmark than in the euro area will cause Denmark's competitiveness to deteriorate. This will reduce exports and hence output and employment, which dampens the pressure on production factors and reduces the rate of price increase. However, this adjustment may involve considerable costs, not least if the deviations have become substantial. Consequently, there is every reason to prevent strong deviations from occurring.

A country's monetary policy has decisive influence on inflation expectations. Inflation expectations are anchored if there is confidence in the

central bank's ability to ensure price stability via its monetary policy. This will impact on e.g. wage formation, since the expected price development is an important starting point for wage negotiations. A more stable wage development contributes to stabilising firms' costs and hence prices. Inflation expectations are thus to a great extent self-fulfilling.

The ECB plans its monetary policy with a view to compliance with the objective of price stability in the euro area inscribed in the Treaty on European Union. The ECB has defined price stability as annual growth in consumer prices of below, but close to, 2 per cent in the medium term. As a result of the credibility of Denmark's fixed-exchange-rate policy, Denmark has adopted the euro area's low inflation expectations.

The ECB's primary instrument is the short-term interest rate. If the ECB – and hence Danmarks Nationalbank, given the fixed-exchange-rate policy – raises interest rates, the monetary-policy transmission mechanism will pass through such an increase to the retail interest rates relevant to consumers and firms, cf. Drejer et al. (2011). Higher interest rates mean higher borrowing costs, making it more attractive to save. Savings thus tend to rise, while investment and consumption tend to fall. This reduces total demand, and the pressure on production factors will be lower than would otherwise have been the case, putting a damper on price increases. Conversely, lower interest rates will boost demand and increase capacity pressures, which will contribute positively to the rate of price increase.

Interest-rate changes also have an impact on exchange rates. An interest-rate increase – which contributes to strengthening a country's currency – will thus reduce import prices, which will, over time, be reflected in lower domestic price increases, cf. section 6.

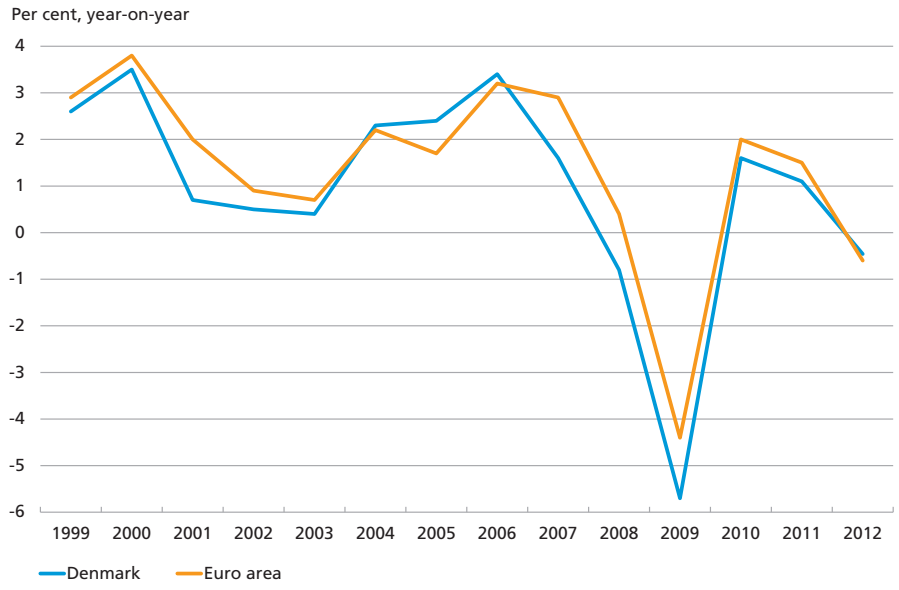
Business cycles and price developments

Most prices of goods and services in Denmark are the result of decentralised price setting, meaning that prices ensure a match between supply and demand. For individual products, supply and demand are determined partly by market-specific circumstances[1], partly by the cyclical position and other macroeconomic factors. A boom period of substantial demand results in rising prices due to stronger pressure on production factors. Moreover, prices may rise if firms are able to achieve higher gross mark-ups due to favourable demand conditions.

External shocks to the economy may also spill over to prices, as was the case in Denmark during the oil crises in the 1970s and early 1980s. At that

[1] For instance the number of buyers and sellers; whether the product has unique characteristics enabling a higher price; the possibilities of marketing the product; visibility of the product quality; firms' price differentiation strategies and the shelf-life of the product.

GDP GROWTH IN DENMARK AND THE EURO AREA Chart 2.6



Note: The most recent observations are from 2012.
Source: Statistics Denmark and Eurostat.

that time, higher energy prices were reflected in higher prices of other goods and to a certain extent also in wages.

While both cyclical factors and economic shocks can influence price increases in the short to medium term, monetary policy is the decisive factor in determining inflation in the medium to long term. In economic theory, there is a consensus that money is neutral in the long term, cf. e.g. Woodford (2003). The implication is that a change in monetary policy will, in the long term, solely influence the level of prices, not output or employment.[1] At the same time, inflation may have some detrimental effects, cf. Box 2.2, so the best way monetary policy can contribute to affluence in society is by ensuring a stable, nominal anchor for the economy.

In Denmark, the division of tasks between fiscal and monetary policy is explicitly formulated. The aim of monetary policy is to ensure a fixed exchange rate against the euro, while a specific Danish need to stabilise cyclical development is the task of fiscal policy. Since the introduction of the euro in 1999, the Danish economy has been in sync with the euro area economy, cf. Chart 2.6. This means that the ECB's monetary policy has contributed to stabilising economic development in Denmark too.

[1] With a floating exchange rate, the nominal exchange rate will also change.

MACROECONOMIC COSTS OF INFLATION Box 2.2

Stable prices have a number of macroeconomic benefits, cf. e.g. Gaspar et al. (2001) and Pedersen and Wagener (2000). The literature often distinguishes between the costs of expected and unpredicted inflation, respectively.

Expected inflation

In a discussion of expected inflation, the focus is on how high rates of price increase can, as such, influence the economy even though they are not surprising to anyone. High inflation makes it less attractive to hold cash instead of interest-bearing assets such as bonds. The general public will therefore tend to hold less cash funds, so they have to make more frequent withdrawals for current transactions. This is called *shoe leather costs* in the literature.

Moreover, high inflation also requires more resources for collection of information on price developments and analysis thereof. This in itself leads to higher costs. In practice, firms have to change their price tags, sales material, etc. more often. Such costs are called *menu costs*. They arise partly in the event of high predicted inflation, but are increased in the event of unexpected development in inflation.

In a nominally based tax system, inflation has a distorting effect. The nominal interest rate is given as the real interest rate plus expected inflation. Given the full deductibility of nominal interest costs, this means that higher inflation entails higher tax deduction for investments.

Consequently, the real rate of return depends not only on the productive return on investments, but also on inflation. In certain periods, this may make investments profitable for individuals even though they are unprofitable from a macroeconomic point of view.

A higher rate of price increase is normally followed by more pronounced fluctuations, which increases uncertainty about future prices. This forces households and firms to use more resources for protection against future inflation when concluding contracts in the financial markets and in the labour and goods markets. In the labour market, this may trigger a wage-price spiral, cf. section 6.

Unpredicted inflation

Unpredicted inflation blurs the information content of prices. This is a problem in a market economy where confidence in the signal value of prices is an essential precondition for the efficient functioning of the economy. For example, consumption and investment decisions depend on relative prices. They can change as a result of productivity variations between different industries or firms, among other factors. Fluctuating, unpredictable inflation makes it more difficult to identify the relative price structure and act optimally on that basis.

A price development deviating from expectations will result in reallocation between lenders and borrowers. This reallocation is not justified, either in real economic or in political terms, but can be regarded *ex ante* as a coincidence. This makes it less attractive for households and firms to conclude long-term nominal contracts. Moreover, lenders will typically require a higher risk premium, which increases real borrowing costs. This tends to dampen investment and economic growth.

CONTINUED Box 2.2

Furthermore, it should be noted that deflation, i.e. generally falling prices, is not desirable either, since it also has negative consequences. A modest rate of inflation is therefore preferable, since it reduces the risk of periods of deflation. At the same time, it can contribute to more flexible adaptation of real wages between firms, sectors and in the whole economy in a situation of downward wage rigidities, cf. Akerlof et al. (1996).

3. INFLATION EXPECTATIONS

Expectations of future inflation play an important role in current price formation. Firstly, the prices of many goods and services are set under the assumption that they are not to be changed within a given period – e.g. because price changes are costly. Firms therefore take the expected general development in prices into consideration when pricing their products. Moreover, well-anchored inflation expectations can reduce the risk of prolonged effects of temporary shocks to the development in prices. Formation of expectations thus plays a key role in ensuring price stability. Finally, inflation expectations affect the consumption, investment and savings decisions of households and firms.

There are two general approaches to measuring expected future inflation: questionnaire surveys and information derived from the financial markets.

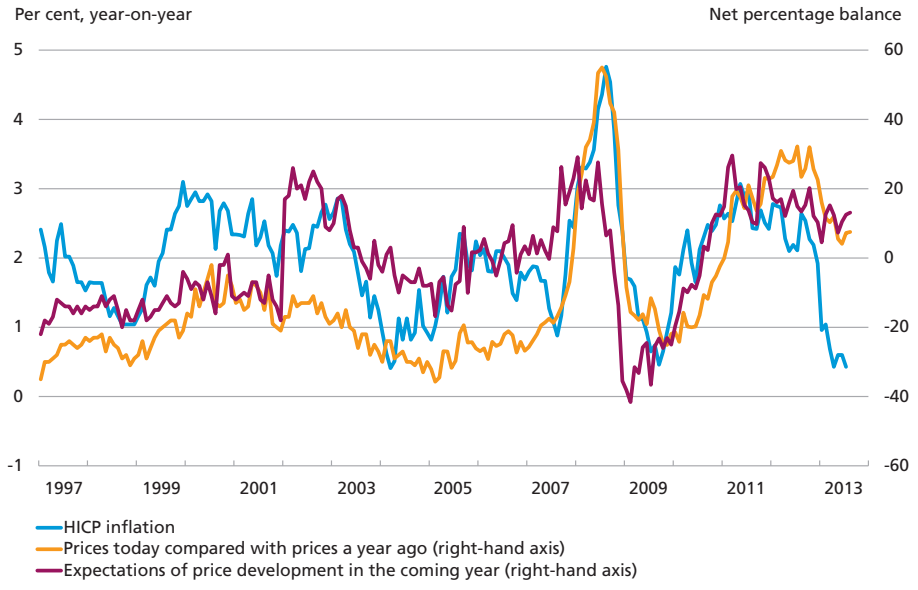
Questionnaire surveys are typically directed at consumers or professional analysts, while information from the financial markets can be derived from financial products, which are either directly index-linked to price inflation, or whose price setting depends indirectly on expectations of future price developments.

Below it is discussed how the two supplementary approaches can be used to gain a more accurate picture of expected future inflation and thus contribute to improved insight into a key element of price formation.

Questionnaire surveys

In Denmark, the monthly consumer expectation survey provides a measure of consumers' perception of current price developments and consumers' expectations of price developments over the next year. There is no direct question about the expected level of inflation, but calculating a net figure on the basis of the responses provides for qualitative comparison of the development with the development in actual HICP in-

CONSUMER EXPECTATIONS AND INFLATION Chart 3.1



Note: The most recent observations of HICP inflation are from July 2013. As regards expectations, the most recent observations are from August 2013. There is a break in the series for future price development as a result of rephrasing of the question in January 2002.
Source: Statistics Denmark.

flation, cf. Chart 3.1.[1] There is a relatively close relationship between the annual increase in the HICP and the consumer perception of current prices compared with prices one year earlier.[2]

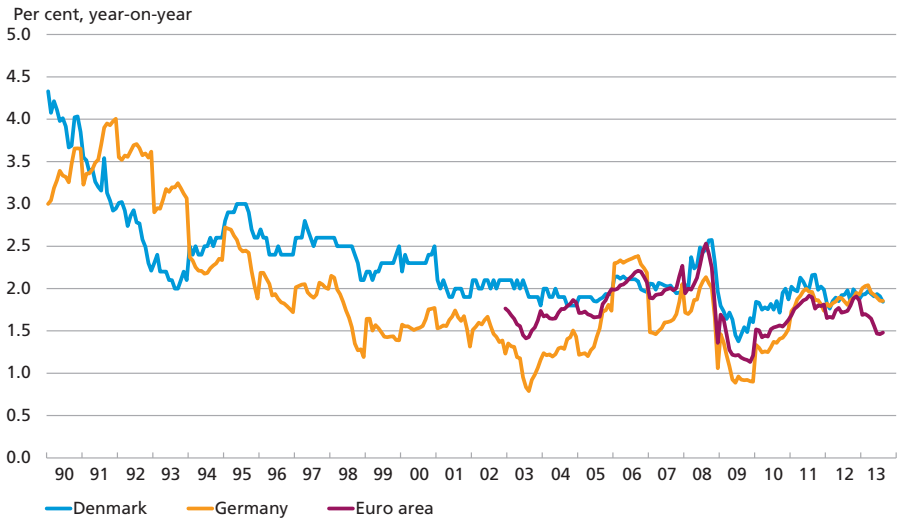
In addition, a relatively close relationship is observed between the consumer perception of price developments over the last year and consumer expectations for the coming year. This may indicate that the most recent price development plays a key role in the formation of expectations.

Consumer expectations can provide an indication of the expected price development in the short term, but they do not say anything about consumers' inflation expectations at longer horizons. Consumer expectations are particularly interesting as regards the interaction with wage formation.

Questionnaire surveys for professional investors and analysts may be used to supplement consumer expectations. These surveys typically quantify inflation expectations for different time horizons. In the short term, analysts expect almost the same inflation rates in Denmark and the euro area, cf. Chart 3.2. According to the most recent statistics, the ex-

1 Consumer expectations are based on a sample of around 1,500 persons. Eurostat publishes comparable statistics for the other EU member states.
2 This relationship is also seen for the period 1986-96, cf. Christensen (1996).

EXPECTED INFLATION IN THE NEXT CALENDAR YEAR Chart 3.2



Note: The Chart shows expected inflation in the next calendar year as an average for the analysts participating in Consensus Economics' monthly questionnaire surveys. For Denmark, the most recent statistics are based on approximately 15 different, mainly international, financial investors and analysts. The most recent observations are from August 2013.
Source: Consensus Economics.

pected annual rate of price increase in 2014 is still very close to 2 per cent despite a strong decline in Denmark's price increase rate in early 2013.

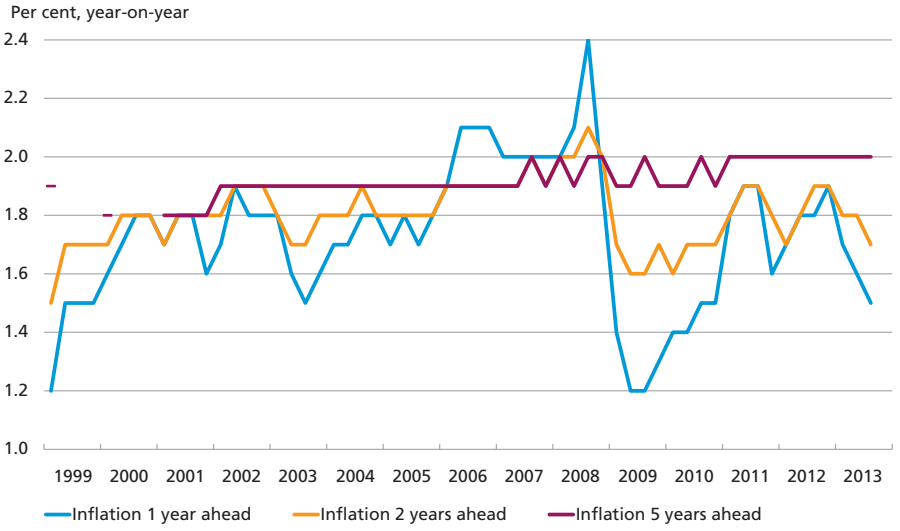
A more detailed survey – the ECB Survey of Professional Forecasters, SPF – is available for the euro area. In contrast to the Danish surveys discussed above, the SPF contains medium-term inflation expectations and information on uncertainty about future inflation.[1]

Chart 3.3 shows considerable fluctuations in inflation expectations one year ahead, especially in 2008-09, when first rising commodity prices, then a strong cyclical reversal resulted in marked fluctuations in the rate of price increase in the euro area. In some periods, expectations two years ahead have also deviated from the objective of an inflation rate of just below 2 per cent in the medium term. On the other hand, expectations five years ahead have been remarkably constant, despite the period of considerable economic instability. Over the last 10 years, expected inflation five years ahead has consistently been within the narrow range of 1.9-2.0 per cent.

The SPF results show a picture of solidly anchored inflation expectations in line with the ECB target. Since the first SPF was conducted in

[1] Similar questionnaire surveys are performed by the Federal Reserve Bank of Philadelphia and the Bank of England.

EXPECTED INFLATION IN THE EURO AREA Chart 3.3



Note: The Chart shows expected future inflation in the euro area on the basis of the ECB Survey of Professional Forecasters, SPF. The survey is based on responses from approximately 50 different financial investors and analysts. The most recent observations are from the 3rd quarter of 2013. The values in the Chart have been rounded to one decimal.

Source: ECB.

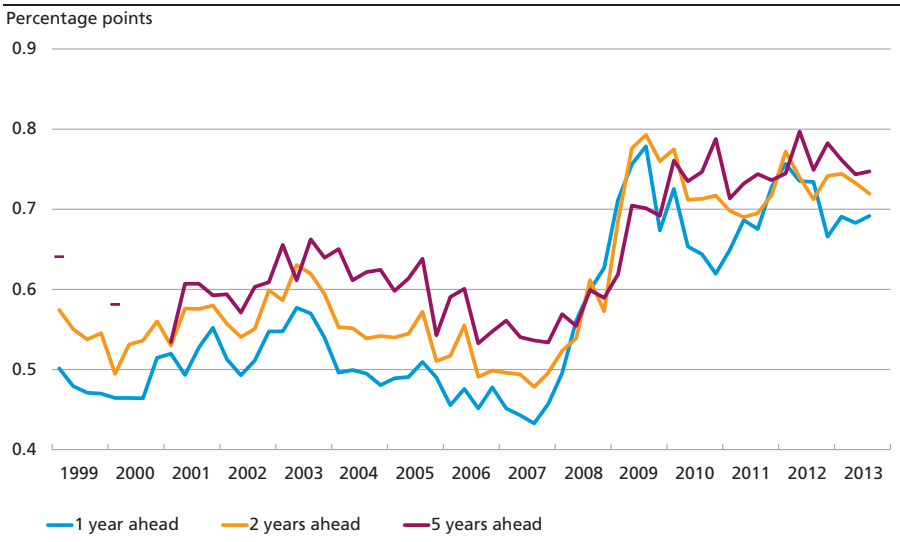
1999, the expected deviations from the target have mainly been downward deviations.

While the average inflation expectations five years ahead have been very stable, the SPF also shows that the level of uncertainty has risen after the financial crisis. Each response in the SPF survey contains the analysts' estimated probability distributions for inflation. These distributions can be aggregated as a total probability distribution of expected future inflation. Chart 3.4 shows the standard deviation for the aggregate probability distribution, which is a measure of the assessed range for expected inflation. There is a clear shift in levels after the outbreak of the financial crisis. The SPF respondents still expect inflation close to the objective, but state higher probabilities of deviations from the objective.[1] A similar pattern is observed for inflation expectations in the UK, cf. Maule and Pugh (2013).

The SPF responses can also be used to assess risks of marked deviations from the inflation target. Estimated probabilities of both annual price decreases and an annual price increase rate of more than 3.5 per cent have risen, cf. Chart 3.5. It is worth noting that both these probabilities are indicated as very low, according to the SPF. However, a recent study

[1] It is also possible to calculate the disagreement among the respondents as a measure of the uncertainty about future inflation. Such a calculation also shows mounting uncertainty from the end of 2008, although it has subsided a little again since then, cf. ECB (2012).

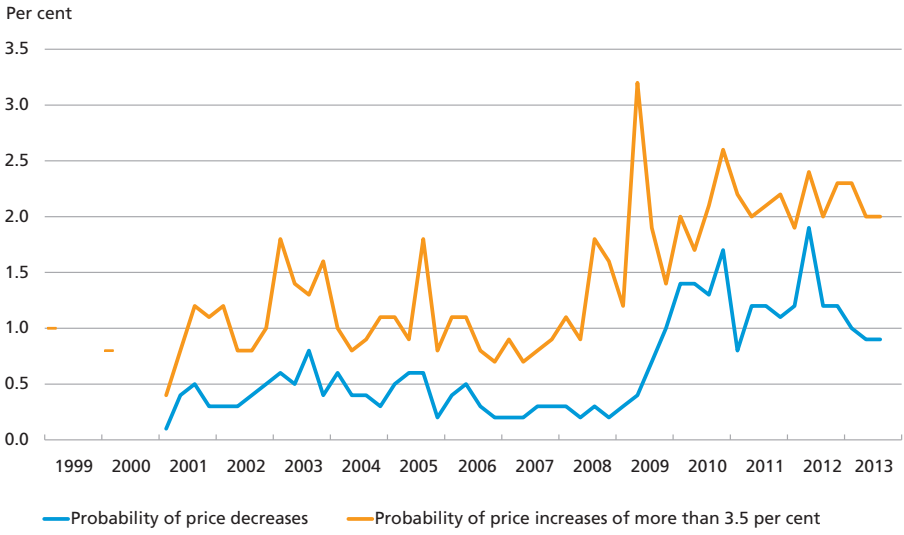
DISPERSION OF INFLATION ESTIMATES FOR THE EURO AREA Chart 3.4



Note: The Chart shows the standard deviation of the aggregate probability distribution for expected future inflation in the euro area on the basis of the ECB Survey of Professional Forecasters, SPF. Each response contains a probability distribution, and all distributions have been aggregated as one distribution. The most recent observations are from the 3rd quarter of 2013.

Source: ECB.

UNCERTAINTY ABOUT INFLATION IN THE EURO AREA 5 YEARS AHEAD Chart 3.5



Note: On the basis of the ECB Survey of Professional Forecasters, the Chart shows estimated probabilities of inflation in the euro area deviating strongly from the inflation objective 5 years ahead. The most recent observations are from the 3rd quarter of 2013.

Source: ECB.

(Kenny, Kostka and Masera (2013)) indicates that respondents generally find it difficult to calibrate probabilities to match the actual occurrence of outliers. This indicates that it is more relevant to consider the development over time, since this is found to be more informative.[1]

If consumers, firms and trade unions include analyst expectations in their own formation of expectations, surveys such as the SPF and Consensus Economics are relevant in relation to price formation and the interaction with wage formation. This also applies if analysts' expectations should turn out to be imprecise or show systematic bias.

Inflation expectations derived from the financial markets

Inflation expectations derived from the financial markets have the advantage of being based on actual transactions of financial products. Investors thus have a direct financial incentive to predict inflation with the highest possible accuracy. Moreover, information from the financial markets may continuously reflect the most recent events, providing a more updated picture compared with questionnaire surveys.

The markets for inflation-linked bonds can be used to calculate break-even inflation by comparing the yields to maturity on nominal and inflation-linked bonds, respectively. Break-even inflation is the level of inflation at which the returns on the index-linked bond and a corresponding nominal bond break even.[2] Subject to some caveats, it can be interpreted as expected inflation, cf. Box 3.1.

In May 2012, the Danish government issued a 10-year Danish inflation-linked government bond. It has been possible to calculate break-even inflation directly since September 2012, when the government's nominal bond with the same maturity date was introduced.[3] Since then, break-even inflation has been within the range of 1.5-2.0 per cent, cf. Chart 3.6. Assessed in terms of break-even inflation, the market thus expects average inflation in Denmark to be just under 2 per cent during the period until 2023.

The close relationship with corresponding calculations for the euro area member states Germany and France shows that financial market expectations of inflation in Denmark are close to the expectations for the euro area.

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1 The development described in Charts 3.4 and 3.5 is very much based on subjective analyst assessments. An extended SPF survey in the autumn of 2008 showed that most of the analysts applied econometric models supplemented by their subjective assessments. Particularly the probability distribution of future inflation is very much based on a subjective assessment (4 out of 5 respondents used no model for this).

2 The calculations of break-even inflation on the basis of Danish government bonds is described in more detail in Danmarks Nationalbank, *Danish government borrowing and debt – 2011*.

3 In the 1980s and 1990s, Denmark saw considerable issuance of index-linked mortgage bonds, but trading in these bonds has been very modest since 1999 when the exemption from real interest rate tax on index-linked bonds was lifted.

INTERPRETATION OF BREAK-EVEN INFLATION Box 3.1

Interpreting calculated break-even inflation solely as expectations of inflation in Denmark gives rise to a number of methodological problems.

Firstly, the yield spread between nominal and index-linked government bonds contains an inflation risk premium, i.e. the excess return demanded by market participants as compensation for exposure to fluctuations in the purchasing power of payments from the nominal bond. In general, this entails higher break-even inflation compared with inflation expectations.[1]

Secondly, the yield spread may contain a liquidity premium as a result of lower liquidity in the index-linked government bond than in the nominal bond. This entails lower break-even inflation compared with inflation expectations.

Thirdly, the yield spread is affected by seasonal variations in consumer prices. Index-linked bonds refer to non-seasonally-adjusted prices in order to prevent dependence on the seasonal adjustment method as regards the return on the bond. The normal seasonal variation should be expected to be reflected in the bond price. During a month when the consumer price index is slightly lower than normal due to a negative seasonal factor, an investor can thus look forward to a higher yield than that indicated by the present rate of increase in consumer prices. This will be reflected in a higher price of the index-linked bond, i.e. a lower real interest rate. Consequently, higher break-even inflation is calculated in months with negative seasonal variation.

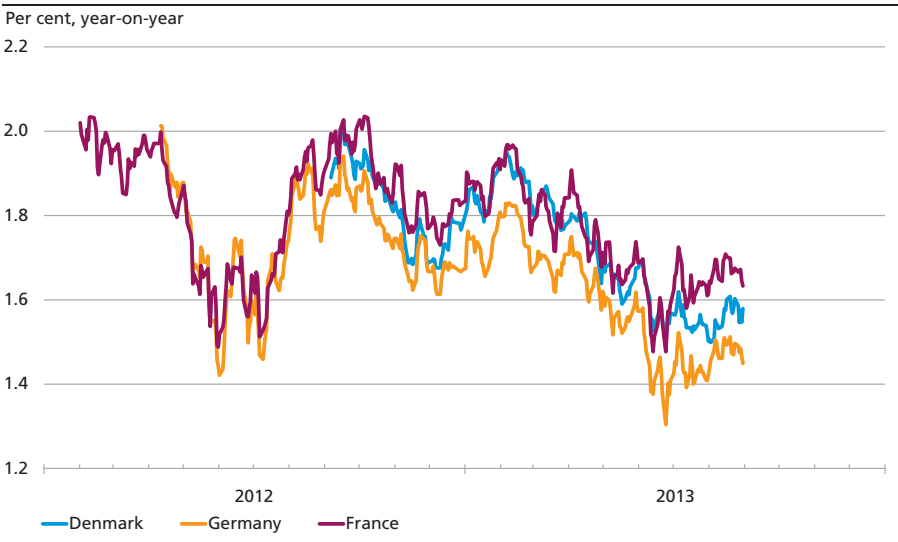
Finally, the yield spread is sensitive to temporary price distortions between nominal and index-linked government bonds. For example, the financial turmoil in the euro area may have given rise to periodical excess demand for the nominal Danish government bond, reducing nominal interest rates and thus also the calculated break-even inflation.

Break-even-inflation decreased by almost half a percentage point during the 1st half of 2013. Most of the decrease is probably attributable to lower inflation expectations, although a changed inflation risk premium may also have played a role. On the other hand, the liquidity premium does not seem to have changed to any significant degree, given the corresponding fall in Germany's break-even inflation, which is based on a highly liquid market. Expectations rose a little during July and August, reflecting a more positive economic outlook.

For the euro area, it is also possible to derive further information about expected future inflation from the markets for inflation swaps and inflation options (floors and caps). The principles behind the calculations are the same. However, break-even inflation calculated using inflation swaps is probably slightly more robust to temporary price distortions.

[1] In principle, the inflation risk premium may also be negative, depending on the market expectations of the correlation between inflation and the business cycle, cf. Danmarks Nationalbank, *Danish government borrowing and debt – 2012*, pp. 100-101.

10-YEAR BREAK-EVEN INFLATION FOR DENMARK AND THE EURO AREA Chart 3.6



Note: Break-even inflation is calculated on the basis of the difference between nominal and real yields on 10-year government bonds. For Denmark, the bond series DGB 1.5'23 and DGBi 0.1'23 are used. For Germany, the bond series used are DBR 1.75'22 and DBRi 0.1'23. For France, the series used are OAT€i 1.1'22 and OAT 3'22. The most recent observations are from 30 August 2013.
Source: Bloomberg.

Moreover, option prices can be used to derive further information on the uncertainty associated with expected future inflation. For example, it is possible to derive, on a regular basis, a market assessment of the probability of annual price drops or an annual price increase in the HICP which is considerably stronger than the objective of just under 2 per cent. Existing inflation-linked swaps can be used to derive inflation expectations for maturities of 1-30 years. Uncertainty about future inflation in the euro area rose substantially from the autumn of 2008, cf. ECB (2011, 2013).

The various calculations of inflation expectations supplement each other, since they measure the expectations of different economic agents. The conclusion across the calculations is that inflation expectations in both Denmark and the euro area have been firmly anchored and very stable for more than a decade. Recent years' economic environment has generally led to more focus on tail risk, and the heightened uncertainty about inflation expectations should be viewed in this context.

The weak economic development has contributed to reducing inflation. This has been countered by accommodative monetary policies. Several central banks have implemented unconventional monetary- policy measures as the possibilities of lowering interest rates to support the economy had been exhausted. Compared with a more normal cyclical

situation with neutral monetary policy, the present situation may be associated with greater uncertainty about the development in inflation, as several factors have rather strong opposite effects. Another element is the uncertainty associated with the phasing-out of unconventional monetary-policy measures. In that light, it is not surprising that the range for expected future inflation has been expanded.

4. UNDERLYING PRICE DEVELOPMENT

The background to the development in overall consumer prices can be better understood by supplementing with more specific price indices, which contribute to distinguishing between various aspects of price developments.

One element here is to use the concept of core inflation to distinguish between temporary and permanent price changes. For example, employees should be expected to be less inclined to demand wage compensation for temporary price increases as long as these increases have no significant effect on inflation expectations. Consequently, temporary fluctuations are less likely to increase the risk of a wage-price spiral. Core inflation eliminates the most volatile prices and may be used as an indicator of the underlying price development.

Another element is to identify how much of the price pressure stems from abroad. This provides for better identification of the part of inflation that can be attributed to a domestic price pressure related to the current capacity utilisation in the economy.

Core inflation excludes certain prices from the consumer price index

Some prices fluctuate so much from one month to the next that they are not suitable as the basis for describing underlying price developments. For this reason, core inflation, which excludes certain prices, is often used. Core inflation is typically constructed by completely excluding from the consumer price index products that fluctuate frequently and substantially. This eliminates some of the more or less random price changes, and gives a better measure of price trends.[1]

The method of excluding food and energy is used in many countries, but with variations as to which specific products are excluded. It is a balancing act to exclude products whose price development contains too much noise for contributing useful information on underlying price pressures, while at the same time ensuring that important price signals that

[1] An alternative approach is to assign lower weights to products, the prices of which fluctuate most over time, cf. Vega and Wynne (2001).

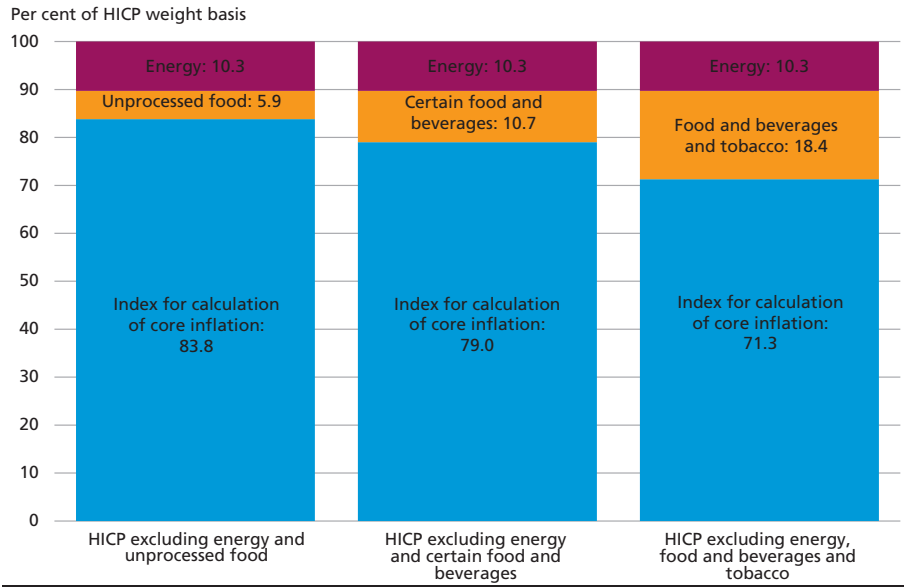
may indicate an undesirable direction of the price development are not removed.

Eurostat publishes several measures of core inflation for all EU member states. One is the HICP excluding energy and unprocessed food. This measure provides a relatively broad definition of core inflation relative to other measures that exclude more products, cf. Chart 4.1. The underlying premises for this measure are that these products are very volatile and that energy prices are very much determined by oil prices in the global market, while prices of unprocessed food depend on factors such as weather and season. Hence, the patterns of these prices do not reflect underlying price pressures in the economy.

This means that the extent to which various prices can be regarded as exogenous relative to the underlying price development has also been taken into account. However, these prices – even energy and food prices – contain a marked domestic element contributing to price movements determined outside the global commodity markets. The price of petrol thus also depends on profit margins, indirect taxes and wage costs for e.g. employees at service stations as well as distribution costs. The latter also play an important role in e.g. district heating. Energy input costs ac

WEIGHTS FOR EXCLUDED GOODS WHEN MOVING FROM AGGREGATE HICP TO VARIOUS CORE INFLATION INDICES

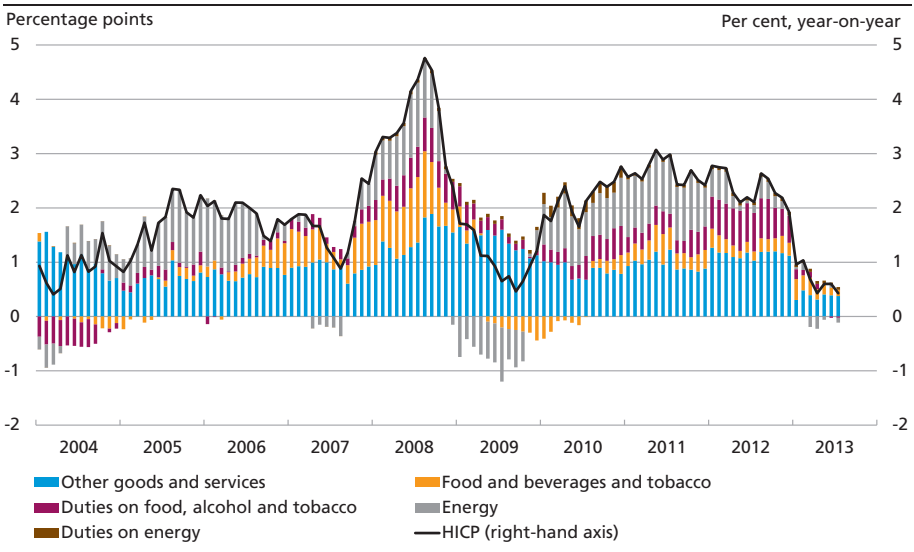
Chart 4.1



Note: The weights reflect the weight basis in January 2013. "Energy" contains the following sub-indices in the COICOP classification: 04.5 Electricity, gas and other fuels and 07.2.2 Fuels. "Unprocessed food" covers 01.1.2 Meat, 01.1.3 Fish, 01.1.6 Fruit and 01.1.7 Vegetables. "Certain food and beverages" also contains 01.1.1 Bread and cereals, 01.1.4 Milk, cheese and eggs, 01.1.5 Oils and fats and 01.2.1 Coffee, tea and cocoa. "Food and beverages and tobacco" covers 01 Food and non-alcoholic beverages and 02 Alcoholic beverages, tobacco.

Source: Statistics Denmark.

CONTRIBUTION TO ANNUAL RATE OF INCREASE IN THE HICP — Chart 4.2



Note: Contributions to price increase rates are calculated on the basis of the HICP and the HICP-CT. The most recent observations are from July 2013.
Source: Statistics Denmark.

count for just over half of the total consumer price of consumption of electricity, gas and other fuels and just under one-third of fuel costs, cf. Spange (2011).

Similarly, energy, food and beverages and tobacco are some of the products that are most often affected by changes in indirect taxes, cf. Chart 4.2. The decomposition of the annual rate of increase in the HICP shows that, in some periods, indirect taxes explain a considerable share of the price development. For example, in 2012, they contributed to increasing the annual rate of increase in the HICP by around 0.5 percentage point. This can be used as an independent argument in favour of excluding these products from core inflation if changes in indirect taxes are regarded as exogenous. On the other hand, changes in indirect taxes are normally permanent, so they should not be excluded when the aim is to exclude temporary price fluctuations.

Danmarks Nationalbank has usually defined core inflation as HICP excluding energy, food and beverages and tobacco. This implies excluding products, the prices of which reflect domestic processing, including labour costs, besides commodity prices. Using this measure, core inflation still represents more than 70 per cent of the goods and services included in the HICP, cf. Chart 4.1.

As a compromise between the above measures, a core inflation measure is constructed excluding – besides energy and unprocessed food –

prices of bread, dairy products, eggs, coffee, tea and cocoa. The underlying assessment is that the prices of these products reflect commodity prices to a considerable extent, and at the same time the prices of these products tend to change more frequently than those of other products, cf. section 5.

A more direct method of adjusting for substantial temporary fluctuations is to calculate core inflation using the *trimmed mean* method. Under this method, products the prices of which have fluctuated the most in a given month relative to the previous month are excluded from the consumer price index. The trimming is based on the 93 sub-indices in the HICP which constitute the highest level of detail published by Statistics Denmark. The largest price changes in each direction are excluded, until around 10 per cent of the weights in the HICP have been eliminated.[1]

As opposed to the other three measures of core inflation, the trimmed mean method excludes different products from the HICP month-on-month. However, the same products are often excluded in the different core inflation measures. Besides energy and food, clothing and package holidays are often excluded in the calculation of core inflation using the trimmed mean method.

All four measures of core inflation show more stable developments than the HICP, cf. Chart 4.3. This is particularly true since 2005 when commodity prices have been fluctuating considerably, and in recent years when several changes in indirect taxes have been implemented.

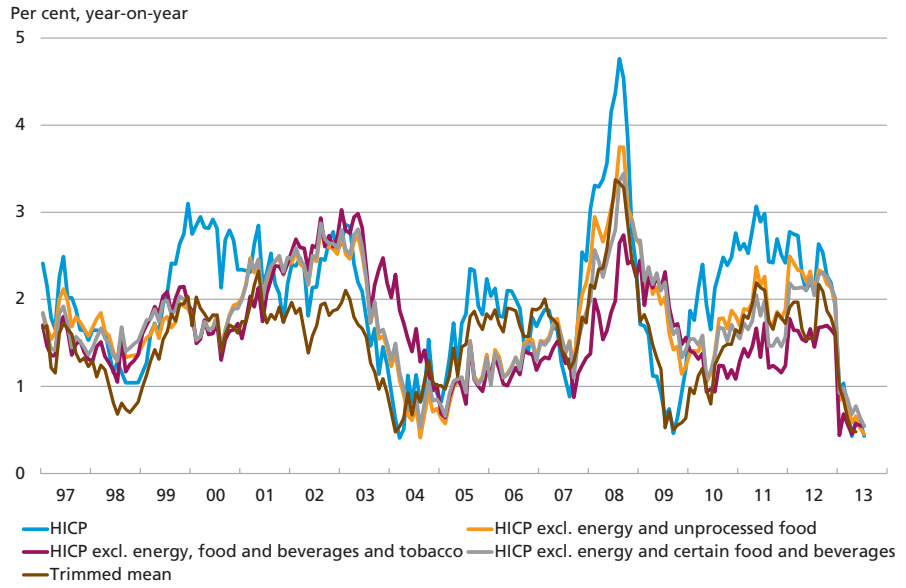
The various core inflation measures follow the same general pattern, although core inflation calculated using the trimmed mean method tends to deviate slightly for prolonged periods.

Calculated for shorter periods, the measures of core inflation that exclude the same goods every month also diverge. In 2008, for example, the measure excluding most goods, i.e. the HICP excluding energy, food and beverages and tobacco, is more stable than the other two measures. This should be viewed in light of the surge in commodity prices in 2007-08, which not only entailed higher prices of unprocessed food, but also spilled over to prices of processed food, such as bread and dairy products. This was also observed for certain beverages, e.g. beer.

From mid-2010 to end-2012, these three measures of core inflation again diverged. During that period, certain commodity prices rose, particularly prices of coffee and cocoa, which are not excluded from the HICP excluding energy and unprocessed food. Consequently – as opposed

[1] Trimming is performed in sequence, starting with the largest price changes. Trimming is stopped as soon as trimming of yet another sub-index means that at least 5 per cent at either end have been excluded.

THE HICP AND VARIOUS MEASURES OF CORE INFLATION Chart 4.3



Note: The most recent observations are from July 2013.
Source: Statistics Denmark and own calculations.

to the other two measures – this measure received a positive contribution to the annual rate of increase from those prices.

Against the background of the above analysis and the analysis of microdata in section 5, the preferred measure of core inflation is the overall consumer price development excluding energy and unprocessed food. The excluded goods are characterised, at both the micro and macro level, by more frequent and more marked price fluctuations than most other goods and services. This means that core inflation focuses solely on excluding temporary fluctuations.

Domestic price pressures

In Denmark, the general development in prices is partially determined by domestic market factors. Other factors play a role too, exerting an impact e.g. via import and energy prices, but also through indirect taxes. To some extent, these factors may be regarded as exogenous relative to domestic price pressures. Consequently, with a view to examining domestic price pressures, Danmarks Nationalbank has calculated a price index for domestic market-determined inflation, the IMI, since 1984, cf. Lauritzen (1987).

Similar to core inflation, the HICP is first considered, then energy and food are excluded, cf. Hansen and Knudsen (2005). This is performed using the preferred measure of core inflation described above. In this

case, energy and unprocessed food prices are excluded because a considerable part of these prices is not determined in a Danish market. In contrast, the main purpose of these exclusions in the calculation of core inflation was to exclude temporary price changes.

Products with administered prices, e.g. rent and public transport, are also excluded, since these prices are partially determined politically and thus not market-determined. Also for this reason, indirect taxes are excluded, using the index of net retail prices. Finally, the remaining goods are stripped of the price effects of the import and energy content using Statistics Denmark's input-output table from 2005.

The IMI index represents less than half of consumption, cf. Table 4.1, implying that a considerable share of consumer prices is determined by factors other than domestic market conditions.

The IMI index contains only goods and services, the prices of which are determined in the Danish market, and which are used for private consumption. The index contains a relatively broad group of products, but the content of services is higher than in the consumer price index due to the exclusion of the import and energy content. For example, the price of a car is included in the IMI index, but both indirect taxes and import content are excluded, so in reality only the car dealer's profit margin is left.

The development in the IMI approximately resembles the deflator of the private non-agricultural sector, cf. Chart 4.4. This is reassuring since the IMI calculation is based on the monthly consumer price indices and price indices for the domestic supply of goods and is therefore not necessarily close to the prices in the national accounts, which in principle reflect all price statistics.

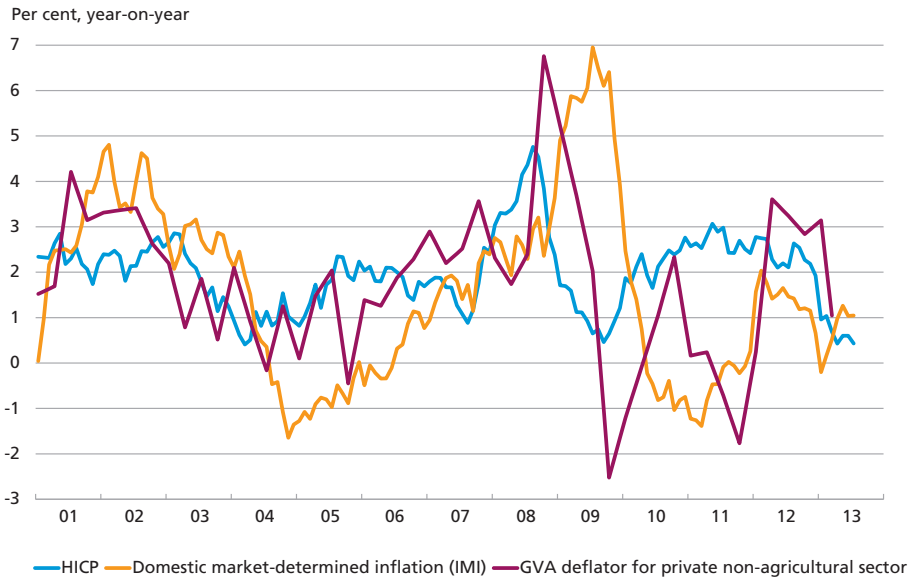
Commodity inputs (i.e. energy and imports) are deducted from the production of goods in the IMI. The result is value added, which indicates

WEIGHTS FOR EXCLUDED GOODS WHEN MOVING FROM AGGREGATE HICP TO DOMESTIC MARKET-DETERMINED INFLATION — Table 4.1

Weight as a percentage of the HICP weight basis	
Overall HICP	100.0
- Energy	10.3
- Food	5.9
- Administered prices	12.5
HICP excl. energy, food and adm. prices	71.3
NPR excl. energy, food and adm. prices	62.0
- Indirect energy content	1.8
- Direct and indirect import content excl. energy	19.6
IMI index	40.6

Note: Weight basis in January 2013.
Source: Statistics Denmark and own calculations.

DOMESTIC MARKET-DETERMINED INFLATION, HICP AND GVA DEFLATOR Chart 4.4



Note: Monthly frequency for the HICP and the IMI. Quarterly frequency for the gross value added (GVA) deflator in the private non-agricultural sector. The private non-agricultural sector is calculated as the private sector overall excluding agriculture, housing, energy extraction and net exports of services other than tourism. The most recent observations are from July 2013 for the HICP and 1st quarter 2013 for the GVA deflator.
Source: Statistics Denmark and own calculations.

what is available for remuneration of the production factors, i.e. labour and capital, including profits. Hence, the IMI corresponds to developments in wages and gross profits related to the goods and services included in the index. Since both wages and profits are related to capacity utilisation in the economy, the IMI index is an indicator of current domestic price pressures.

The IMI shows somewhat stronger fluctuations than the HICP, cf. Chart 4.4. Since 2001, there has been a tendency for a negative correlation between the IMI and the HICP. This is due to frequent and considerable changes in energy and import prices. These price changes lead to substantial fluctuations in the IMI when they are not passed on to consumers directly. In the very short term, the adjustment is often seen in corporate gross profits because firms keep sales price to consumers unchanged despite changes in input prices. If changes in import or energy prices are persistent, profit margins are adjusted towards the normal level, cf. section 6. Consequently, changes in exogenous prices will initially influence the IMI index, which will then adjust to its original level, cf. Box 4.1.

A case in point is the strong increase in the IMI index throughout 2009 because firms did not reduce prices in step with falling oil prices. This was

EXOGENOUS AND DOMESTIC MARKET-DETERMINED PRICES Box 4.1

The purpose of the IMI index is to capture the part of the price pressure that is formed in a Danish market. However, goods and services, the prices of which are determined by exogenous factors, may influence the IMI. For instance, this is the case if firms keep their sales prices to consumers more or less unchanged despite a change in the exogenous prices that make up part of the firm's total costs.

The possible impact of exogenous prices on the IMI can be examined using the equation below, which is estimated on Danish monthly data for the period from January 2001 to July 2013[1]:

$$\pi_t^{IMI} - \pi_{t-12}^{IMI} = \alpha + \beta(\pi_{t-12}^{HICP} - \pi_{t-12}^{IMI}) + \varepsilon_t$$

π_t^{IMI} and π_t^{HICP} are the annual rates of increase in the IMI and the HICP, respectively, at time t. ε_t is an error term, while α is the constant. β is a coefficient denoting how the IMI is influenced by a preceding difference between the annual rates of increase in the HICP and the IMI. This difference is due to exogenous prices. A value of β of around 1 can thus be taken to mean that a change in exogenous prices will result in an increase in domestic market-determined prices during the following year. We get a point estimate for β of 1.04, which is not significantly different from 1.

The impact of exogenous prices on the IMI should be viewed against the backdrop of some firms – in the event of changes in an exogenous price, such as energy – initially keeping sales prices to consumers unchanged, accommodating the adjustment in their profit margins instead. The result is considerable fluctuations in the IMI, while the annual rate of increase in consumer prices is far more stable.

In the event of permanent changes in exogenous prices, firms will, over time, adjust their sales prices to restore previous profit margins. In the event of temporary changes in exogenous prices, the profit margins at unchanged sales prices will return to their previous level without further adjustment.

The fact that the IMI is influenced by changes in exogenous prices can also be interpreted as second-round effects, i.e. changed exogenous prices generate new inflation expectations and hence changed wage demands. If that happens, it will affect the IMI. But inflation expectations have been stable in the period under review, cf. section 3. This reduces the probability of such development causing exogenous prices to influence the IMI.

[1] The model follows Cecchetti and Moessner (2008) and is estimated using autoregressive least squares.

followed by a period throughout most of 2010-11, when a negative annual increase in the IMI index indicated very weak domestic price pressures.

HICP, core inflation and IMI

Developments in the HICP, core inflation and the IMI together provide detailed insight into price developments over time. All of these measures can be calculated quickly and are based on publicly available data which are not normally revised.

MEAN AND STANDARD DEVIATION FOR THE ANNUAL RATE OF INCREASE IN VARIOUS PRICE INDICES

Table 4.2

	Mean (per cent)	Standard deviation (percentage points)
HICP	2.0	0.84
Core inflation	1.8	0.70
Domestic market-determined inflation, IMI	1.6	1.96

Note: Calculated on the basis of the annual rates of increase in the period January 2001 – July 2013. Core inflation has been calculated as the HICP excluding energy and unprocessed food.
Source: Statistics Denmark and own calculations.Source: Statistics Denmark and own calculations.

When core inflation is constructed by excluding temporary fluctuations, it should be expected to be more stable than the annual rate of increase in the HICP. This is also the case measured in terms of the standard deviation, cf. Table 4.2. The IMI index shows markedly stronger fluctuations.

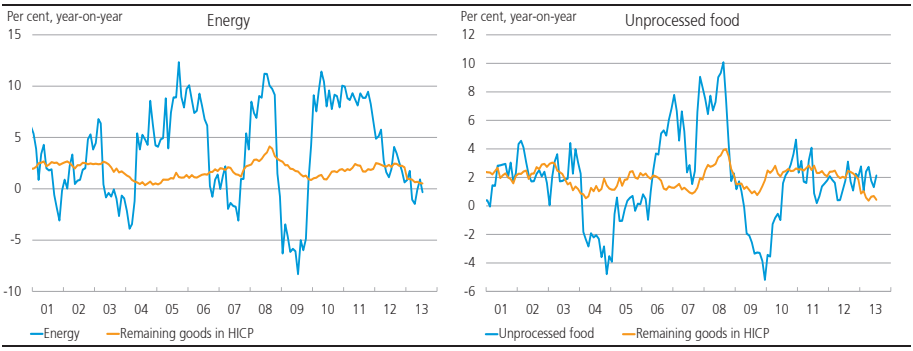
From January 2001 to July 2013, average HICP growth was 2.0 per cent year-on-year. The year-on-year increases were 1.5 per cent for goods and 2.8 per cent for services. Since the IMI index contains a relatively larger share of services, the rate of increase over time can be expected to be higher for the IMI than for the HICP. However, this was not the case during the analysis period, as the annual rate of increase in the IMI was 1.6 per cent on average. The reason is that this period was dominated by strong growth in energy prices (an average of 3.6 per cent year-on-year), which are excluded from the IMI.

Hence, both core inflation and the IMI fluctuated around a lower level than HICP inflation over a relatively long period. This is important to keep in mind when interpreting these price indices relative to the HICP.

In other words, the excluded goods do not show the same price trend as the goods included in core inflation and the IMI, cf. Chart 4.5. A case

ANNUAL RATE OF INCREASE FOR EXCLUDED AND REMAINING GOODS IN THE HICP

Chart 4.5



Note: The most recent observations are from July 2013.
Source: Statistics Denmark.

in point is energy prices. They are removed because they contain substantial temporary fluctuations. However, when rising over a longer period, they also impact underlying price developments.

With a view to examining the relationship between the HICP, core inflation and the IMI it can be analysed whether core inflation or the IMI contributes to predicting the future annual rate of increase in consumer prices. A simple method of testing this is to explain the annual rate of increase in consumer prices 12 or 24 months ahead, π_{t+m}^{HICP}, in terms of a constant, the current annual increase in consumer prices, π_t^{HICP}, and the inflation measure, π_t^*, for which we want to examine the predictive power:

$$\pi_{t+m}^{HICP} = \alpha + \beta_1 \pi_t^{HICP} + \beta_2 \pi_t^* + \varepsilon_t, \quad (4.1)$$

where m = 12 and 24 months. Both core inflation and the IMI are used as π_t^*.

The purpose of the IMI index is to capture the part of the price development that is determined in a Danish market. The business cycle plays an important role in this context, so the IMI index should initially be expected to respond to economic pressures at an earlier stage than consumer prices. This indicates that the IMI can contribute to predicting the annual rate of increase in the HICP.

The results show a significant contribution from the IMI index to the prediction of consumer prices 12 and 24 months ahead, cf. Table 4.3. Given

REGRESSION RESULTS FOR TEST OF PREDICTIVE POWER — Table 4.3

	α (constant)	π_t^{HICP} (annual increase in consumer price index)	π_t^* (examined inflation measure)	Adjusted R^2
Regressions for left-hand variable π_{t+12}^{HICP}				
Core inflation	1.51***	0.40***	-0.08	17.2
Domestic market-determined inflation, IMI	1.36***	0.19***	0.19***	27.7
Regressions for left-hand variable: π_{t+24}^{HICP}				
Core inflation	1.37***	0.36***	0.04	15.4
Domestic market-determined inflation, IMI	1.41***	0.12**	0.21***	30.2

Note: The Table shows the estimated coefficients on the explanatory variables in equation (4.1). The variable "examined inflation measure" has a different value in each row. The regression is performed for the annual rate of increase in the consumer price index 12 and 24 months ahead. In addition, the Table shows the adjusted degrees of explanation, just as the number of stars indicates the level of significance, where *** denotes p<0.01, ** denotes p<0.05 and * denotes p<0.10. The data period is January 1985 to July 2013. The HICP was used from 1997 and before that the national consumer price index was used. Before 1997 the measures are only calculated excluding energy, food and beverages and tobacco and afterwards excluding energy and unprocessed food. Regression only from 1997 onwards results in considerably lower degrees of explanation, and in several cases only the constant is significant.

Source: Statistics Denmark and own calculations.

INFLATION DYNAMICS Box 4.2

Core inflation should reflect the underlying price trend. If the annual rate of increase in the HICP, π_t^{HICP}, differs from core inflation, π_t^{core}, this should therefore be attributable to temporary factors, ε_t. This can be written as $\pi_t^{HICP} = \alpha + \beta\pi_t^{core} + \varepsilon_t$, where the significance of the temporary factors will disappear over time, meaning that the HICP and core inflation will show the same trends in the long term.

An examination of the possibility of cointegration between core inflation and the annual rate of increase in the HICP enables testing of whether the above relationship exists empirically and testing of the typical direction of the adjustment. The existence of cointegration is tested by including the various measures of core inflation in addition to the HICP. This method assumes that neither the HICP nor core inflation is stationary beforehand. This holds true in the period under review from January 1997 to July 2013. The results show cointegration between the HICP and core inflation, and it cannot be ruled out that the coefficient on core inflation is 1. In that case, the HICP is determined by the development in core inflation in the long term.

The results also show that the annual rate of increase in the HICP adjusts significantly to core inflation, whereas the opposite is not the case. In practice, this e.g. means that if the annual rate of increase in the HICP has been higher than core inflation for some time, the HICP will normally decrease and approach core inflation. This supports the use of core inflation as an indicator of the underlying price trend.

Given the positive coefficients, the annual rate of increase in consumer prices rises in the wake of an increase in the IMI.

Core inflation is insignificant and does not contribute to predicting the HICP trend 1-2 years ahead. On the other hand, a supplementary analysis shows that core inflation is decisive for HICP inflation in the long term. In this case, HICP inflation typically adjusts to core inflation – not the other way around, cf. Box 4.2. This supports the use of core inflation as an indicator of the underlying price trend.

5. CONSUMER PRICES AT THE MICRO LEVEL

This section takes a closer look at the microdata underlying the calculation of consumer prices in Denmark. These data enable, *inter alia*, an analysis of how often and how much the individual prices change and how price setting varies across different goods and sectors. The purpose is to gain more insight into the underlying price setting behaviour and how general increases in consumer prices are a function of the frequency and size of individual price changes.

Microdata from Statistics Denmark allow us to follow the price of a specific product sold by a given retailer over the period from January 1997 up to and including April 2013 (196 months). The data set includes

a total of 4,770,694 observations, i.e. almost 25,000 monthly. The analysed data consist of information on price, product name, product group, retailer and month of collection of the price information. The details about each retailer have been anonymised, and Statistics Denmark conducts an error search on the data.

The analysed data cover all goods and services in the HICP. However, for the purposes of this analysis we exclude a number of prices, focusing on market-determined prices. Administered prices and imputed rent prices, as well as price indices for books and computers, are excluded since they are not measured as directly observable market prices. More details about the data cleaning can be found in Hansen and Hansen (2006), containing an analysis of microdata up to and including 2005. The final data set covers around 85 per cent of the goods and services included in the official HICP. Prices in the microdata have not been adjusted for quality. Statistics Denmark adjusts certain prices in connection with the construction of the consumer price index.

Chart 5.1 shows six typical price spells of goods over the analysis period in order to illustrate the different types of prices. The price movements shown are for specific goods sold by given retailers.

The price of a bottle of Gammel Dansk is typically changed once a year at the most. In 2003, the price dived as a result of a reduction of the indirect tax on spirits.

The two price spells for the price of a haircut for men show that the price is adjusted at 1- or 2-year intervals. For services, labour costs typically constitute a larger share of the production costs. Consequently, wage developments (and productivity) will, over time, be decisive for price developments for services.

Prices of district heating and petrol show the same increasing trend over the analysis period, but with considerably stronger month-on-month fluctuations in petrol prices.

Finally, other goods show highly volatile price developments. E.g. the price of a fillet steak or a summer skirt. The price spells of these goods are considerably shorter, since Statistics Denmark collects the prices from different retailers in order to reduce the reporting burden on individual retailers.

In addition, as regards clothing the products are changed often, so a specific product is included only for 1-2 years. The price spell illustrated for a skirt is from the same retailer and in principle for the same product throughout the period. A clear seasonal pattern is shown, in that the price is reduced during the spring.

Overall, the price spells illustrate natural price developments over time for some goods and services, while the prices of other goods are neces-

EXAMPLES OF PRICE SPELLS Chart 5.1

Note: The Chart shows examples of price spells for various products. Each colour indicates a price spell for a certain product from the same retailer.
Source: Own calculations based on microdata from Statistics Denmark.

sarily a synthetic composition of prices of a product, which can show considerable quality fluctuations over time.

Both list prices and their temporary fluctuations contribute to the general price dynamics and are therefore included in the analysis. This approach is used in several other studies, but there are also analyses of data excluding temporary special offers. For example, Nakamura and Steinsson (2013) show that requency at the micro level can give an inaccurate picture of price flexibility at the macro level if a substantial share of the price variation is of a temporary nature only. At the macro level, price stickiness is an important building block for macroeconomic

models, having decisive implications for, *inter alia*, the pace of recovery after a shock to the economy, cf. Gagnon, López-Salido and Vincent (2013).

However, this analysis does not aim to interpret the flexibility of micro prices directly as an expression of price flexibility at the macro level. Moreover, it is not clear how sale prices should be excluded in practice. Consequently, seasonal and sale prices have not been excluded. In this context, it is also worth noting that many prices do not return to their initial level after being on sale. According to Klenow and Kryvtsov (2008), this applies to more than 40 per cent of prices in a study of US data. Thus, sale prices should not be regarded solely as temporary fluctuations, but as deviations that may be more persistent and may influence price developments at the macro level.

How often are prices changed?

Inflation can basically shift if more prices change (extensive margin), or if price changes become higher or lower (intensive margin). The share of goods changing price each month is examined. On average, 18.5 per cent of all prices change in a single month, cf. Table 5.1. In more detail, 10.8 per cent of the prices are raised, while 7.7 per cent are reduced. Prices are thus raised more frequently than they are reduced, which is not surprising in an economy with positive inflation rates.

However, at the same time observations show that a large number of prices are reduced each month, indicating that prices are more flexible than suggested by the general price development.

The frequency of price changes in Denmark matches the findings of similar analyses in other countries. Klenow and Malin (2010) review the available studies of micro prices with special focus on the USA. The studies are not directly comparable, varying in terms of period and compositions of goods, but they may provide an overall indication of price flexibility.

Most international studies do not cover recent years. As regards the Danish microdata, the main findings do not depend on the timeliness of the data series, i.e. whether they are observations until April 2013, or – as in the previous analysis – until 2005, cf. Hansen and Hansen (2006).

In the USA, 26.5-36.2 per cent of all prices are changed in an average month, cf. Nakamura and Steinsson (2008) and Klenow and Kryvtsov (2008). US prices thus tend to change more frequently than Danish prices, initially indicating more flexible price formation in the USA. The high frequency is attributable to e.g. more widespread use of sale prices and a generally higher and more volatile rate of inflation.

FREQUENCY OF MONTHLY PRICE CHANGES IN DENMARK Table 5.1

Per cent	Price changes	Price increases	Price decreases	Share of price increases
COICOP classifications:				
1. Food and non-alcoholic beverages	24.8	13.6	11.2	54.8
2. Alcoholic beverages and tobacco	12.5	8.3	4.1	66.9
3. Clothing and footwear	15.9	6.2	9.8	38.6
4. Housing	30.0	18.5	11.5	61.7
5. Furnishings and household services	6.6	4.2	2.4	63.8
6. Health	7.0	6.1	0.9	86.8
7. Transport	30.6	17.5	13.1	57.2
8. Communication	3.8	1.9	1.9	49.3
9. Recreation and culture	10.4	6.1	4.3	58.4
10. Education	-	-	-	-
11. Restaurants and hotels	3.8	3.4	0.5	88.0
12. Other goods and services	6.9	5.4	1.5	78.6
Main components:				
Unprocessed food	39.3	20.5	18.8	52.2
Processed food	13.8	8.6	5.2	62.3
Energy	56.0	32.0	24.1	57.1
Industrial goods excl. energy	10.0	5.5	4.5	54.9
Services	8.9	6.5	2.5	72.5
All goods and services	18.5	10.8	7.7	58.4

Note: The Table shows the share of prices that changes from one month to the next. Education prices have been excluded as they are primarily administered prices. The frequencies have been calculated as weighted averages based on frequencies at product level and the HICP weights of the products. The period is January 1997 to April 2013.

Source: Own calculations based on microdata from Statistics Denmark.

For the euro area, Dhyne et al. (2006) summarise the findings of a number of studies in connection with the European Inflation Persistence Network, a joint research project headed by the ECB. In the euro area, 15.1 per cent of all prices are changed during an average month. This percentage is slightly lower than that of the Danish data, but the difference is not conspicuous, considering the different calculation methods.[1] Hence, according to the general picture, frequencies in Denmark are on a par with those of the euro area and lower than those of the USA.

The frequency of price changes varies considerably across different product groups, cf. Table 5.1. This applies to both classification according to the 12 main categories of the international COICOP classification and to grouping according to the five main components that are typically used for analysis of price developments in the euro area.

[1] The results for the euro area are for a representative composition of 50 different goods and services, i.e. a subset of HICP. Using the Danish microdata, the results are almost the same when using only the 50 products, but the differences are more pronounced for the various classifications of goods and services.

Among the COICOP categories, transport and housing account for the most frequent price changes. A principal reason is that these categories include petrol prices and housing heating costs. The second most frequently changed prices are in the categories of food and non-alcoholic beverages, where around one-fourth of the prices are changed in a given month.

The main component classification shows that unprocessed food prices are changed at a far higher frequency than processed food prices, and the frequency applying to the latter is inherently lower than the average for all goods and services.

A common feature of several of the groups with the lowest frequencies of change is that they contain a large share of services. Prices are changed monthly for only 8.9 per cent of services, and in particular, a smaller share of services show falling prices. In more than 7 out of 10 cases, adjustment of the price of a service means an upward adjustment. This is presumably attributable to the higher share of labour costs in services, so stickiness in nominal wages also entails some price stickiness. Stickiness in service prices may also be associated with a more widespread use of contracts. In an analysis of producer micro prices, Vermeulen et al. (2012) emphasise the relationship between labour costs and price stickiness.

For the euro area, the frequency of price change is also lower for services. During an average month, 4.2 per cent of service prices are raised, while only 1.0 per cent are reduced, cf. Dhyne et al. (2006). In the USA, no less than 15 per cent of service prices are changed monthly, indicating that the service sector plays a central role when it comes to understanding the difference in price flexibility between the USA and Europe.

The estimated frequencies can be converted into an average duration of the typical time interval between price changes. There are various methodological approaches to calculating duration. The concept used here is the average implied duration resulting from weighting the calculated durations for all products, $D_i = -1/ln(1 - f_i)$, where f_i is the frequency of price change for product i.[1] This calculation shows that in Denmark a price is, on average, changed after 12.8 months.[2] As regards energy and unprocessed food, the duration is less than five months, while the average duration for services is 21 months. These averages

[1] Alternatively, the duration can be calculated directly from the observations, but this requires taking into account censoring of price spells, i.e. prices for which it is not observed when they were first set or when they are changed, cf. the discussion in the Appendix in Dhyne et al. (2006).

[2] The relationship between frequency and duration is non-linear, meaning that the averages of the implied durations for the individual products deviate from the implied duration calculated for the average frequency applying to all goods.

should not be overinterpreted, but an interesting feature is that service prices are changed at almost the same frequency as collective agreements in the Danish labour market.

How much do prices change?

Inflation is also determined by the size of the price changes. Table 5.2 shows percentage changes for the products for which a price change is observed relative to the previous month. The average price change is 12.7 per cent when prices are raised and 16.1 per cent when they are lowered. When it comes to driving the general development in prices, the relatively larger price reductions partially offset the relatively higher frequency of price increases.

In the euro area, the size of price changes is a little smaller, but the price increases of 8.2 per cent are also lower than the price decreases of 10.0 per cent. Price changes tend to be slightly more pronounced in the USA, where prices are, on average, raised by 12.7 per cent and lowered by 14.1 per cent, cf. Klenow and Kryvtsov (2008).

Price changes are generally substantial relative to the average inflation rate. Hence, it is not only a question of prices being adjusted annu-

SIZE OF AVERAGE MONTHLY PRICE CHANGES — Table 5.2

Per cent	Size of price increases	Size of price reductions
COICOP classifications:		
1. Food and non-alcoholic beverages	15.7	18.3
2. Alcoholic beverages and tobacco	9.6	10.4
3. Clothing and footwear	35.3	39.3
4. Housing	6.7	7.2
5. Furnishings and household services	15.2	20.2
6. Health	6.3	16.8
7. Transport	5.1	8.6
8. Communication	27.6	23.0
9. Recreation and culture	15.1	20.1
10. Education	-	-
11. Restaurants and hotels	8.4	13.0
12. Other goods and services	10.8	19.3
Main components:		
Unprocessed food	19.2	20.6
Processed food	11.9	14.2
Energy	4.7	4.6
Industrial goods excl. energy	15.3	19.8
Services	11.5	16.7
All goods and services	12.7	16.1

Note: Price changes have been calculated as the change in the logarithm of the price relative to the preceding month for the products for which prices are changed. The changes have been calculated as weighted averages of the changes at product level on the basis of the HICP weights of the products. The period is January 1997 to April 2013.

Source: Own calculations based on microdata from Statistics Denmark.

ally in relation to the general development in prices (as would have been the case if a large share of the prices had been index-linked). Instead, the relatively substantial price changes seem to indicate that prices are very much determined by specific market factors for the individual products. Shocks to supply and demand for individual products thus seem to have played a more important role than macroeconomic shocks to the economy as a whole.[1]

Clothing and footwear account for the strongest price changes. These products are characterised, *inter alia*, by sale prices when stocks are to be sold off before new collections are introduced. In reality, these price reductions are the result of the products losing part of their value so that they are put on sale. In theory, adjustment should be made for such differences in quality, but changes in price and quality are difficult to separate in practice. As mentioned earlier, Statistics Denmark seeks to make adjustment for changes in quality for certain products when calculating the general development in consumer prices. In this specific case, however, no adjustment is made for changes due to clothing falling out of fashion, since the fashion factor is not regarded as a quality parameter in a HICP context. In any case, no quality adjustment has been made in microdata. This is a contributing factor to the substantial price changes.

The second-largest price decreases are seen for communication, which is also one of the product groups with the longest intervals between price adjustments, cf. Table 5.1. The price of communication services has otherwise been declining over the period under review, due to strong price drops for telecommunications equipment.

The product groups with the smallest price changes are also the groups with the highest frequencies. Energy is a case in point.

Moreover, it is noted that price reductions for services considerably exceed price increases. Price decreases for services occur relatively rarely, but when they do occur, the price is reduced by 16.7 per cent on average. The same pattern is observed for the product group health. As regards this product group, prices of vitamins, minerals and medicine, among others, are characterised by relatively substantial price reductions, but this also applies to prices of medical and paramedical services. For the latter two groups, the size of the price changes should, however, be viewed in light of the far more frequent price increases.

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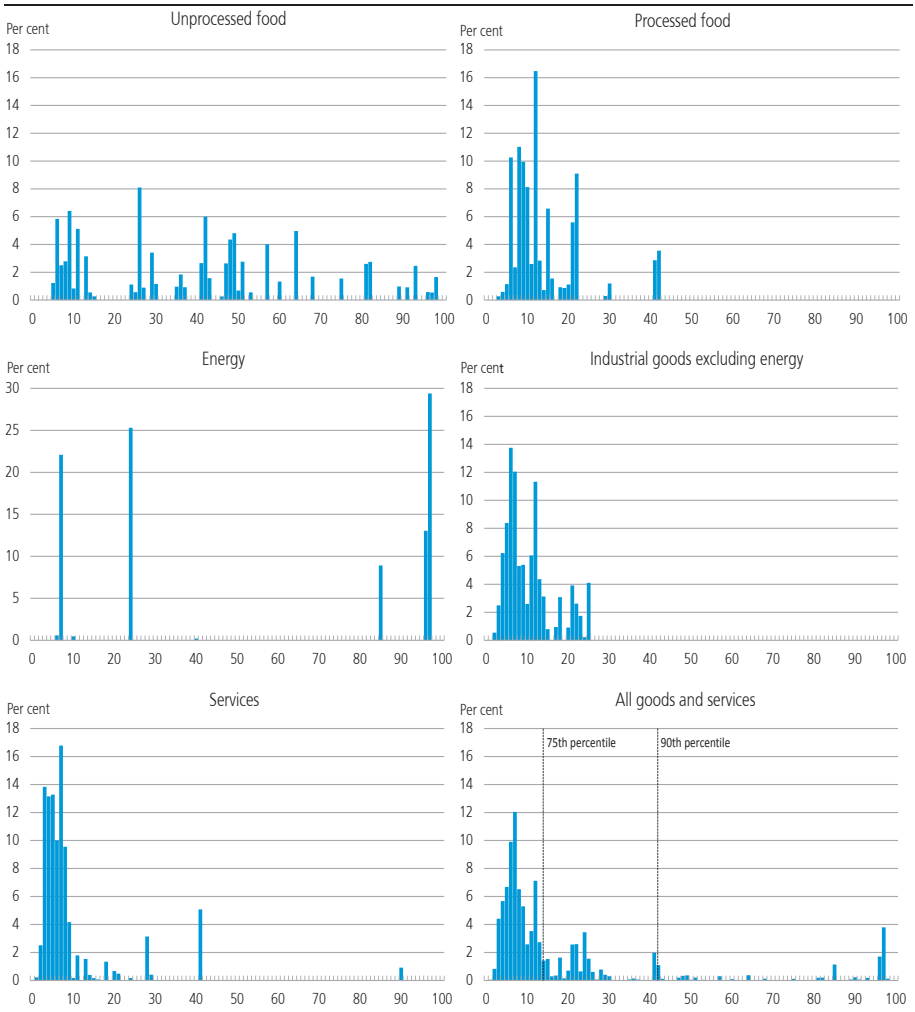
[1] Mackowiak and Smets (2008) and Mackowiak and Wiederholt (2009) demonstrate how the typical microdata results can be supported by a model, in which it is rational for firms to concentrate on idiosyncratic shocks and disregard macroeconomic shocks. One implication is that nominal shocks to the economy may have sustained real effects.

Heterogeneity in frequencies

Considerable heterogeneity is also observed *within* individual product groups. Chart 5.2 shows the frequency distributions for the individual products in the five main components. The bars represent the weights of the goods changed at the given frequency. Energy, for instance, is characterised by comprising a number of products with a relatively low frequency of price change (electricity and district heating), and some products with a very high frequency of price change (petrol and fuel oil).

DISTRIBUTION OF THE MONTHLY FREQUENCY OF PRICE CHANGES — Chart 5.2



Note: The Chart shows the distribution of monthly frequencies of price changes for individual goods and services in each of the five main components and for all goods and services. The bar thus represents the weights of products with given frequencies, as percentages. Both frequencies and weights have been calculated as averages over the period from January 1997 to April 2013.

Source: Own calculations based on microdata from Statistics Denmark.

The unprocessed food group also contains very different products, with frequencies covering the entire scale from low to high.

For the remaining product groups, the frequency of price change is relatively low for most products. The processed food group contains slightly more products with a relatively high frequency, such as coffee and cheese, but otherwise the distribution is similar to that for industrial goods excluding energy. For services, the distribution is strongly concentrated on the low frequencies. Package holidays stand out with a frequency of more than 40 per cent, which is due to widespread use of campaign and sale prices.

In the calculation of core inflation, it is sought to exclude the most volatile prices, cf. section 4. On the basis of microdata, these are first and foremost energy and unprocessed food prices. It is less obvious that processed food products should also be excluded since the frequency of price change is relatively low for most processed food products.

Price setting behaviour over time

The analysis period with a fixed-exchange-rate policy against a stable, nominal anchor has generally been characterised by price stability. A breakdown of the HICP into the five main components shows considerably stronger fluctuations, especially in prices of energy and unprocessed food.

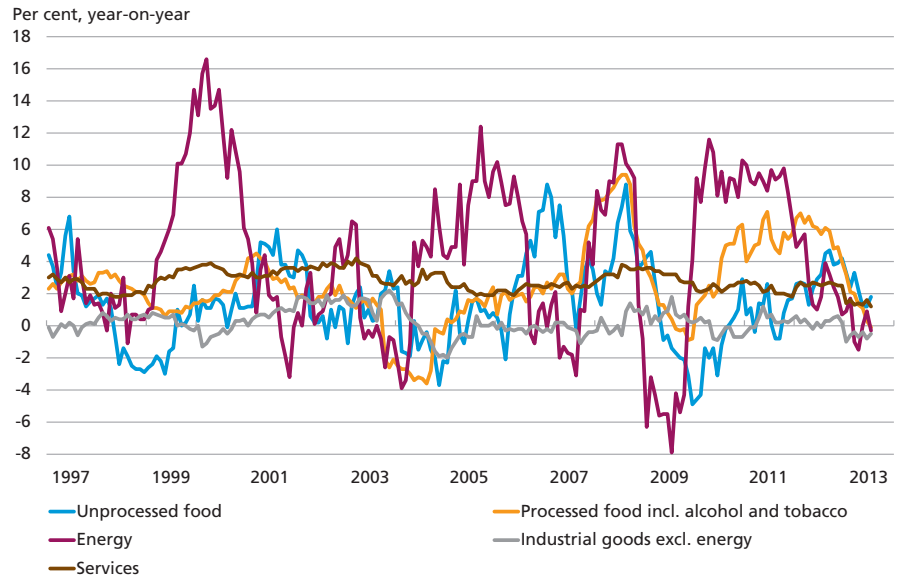
However, during the period of overheating of the Danish economy in 2006-08 and the recession after the financial crisis, the annual rate of increase in the HICP showed somewhat stronger fluctuations. This variation was primarily attributable to volatile energy and food prices, cf. Chart 5.3. But what other information about price setting behaviour during this period can be derived from microdata?

Chart 5.4 shows the annual rate of increase in the HICP and the frequencies of price increases and decreases. A change in the inflation rate normally coincides with movements in frequencies. For example, the marked growth in the HICP from August 2007 to August 2008 was first accompanied by a higher frequency of price increases. Until January 2008, the inflation rate rose from 1 to 3 per cent without any significant changes in the frequency of price decreases or the size of average price changes.

Currently, the most recent decline in the inflation rate at the beginning of 2013 coincided with considerably fewer price increases and more price reductions.

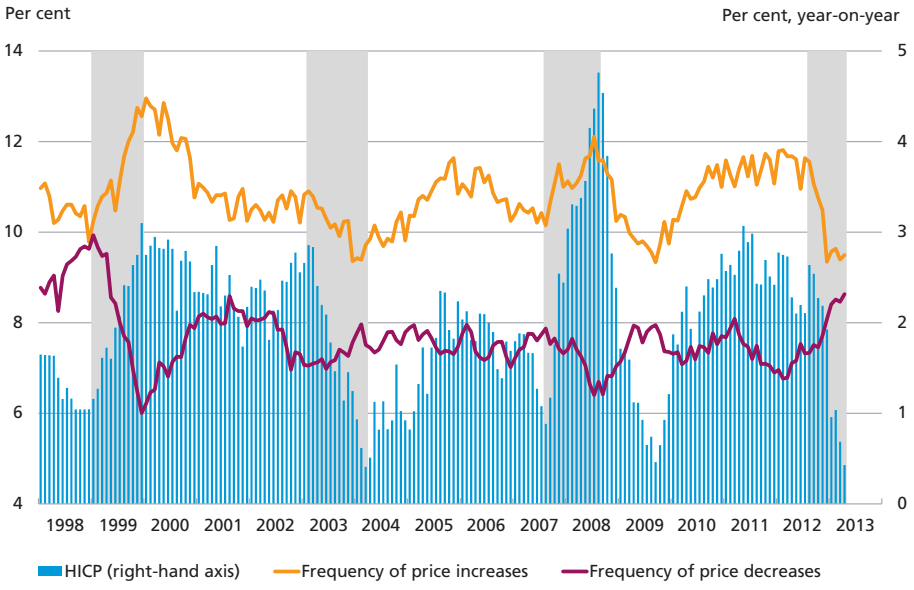
Similar movements are also observed in earlier periods of changes in the inflation rate. The pattern of variation in frequencies is thus relatively close to the pattern for the inflation rate. The correlation between

PRICE DEVELOPMENTS OF THE FIVE MAIN COMPONENTS OF THE HICP — Chart 5.3



Note: The most recent observations are from July 2013.
Source: Eurostat.

FREQUENCY OF PRICE INCREASES AND DECREASES — Chart 5.4



Note: The Chart shows the HICP inflation rate together with 12-month moving averages of monthly frequencies of price increases and decreases. The frequencies applying to individual goods and services have been weighted at product level together with the weights of the HICP index. The grey areas denote periods of marked changes.
Source: Statistics Denmark and own calculations based on microdata from Statistics Denmark.

the frequency of price increases and HICP inflation is 0.73, while the correlation with the frequency of price decreases is -0.51.

This is consistent with a price model where, for various reasons, it is expensive for firms to change prices. Consequently, they do not adjust prices until the set price deviates sufficiently from the optimum price they want to set, given the current market conditions. Models for this type of price setting behaviour are generally referred to as state-dependent, contrasting with time-dependent price models in which firms choose how much they want to adjust prices, but not when. For example, prices may be adjusted once a year or – perhaps in more model-theoretical terms – a certain share of firms have the opportunity to adjust their prices in each period.[1]

Prices are set in so many different situations and for goods and services that are so different that one stylised model cannot be expected to match the data. However, the movements of frequencies point to state-dependent models that allow firms to choose both when and how much they want to change prices.

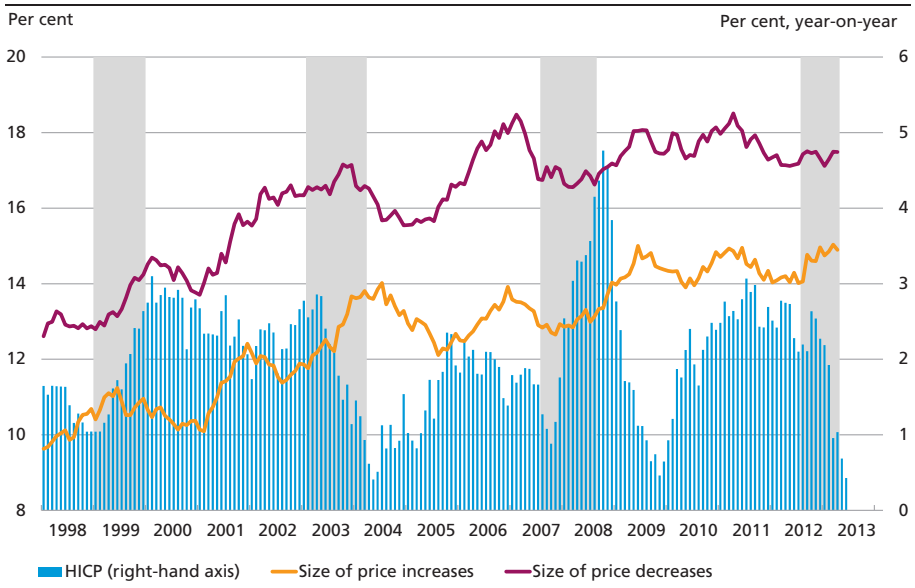
If prices were mainly adjusted at a regular frequency, the rate of price increase would fluctuate only if firms varied the size of their price changes. This does not seem to be the case, cf. Chart 5.5. There is a clear trend over time towards more pronounced percentage price changes, but it is difficult to spot any systematic relationship between the size of price changes and HICP inflation. The correlation with the size of price increases is -0.11, and 0.06 for price decreases.

Thus, there are not many indications of firms performing the entire price adjustment by adjusting prices at set times. Rather, there seems to be a tendency for changes in frequency to impact the average size of price changes. When the frequency rises, the average price adjustment falls, and vice versa when the frequency falls.

The previously mentioned increase in HICP inflation in 2008 illustrates that the size of price changes does matter after all. This increase was initially driven by more price increases. But the growth from 3 to almost 5 per cent year-on-year in August 2008 was also driven by relatively larger price increases. One possible explanation could be that some firms chose to raise prices with a certain lag or that they did not have the opportunity to do so before. In return, they increased prices considerably more than they would have done under normal circumstances.

[1] The classic time-dependent price models are described in Taylor (1980) and Calvo (1983), while the state-dependent models are described in Barro (1972) and Sheshinski and Weiss (1977).

SIZE OF PRICE INCREASES AND DECREASES Chart 5.5



Note: The Chart shows the HICP inflation rate together with 12-month moving averages of monthly sizes of price increases and decreases as percentages. The price changes of individual goods and services have been weighted at product level together with the weights of the HICP index. The grey areas denote periods of marked changes.
Source: Statistics Denmark and own calculations based on microdata from Statistics Denmark.

Out of the total year-on-year increase in prices of 4.8 per cent in August 2008, direct contributions from energy prices accounted for only 1.1 percentage points, while food and beverages accounted for 1.8 percentage points.

Other goods and services accounted for the rest. The top 20 of the largest annual price increases in August 2008 contained – besides energy and food prices – price increases for holiday homes (22 per cent), passenger transport by ferry (15.8 per cent), postage (14.5 per cent) and sewage tax (11.8 per cent).[1]

Here, the rather strong growth in wages in this period should also be borne in mind. Throughout 2008, the rate of wage increase in the private sector exceeded 4 per cent. This contributed to the higher rate of increase in the consumer price index, since, *inter alia*, services for which wages constitute a relatively large share of total production costs make up around 54 per cent of the index. Hence, the substantial price increases in this period cannot be interpreted as being driven only by rising oil and commodity prices, cf. section 6.

[1] Based on the most detailed decomposition into 110 sub-indices for Statistics Denmark's consumer price index. This includes administered prices, which are not otherwise included in the analysis.

Decomposition of price developments into frequency and size of price changes

In order to gain more precise insight into whether the frequency or size of price changes is the main driver of price developments, it is useful to perform an actual decomposition, cf. Wulfsberg (2010).

Basically, inflation can be approximated by $\hat{\pi}_t$ as a weighted average of the monthly price changes for individual goods and services:[1]

$$\hat{\pi}_t = \sum_i w_{it}\, dp_{it} \tag{5.1}$$

w_{it} denotes the scaled HICP weight for product i in month t and dp_{it} denotes the average month-on-month price change (including goods for which prices are not changed). At the product level, the average price change is calculated by multiplying the average price changes for goods for which prices are actually changed, dp_{it}^*, by the frequency of price changes for the relevant month, f_{it},

$$dp_{it} = f_{it} dp_{it}^*. \tag{5.2}$$

The average price change for prices that are changed can be written as a function of the size and frequency of price increases (+) and decreases (-),

$$dp_{it}^* = \frac{f_{it}^+}{f_{it}} dp_{it}^+ + \frac{f_{it}^-}{f_{it}} dp_{it}^-. \tag{5.3}$$

The above equations can be combined as the following approximation of inflation:

$$\hat{\pi}_t = \sum_i w_{it} \left(f_{it}^+ dp_{it}^+ + f_{it}^- dp_{it}^-\right) \tag{5.4}$$

It turns out that the approximation follows the development in actual HICP inflation rather closely despite the completely different approaches to calculation of the two series, cf. Chart 5.6.[2] The correlation between the two series is 0.84.[3]

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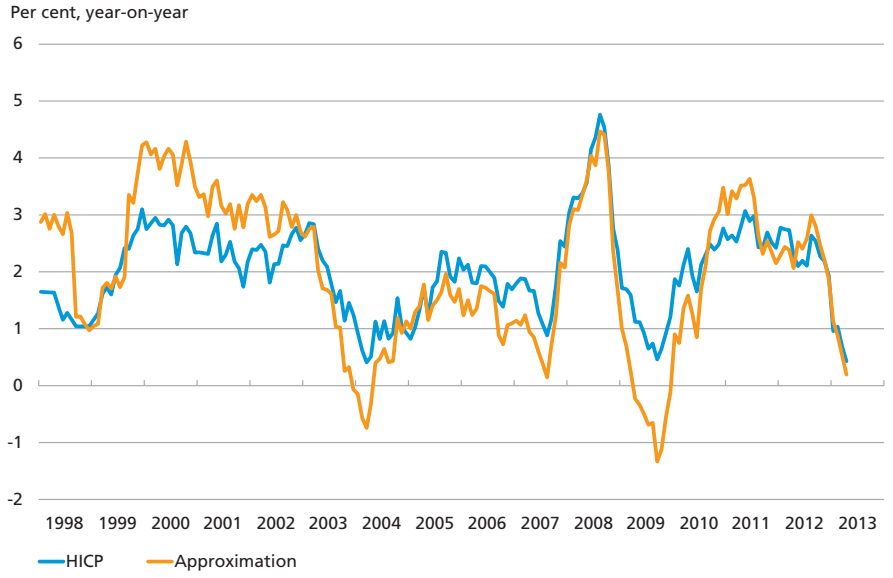
1 More precisely, the calculations are based on weighting of the 412 basic prices (approximately 450 including administered prices).

2 Actual HICP inflation is calculated by Statistics Denmark on the basis of the same micro prices, but involves considerably more complex data processing, troubleshooting and calculations compared with the weighting of monthly frequencies and sizes of price changes in the approximation. Further documentation is contained in Statistics Denmark (2009). The approximation level has been adjusted from 0.70 per cent to 2.02 per cent, which is the average level of actual HICP inflation over this period. Part of the difference in level can be attributed to the exclusion of rent and other non-market-determined prices. Wulfsberg (2010) also includes adjustment of the mean value.

3 A 12-month moving average has been used in the Chart and the calculations. In addition, we have constructed a corresponding approximation without exclusion of administered prices, etc., resulting in a correlation of 0.85.

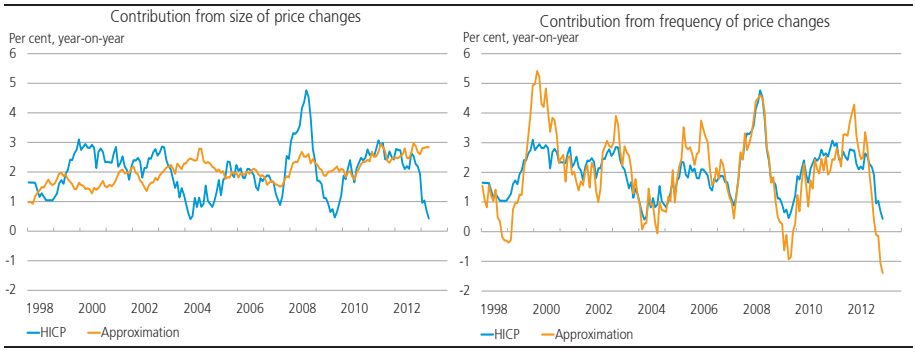
APPROXIMATED AND ACTUAL ANNUAL RATE OF INCREASE IN THE HICP — Chart 5.6



Note: The calculation of the approximation is described in more detail in the main text.
Source: Statistics Denmark and own calculations based on microdata from Statistics Denmark.

Freezing sub-elements in equation (5.4) at their mean values provides a measure of the importance of the other elements as drivers of the overall development in prices. When frequencies are kept constant over time, changes in the size of price changes cannot shift the overall development in prices sufficiently, cf. Chart 5.7 (left). It is difficult to see any systematic relationship, and the correlation between the two series is 0.08. On the other hand, the development in frequencies over time

PRICE DEVELOPMENTS EXPLAINED BY CHANGES IN THE SIZE OR FREQUENCY OF PRICE CHANGES — Chart 5.7



Note: The left-hand chart shows the approximated price development when frequencies are frozen at their mean value over the entire period. The right-hand chart shows the corresponding approximation when the size of average price changes is kept constant.
Source: Statistics Denmark and own calculations based on data from Statistics Denmark.

can explain most of the development in prices, cf. Chart 5.7 (right). Here the correlation is 0.85.

According to a simple OLS regression of HICP inflation on the contribution series in Chart 5.7, the extensive margin explains 68 per cent of the variation, while the intensive margin explains the remaining 32 per cent, assuming homogeneity. The movements of frequencies are thus most important, but the sizes of price changes are not as unimportant as the Charts and the simple correlation could suggest. They explain part of the variation in HICP inflation that cannot be captured in the frequencies. Similar decompositions of price developments in other countries do not show clear results and seem to depend on the exact method of decomposition applied, cf. Box 5.1.

The contribution from frequencies can be decomposed further into contributions from price increases and decreases. An OLS regression of HICP inflation on the four contribution series that have been constructed

DECOMPOSITION OF INFLATION RATES IN OTHER COUNTRIES Box 5.1

Klenow and Malin (2010) summarise a number of decomposition analyses of inflation rates for both the USA and the euro area. Their conclusion is that most of the variance in inflation can be attributed to changes in the intensive margin, while the frequency plays only a minor role. Conversely, Nakamura and Steinsson (2008) find that the frequency of price increases determines the course of inflation in the USA, while both the frequency of price decreases and the size of price increases and decreases play a minor role. Dhyne et al. (2006) summarise the results for 10 euro area member states, concluding that both the frequency and the size of price changes influence price developments. Gagnon, López-Salido and Vincent (2013) use a slightly different methodology in that they examine firms' price setting behaviour in the event of considerable shocks to the economy. They find that frequency plays an important role.

The deviating conclusions seem to be attributable to important methodological differences in the decomposition analyses, among other factors. Firstly, the frequencies of price increases and decreases tend to offset each other. High inflation entails more price increases, but fewer price decreases, so it will not necessarily be reflected in the total frequency of price changes. This may blur the relationship between frequency and inflation rates.

In an analysis of microdata on price developments in Mexico, Gagnon (2009) finds that frequency plays an important role in the event of high, volatile inflation. In any case, hardly any price decreases are observed in such periods and thus no equalisation of the aggregate frequency of price increases and decreases. When inflation is lower and more stable, on the other hand, frequency plays an almost negligible role, according to Gagnon (2009).

The same pattern is found in an analysis of Norwegian microdata on price developments in 1975-2004, cf. Wulfsberg (2010). In the period 1975-1989, inflation was relatively high in Norway, and the development was primarily driven by frequency. The subsequent period, 1990-2004, saw low and more stable inflation, and the size of price changes was at least as important as frequency.

CONTINUED Box 5.1

The significance of possible equalisation of the aggregate frequency can be examined by more detailed decomposition into frequencies and sizes for both price increases and price decreases. However, this does not make any decisive difference in our analysis of Danish data.

The method of definition of the size of price changes then turns out to play a key role. Wulfsberg (2010) has introduced the method of decomposition used in our analysis of Danish data. As opposed to several of the other analyses, the size of price changes is defined here as dp_{it}^{*}. This is the average price change for goods, the prices of which are actually changed in a given month. This seems to be the most relevant definition for describing corporate price setting behaviour. In most other studies, size is instead defined as the price change in a basic index, dp_{it}, which in itself is a function of the share of goods in this basic index for which prices are changed and by how much, cf. equation (5.2). In connection with a decomposition analysis, the latter definition results in a mix-up of the significance of size and frequency, so this approach has been deselected in our analysis of Danish data.

by allowing variation in, in turn, f_{it}^{+}, f_{it}^{-}, dp_{it}^{+} and dp_{it}^{-}, respectively, provides a more complex picture of the significance of the frequency and size of price changes. The frequencies of price increases and decreases explain 36 per cent and 22 per cent, respectively, while the sizes of price increases and decreases account for 18 and 25 per cent of the variation, meaning that they are not unimportant.

6. INTERACTION WITH WAGE FORMATION

Payroll costs constitute a substantial part of firms' total costs. Consequently, wage developments will, over time, be reflected in the prices charged by firms for their goods and services. At the same time, the expected development in prices impacts wage formation via wage negotiations between employees and employers. The negotiation parties are looking ahead, since wages are normally fixed for several years at a time. Higher prices may thus lead to higher wage increases, just as higher wage increases may result in rising prices. This interdependence entails a risk that shocks to wages or prices may start a self-reinforcing process if inflation expectations are no longer anchored. This could steer the economy away from a stable equilibrium course and lead to costly adjustment.

With a view to analysis of the interaction between prices and wage formation, a model is constructed which accounts for the interdependence between wages and prices. The foundation of the model is an economic model which regards wages as a result of negotiations between trade unions and employers' organisations, i.e. a bargaining

model. A similar model for wage formation was previously estimated in Storgaard (2011), and this model is extended here to include a price relation based on corporate price setting behaviour.

The model for price setting behaviour is based on monopolistic competition. This enables firms to set a price which is higher than their marginal costs. The higher the price set by a firm, the lower the demand for its products. Firms choose the price that yields the maximum profit. Under conditions of perfect competition, firms would, instead, take prices for granted. If a firm attempted to raise the price, consumers would go to a competitor to buy the same product cheaper. This is not possible for consumers under monopolistic competition where no other firms sell exactly the same product. But consumers will tend to buy other similar products if a firm increases its prices too much. Firms will thus be facing a declining demand curve.

The theoretical foundation of the model and the identification of its equations are described in Box 6.1. The relationship between price and wage formation is estimated for the period from the 1st quarter of 1975 to the 1st quarter of 2013.

The empirical estimation takes into account the dynamic relationships between the model variables, i.e. the development in prices is e.g. permitted to depend on the development in wages in the preceding quarter or the productivity pattern over the last year. This is achieved by estimating a cointegrated VAR model, described in more detail in Box 6.2. This model is suitable for mapping the relationships between economic variables that are so closely related that their long-run trends will be identical over time. The interesting variables in this context are wages, prices, productivity, unemployment and import prices.

Wages (w_t) are represented by hourly wages for industrial workers as the benchmark for private-sector employees and, subject to a certain time lag, also for public-sector employees due to the regulation scheme, which contributes to public-sector wages generally moving in tandem with private-sector wages. Prices (p_t) are given as the index for the private consumption deflator according to the national accounts. Productivity (a_t) is measured as hourly productivity in the private non-agricultural sector, and UR_t denotes the unemployment rate. Import prices are given as pi_t.

Assessed on the basis of a number of statistical tests, the empirical model seems to be well-specified, and it gives rise to the following long-run relations for wages and prices:

(6.1) $$(w_t - p_t - a_t) = -1.68UR_t + ecm_{w,t}$$

(6.2) $$p_t = 0.35(w_t - a_t) + 0.65pi_t + ecm_{p,t}$$

THEORETICAL FOUNDATION AND IDENTIFICATION Box 6.1

Wage and price formation is modelled using a model containing decentralised wage bargaining and monopolistic competition, cf. e.g. Layard, Nickell and Jackman (2005). The theory is based on firms and their organisations wanting to maximise profits, while employees and unions want to maximise their utility, which is affected positively by real wages and negatively by the rate of unemployment.

A large number of identical firms produce goods with labour as the only production factor and constant return to scale. The price is set to maximise the firm's profits,

$$\Pi = Y(Q - W/A),$$

where Y is output, Q is the producer price, W is nominal wages and A is average labour productivity. This gives rise to the following price relation:

(6.3) $$Q = \frac{\varepsilon}{((\varepsilon-1))}(\frac{W}{A}).$$

where $\varepsilon = -(Y_Q'Q)/Y > 1$ is the absolute value of the firm's elasticity of demand. The price is thus set as a mark-up on the marginal costs.

Wages are negotiated between unions and employers and are assumed to be given as the Nash bargaining solution, found by maximising the Nash product,

$$\mathcal{N} = (v - v_0)^{\sigma}\pi^{1-\sigma},$$

where σ is the relative bargaining strength of unions. The utility of unions, $v(W/P, U, Z)$, is affected positively by workers' consumption real wages (W/P), where P is the consumer price, and negatively by the unemployment rate, U. Z denotes other factors influencing the utility of unions. The utility of unions in the event of breakdown of the negotiations, $v_0(\overline{W}/P, U)$, depends on what the worker can obtain outside the firm and hence on the overall level of real wages in the economy ($\overline{W}/P$) and the unemployment rate. $\pi = \Pi/\mathrm{Q}$ is the firm's real profits, which are zero in case of a breakdown of the negotiations.

Inserting the utility functions and maximising the Nash product with respect to producer wages result in an equilibrium relation which gives an implicit solution for negotiated producer real wages, $W_q^b = W/Q$, as a function of A, Z, σ, U and the wedge between consumer and producer prices, $P_a = P/Q$. In log-linearised form, the solution can be written as

$$w_{q,t}^b = m_b + \iota a_t + \omega p_{q,t} - \varpi u_t, \quad 0 < \iota \leq 1, \quad 0 \leq \omega \leq 1, \quad \varpi \geq 0$$

where m_b depends on Z and σ and is assumed to be constant. Inclusion of $w_{q,t}^b = w_t^b - q_t$ and $p_{q,t} = p_t - q_t$ provides for constructing the following long-run relation:

(6.4) $$w_t = m_b + (1-\omega)q_t + \iota a_t + \omega p_t - \varpi u_t + ecm_{b,t}$$

where $ecm_{b,t} = w_{q,t} - w_{q,t}^b \sim I(0)$.

On the basis of (6.3) a relation is constructed for the real wages that are consistent with firms' price setting. In the general case, corporate mark-up on marginal costs may vary with the business cycle. This can be modelled by including the unemployment rate. The long-run relation can thus be written in log-linearised form as

CONTINUED Box 6.1

(6.5) $$w_{q,t} = m_f + a_t + \vartheta u_t + ecm_{f,t}$$

where m_f depends on the elasticity of demand. As in the wage relation, $w_{q,t}^b = w_t^b - q_t$ is inserted to enable the following price relation to be written as

(6.6) $$q_t = -m_f + w_t - a_t - \vartheta u_t - ecm_{f,t}$$

The overall model is thus described by the two cointegrated relations (6.5) and (6.6) together with the definition of the consumer price,

(6.7) $$p_t = \phi q_t + (1-\phi) pi_t,$$

where pi_t is the import price. Inserting (6.6) into the other two equations gives the following two equations for consumer price and nominal wages:

(6.8) $$w_t = m_b + \left(\frac{1-\omega(1-\phi)}{\phi}\right) p_t + \iota a_t - \varpi u_t - \left(\frac{(1-\omega)(1-\phi)}{\phi}\right) pi_t + ecm_{b,t}$$

(6.9) $$p_t = -\phi m_f + \phi(w_t - a_t) - \phi\vartheta u_t + (1-\phi) pi_t - \phi ecm_{f,t}$$

These equations contain non-linear restrictions in ϕ and are not identified. In other words, we cannot use empirical data to distinguish between various combinations of the equations' coefficients. Bårdsen et al. (2005) state several possible identification strategies and for an aggregate price-wage model, the identification is achieved by setting $\omega = 1$ and $\vartheta = 0$. The first restriction entails that movements in the wedge between consumer and producer prices in the long term are passed through fully to wages. An increase in the VAT rate or indirect taxes will thus, over time, lead to higher wages. The reason is that at the aggregate level, the negotiation partners have to consider the significance of indirect taxes to employees' real wages. The other restriction means that corporate price setting behaviour depends on marginal costs, but not directly on the cyclical position measured by the unemployment rate. This implies identification of the following long-term equilibria:

(6.10) $$w_t = m_b + p_t + \iota a_t - \varpi u_t + ecm_{b,t}$$

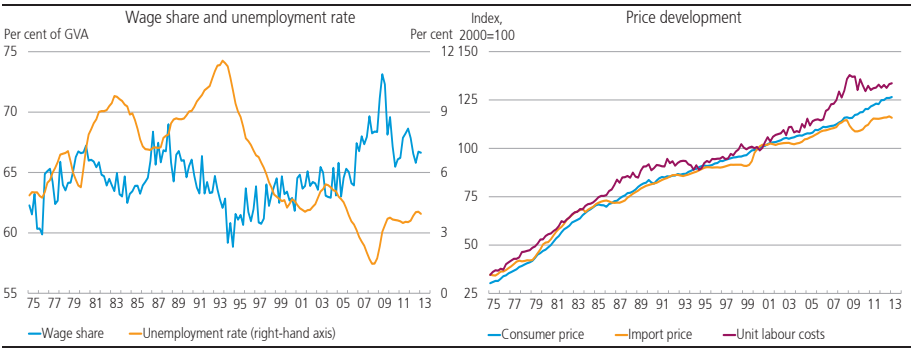
(6.11) $$p_t = -\phi m_f + \phi(w_t - a_t) + (1-\phi) pi_t - \phi ecm_{f,t}$$

All of the variables – except UR_t – are measured in logarithms, allowing interpretation of the coefficients as long-run elasticities, i.e. denoting the percentage change in the left-hand variable on a 1-per-cent change in the relevant right-hand variable. The two residuals, $ecm_{w,t}$ and $ecm_{p,t}$, represent the deviation from the long-term equilibria.

The long-run relations are in accordance with the theoretical model and with findings of similar analyses.[1] The relation in equation (6.1) rep-

[1] Bårdsen and Fisher (1998), Bårdsen, Hurn and McHugh (2007), Pétursson and Sløk (2001), Pétursson (2002) and Marques, Martins and Portugal (2010), among others.

WAGE SHARE AND PRICE DEVELOPMENT Chart 6.1



Note: Left-hand chart: The wage share is payroll costs relative to gross value added in the private non-agricultural sectors. Right-hand chart: The consumer price is the implied consumption deflator from the quarterly national accounts. Import prices are from the price index for the domestic supply of goods. Unit labour costs are labour costs per unit in the private non-agricultural sector.
Source: The MONA data bank.

resents a real-wage curve with the wage share depending on the unemployment rate in the long term. The equilibrium level of the wage share varies with the unemployment rate, i.e. the wage share is high when unemployment is low and vice versa, cf. Chart 6.1 (left).

According to the relation, price increases are fully reflected in wages in the long run. In the theoretical model, this entails that price increases give rise to higher nominal wage demands, as they would otherwise erode real wages. Similarly, productivity improvements are fully reflected in wages, since higher labour productivity makes firms more inclined to accept higher wage demands as profitability grows. The wage share of the output value thus remains unchanged in the long term.

Increases in the unemployment rate are associated with downward pressure on real wages. The coefficient on the unemployment rate in the wage equation is a semi-elasticity, since unemployment – as opposed to the other variables – is included in level. Multiplying the coefficient by the average unemployment rate of 6.1 per cent over the period gives an approximated elasticity of 0.1. The elasticity denotes the sensitivity of real wages to labour market pressures in the longer term. The results are in accordance with the literature, where an elasticity of 0.1 is regarded as the benchmark, cf. Blanchflower and Oswald (1994).

The estimation also shows that deviations from the long-run equilibrium are adjusted by adaptations in wages and productivity, while the statistical tests cannot rule out that the unemployment rate is weakly exogenous. Changes in the unemployment rate can thus affect wages, but they are not the factor that restores equilibrium in the long-run relation.

On the basis of the theoretical model, the role of wages as an equilibrium mechanism can be regarded as a result of wage bargaining between the social partners. Deviation in wages from the long-term equilibrium causes a shift in the relative bargaining position. High profits (a low wage share) entail increased wage demands, which firms will be more inclined to accommodate, causing wages to return to their equilibrium.

In addition, there are other mechanisms, which are outside the theoretical model, but which impact wage formation in practice. When high wage increases may be attributed to overheating of the economy, stability-oriented economic policy will also contribute to steering wages back towards equilibrium e.g. via fiscal tightening. Moreover, in the longer term international competition will lead to lower demand for goods manufactured in countries where wages and hence prices are high. This will reduce the demand for labour in these countries, which in turn dampens wage increases.

The price relation in equation (6.2) reflects that in the long run, prices are determined by production costs. They depend partly on unit labour costs, $(w_t - a_t)$ partly on import prices, pi_t – import prices accounting for the highest weight. The weight of import prices can be seen as an estimation of the share of import goods relative to domestically manufactured goods in Danish households' total basket of consumer goods. The lower weight on $(w_t - a_t)$ relative to pi_t is consistent with Denmark being a rather open economy. It is also consistent with the calculation of domestic market-determined inflation, the IMI, which represents less than half of the goods in the consumer price index, cf. section 4.

In the longer term, both increases in unit labour costs and higher import prices contribute to higher prices, cf. Chart 6.1 (right). Adjustment for deviations from this long-term equilibrium comes from the prices themselves. When prices are lower than their long-term equilibrium, firms will increase prices over time, which will restore prices to equilibrium.

Wages and prices appear in both relations, and this interdependence may give rise to wage-price-spiral effects. Shocks to either wages or prices will have a negative impact on the equilibrium of both relations. Besides wages and prices, the subsequent adjustment will also involve productivity. This adjustment may be rather costly in the event of shocks that have pushed the economy far away from equilibrium or if the speed of adjustment is too sluggish so that the economy is some distance from equilibrium for a prolonged period.

MODEL ESTIMATION Box 6.2

To estimate the model, the following cointegrated VAR model is set up in error correction form:

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{k-1} \Omega_i \, \Delta x_{t-i} + \phi Z_t + \epsilon_t$$

The first term after the equals sign, Π, contains the long-run relations between the variables represented by the vector x_t, and the associated adjustment coefficients. The second term contains the short-term dynamics, where k is the number of lags. The third term, Z_t, represents the non-modelled variables, and the last term is the residuals (unexplained variation), which are assumed to be identical and independently normally distributed.

The following data vector is applied[1]

$$x_t' : x_{1,t}' = (w_t, p_t, a_t, UR_t), x_{2,t}' = (ti_t, tp_t, pi_t)$$

$x_{1,t}'$ represents the vector of the modelled variables that are included as endogenous in the model, and $x_{2,t}'$ the exogenous variables. Small caps denote the logarithm of the variable in question. Wages, w_t, are represented by hourly wages for industrial workers as the benchmark for other private-sector employees and, with a certain lag, also for public-sector employees, given the regulation scheme, which contributes to public-sector wages generally moving in tandem with private-sector wages. Prices are given as the index for the private consumption deflator according to the national accounts, p_t. a_t is hourly productivity in the private non-agricultural sector and UR_t is the unemployment rate.

The following non-modelled variables are included: income tax for wage earners, ti_t, indirect corporate labour costs, tp_t, and import prices, pi_t. Since these variables are primarily politically determined or determined abroad, they are defined as exogenous from the start. Generally, the model does not show signs of misspecification, cf. Table 6.1. The columns show tests of whether the statistical assumptions can be rejected or not when the model has been estimated with 4 lags.

SPECIFICATION TESTS Table 6.1

Equation	AR 1-5	ARCH 1-4	Hetero	Normality
Statistical distribution of test result	F(5,107)	F(4,141)	F(64,80)	$\chi^2(2)$
w	3.30**	1.27	1.58*	2.82
p	0.77	3.78**	1.56*	9.50**
a	0.42	1.21	1.06	1.69
UR	2.82*	0.03	1.42	5.60
Statistical distribution of test result	F(80,353)	..	F(256,310)	$\chi^2(8)$
System	1.31	..	1.33**	16.07*

Note: *AR 1-5* tests the absence of autocorrelation, *ARCH 1-4* tests the absence of autoregressive conditional heteroskedasticity, *Hetero* tests for homoskedasticity and *Normality* tests whether error terms are normally distributed. The bottom line denotes a total test comprising all of the variables. * (**) denotes that the test value is significant at a level of 5 (1) per cent.

[1] Data are from the MONA databank, and the estimation has been made using PcGive.

CONTINUED Box 6.2

The first column shows the test for autocorrelation. For the system, the absence of autocorrelation cannot be ruled out, despite the indications in the wage and unemployment equations of autocorrelation in the residuals. The other tests indicate problems with heteroskedasticity and normality, both attributable to prices. This probably reflects the relatively high rates of price increase in the period up to around 1990 compared with the subsequent period, cf. Chart 2.5.

TEST FOR COINTEGRATION RANK Table 6.2

Rank	Intrinsic value	Trace	P value
0	0.27	99.98	0.000**
1	0.18	53.24	0.003**
2	0.11	24.26	0.077
3	0.04	6.08	0.461

Note: * (**) denotes that the test value is significant at a level of 5 (1) per cent.

A test for unit root shows that the variables can be regarded as integrated of the first order, which is consistent with the assumptions behind the cointegration analysis. Cointegration tests for the number of stationary relationships point to two cointegrated relations, cf. Table 6.2.

In order to take outliers into account, which are probably attributable to non-modelled variation, three dummies have been included for single quarters with substantial outliers for wages, $D_{p79:4,t}$, $D_{p87:1,t}$, $D_{p87:2,t}$, and one dummy, $D_{p86:1,t}$, for prices.[1]

The unrestricted estimates indicate wage and price relations, respectively, that are generally in accordance with the previous analysis by Storgaard (2011) based on data up to and including 2007.

Adding the overidentified restrictions resulting from the theoretical model described in Box 6.1 gives the long-run relations. Furthermore, ti_t, tp_t and pi_t are excluded from the wage relation, and UR_t, ti_t and tp_t from the price relation, since their coefficients do not differ significantly from zero. This gives the following relations:

$$w_t = p_t + 0.93a_t - 1.66UR_t + ecm_{w,t}$$
$$p_t = 0.38w_t - 0.38a_t + 0.56pi_t + ecm_{w,t}$$

Finally, homogeneity restrictions are imposed on w_t, p_t and a_t in the wage relation, so that an increase in price or productivity in the long term leads to a corresponding increase in nominal wages. A homogeneity restriction is also imposed on the price relation to ensure that a percentage increase in unit labour costs and import prices in the long term results in an equivalent percentage increase in prices. The restrictions are accepted with the test value $\chi^2(10) = 14.26\,[0.16]$, and the estimated long-run relations are given in equations (6.1) and (6.2).

[1] The pronounced fluctuations can be related to such factors as the changes in agreed working hours as from the end of 1986. See Hansen and Storgaard (2011) for a historical review of wage developments in Denmark.

7. LITERATURE

Barro, R. J. (1972), A theory of monopolistic price adjustment, *Review of Economic Studies*, No. 39.

Blanchflower, D. G. and A. J. Oswald (1994), *The wage curve*. The MIT Press, Cambridge, MA.

Bryan, M. F., S. G. Cecchetti and R. O'Sullivan (2002), Asset prices in the measurement of inflation, NBER, *Working Paper*, No. 8700, January.

Bårdsen, Gunnar, Paul G. Fisher (1998), Economic theory and econometric dynamics in modelling wages and prices in the United Kingdom, *Empirical Economics, Springer-Verlag*, Vol. 24, No. 3.

Bårdsen, Gunnar, Oyvind Eitrheim, Eilev S. Jansen and Ragnar Nymoen (2005), *The econometrics of macroecoonomic modelling*, Oxford University Press, July.

Bårdsen, Gunnar, Stan Hurn and Zo McHugh (2007), Modelling wages and prices in Australia, *The Economic Record*, Vol. 83, No. 261, June.

Calvo, G. A. (1983), Staggered prices in a utility-maximizing framework, *Journal of Monetary Economics*, No. 12.

Cecchetti, Stephen G. and Richhild Moessner (2008), Commodity prices and inflation dynamics, *BIS Quarterly Review*, December.

Christensen, Anders Møller (1996), Households' inflation expectations, Danmarks Nationalbank, *Monetary Review*, 4th Quarter.

Danmarks Nationalbank (2011), *Monetary policy in Denmark*, 3rd edition.

Danmarks Nationalbank (2011), *Danish government borrowing and debt 2011.*

Danmarks Nationalbank (2012), *Danish government borrowing and debt 2012.*

Danmarks Statistik (2009), *Forbruger- og nettoprisindekset (The consumer price index and the index of net retail prices – in Danish only)*.

Dhyne, E., L. J. Álvarez, H. L. Bihan, G. Veronese, D. Dias, J. Hoffmann, N. Jonker, P. Lunnemann, F. Rumler and J. Vilmunen (2006), Price changes in the euro area and the United States: some facts from individual consumer price data, *Journal of Economic Perspectives*, No. 20(2).

Drejer, Peter, Marianne Clausager Koch, Morten Hedegaard Rasmussen, Morten Spange and Søren Vester Sørensen (2011), The effects of monetary policy in Denmark, Danmarks Nationalbank, *Monetary Review*, 2th Quarter, Part 2.

ECB (2011), *The Monetary Policy of the ECB*, 3rd edition, May.

ECB (2011), Inflation expectations in the euro area: a review of recent developments, *Monthly Bulletin*, February.

ECB (2012), Assessing the anchoring of longer-term inflation expectations, *Monthly Bulletin*, July.

ECB (2013), Box 5: The information content of inflation options, *Monthly Bulletin*, July.

Eurostat (2012), Technical manual on owner-occupied housing for harmonized index of consumer prices, Draft, March.

Eurostat (2013), Handbook on residential property prices indices (RPPIs).

Gaspar, Victor, Alicia Herrero, Lex Hoogduin, Julian Morgan and Bernhard Winkler (eds.) (2001), Why price stability?, The European Central Bank.

Gagnon, Etienne (2009), Price setting during low and high inflation: evidence from Mexico, *Quarterly Journal of Economics*, Vol. 124, No. 3.

Gagnon, E., D. López-Salido and N. Vincent (2013), Individual price adjustment along the extensive margin, in: *NBER Macroeconomics Annual 2012*.

Hansen, Bo William and Niels Lynggård Hansen (2006), Price setting behaviour in Denmark – a study of CPI micro data 1997-2005, Danmarks Nationalbank, *Working Paper*, No. 39, June.

Hansen, Bo William and Dan Knudsen (2005), Domestic market-determined inflation, Danmarks Nationalbank, *Monetary Review*, 4th Quarter.

Hansen, Bo William and Dan Knudsen (2006), The cyclicality of domestic prices, Danmarks Nationalbank, *Monetary Review*, 4th Quarter.

Hansen, Niels Lynggård and Peter Ejler Storgaard (2011), *Løn, priser og indkomster (Wages, prices and incomes – in Danish only)*, 1st edition, Handelshøjskolens Forlag.

Kenny, Geoff, Thomas Kostka and Federico Masera (2013), Can macroeconomists forecast risk? Event-based evidence from the euro area SPF, *ECB Working Paper Series*, No. 1540, April.

Klenow, P. J. and O. Kryvtsov (2008), State-dependent or time-dependent pricing: Does it matter for recent U.S. inflation?, *The Quarterly Journal of Economics*, No. 123(3).

Klenow, P. J. and B. A. Malin (2010), Microeconomic evidence on price-setting, in: B. M. Friedman and M. Woodford (eds.), *Handbook of Monetary Economics*, No. 3, Elsevier.

Layard, Richard, Stephen Nickell and Richard Jackman (2005), *Unemployment: macroeconomic performance and the labour market*, Oxford University Press.

Lauritzen, Finn (1987), Fortsat lav inflation (Continued low inflation – in Danish only), *Samfundsøkonomen*, No. 5.

Mackowiak, B. and Frank Smets (2008), On implications of micro price data for macroeconomic models, *CEPR Discussion Paper*, No. 6961.

Mackowiak, B. and M. Wiederholt (2009), Optimal sticky prices under rational inattention, *American Economic Review*, No. 99 (3).

Marques, Carlos Robalo, Fernando Martins and Pedro Portugal (2010), Price and wage formation in Portugal, *ECB Working Paper series,* No. 1225.

Maule, Becky and Alice Pugh (2013), Do inflation expectations currently pose a risk to the economy?, Bank of England, *Quarterly Bulletin*, No. 2.

Nakamura, E. and J. Steinsson (2008), Five facts about prices: a reevaluation of menu cost models, *Quarterly Journal of Economics*, No. 123, November.

Nakamura, E. and J. Steinsson (2013), Price rigidity: microeconomic evidence and macroeconomic implications, *Annual Review of Economics* (forthcoming).

Pedersen, Erik Haller and Tom Wagener (2000), Macroeconomic costs and benefits of price stability, Danmarks Nationalbank, *Monetary Review*, 3rd Quarter.

Pétursson, Thórarinn G. and Torsten Sløk (2001), Wage formation and employment in a cointegrated VAR model, *Econometrics Journal* Vol. 4.

Pétursson, Thórarinn G. (2002), Wage and price formation in a small open economy: Evidence from Iceland, *Working Paper*, No. 16, Economics Department, Central Bank of Iceland.

Spange, Morten (2011), Commodity prices and inflation in Denmark, Danmarks Nationalbank, *Monetary Review*, 2nd Quarter, Part 1.

Sheshinski, E. and Y. Weiss (1977), Inflation cost of price adjustment, *Review of Economic Studies,* No. 44.

Storgaard, Peter E. (2011), Wage dynamics in Denmark, Danmarks Nationalbank, *Working Paper*, No. 76.

Taylor, J. (1980), Aggregate dynamics and staggered contracts, *Journal of Political Economy*, No. 88.

Vega, Juan-Luis and Mark A. Wynne (2001): An evaluation of some measures of core inflation in the euro area, *ECB Working Paper*, No. 53.

Vermeulen, P., D. A. Dias, M. Dossche, E. Gautier, I. Hernando, R. Sabbatini and H. Stahl (2012), Price setting in the euro area: some stylized facts from individual producer price data, *Journal of Money, Credit and Banking*, Vol. 44, No. 8, December.

Woodford, Michael (2003), *Interest and prices: foundations of a theory of monetary policy*, Princeton University Press.

Wulfsberg, F. (2010), Inflation and price adjustments: evidence from Norwegian consumer price data 1975-2004, *SSRN Working Paper*.

Danish Families in Mortgage Arrears

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1. INTRODUCTION AND SUMMARY

The vast majority of Danish families service their mortgage loans on time. According to data from the Association of Danish Mortgage Banks and the Danish Mortgage Banks' Federation, only 0.3 per cent of the total interest and principal payments that fell due in the 1st quarter of 2013 had not been paid three and a half months after the date they were due. This means that the amount of mortgage arrears has fallen by almost half relative to the peak during the financial crisis in 2009. Compared with the early 1990s, the level of arrears is considerably lower today.

However, the question is whether the arrears rate can be expected to remain at the current low level in future. Danish families have far more debt relative to income than families in other countries. This has caused some concern among observers as to whether the families will be able to service their debt, especially if the Danish economy is affected by another serious downturn. If a sufficient number of families turn out to be unable to meet their obligations to the mortgage banks, this could undermine confidence in the mortgage banks' credit standing.

In this article we use detailed microdata for Danish families to examine how difficulties in servicing mortgage loans depend on key financial variables for the individual family. Based on the estimation results, we assess how the families' mortgage arrears levels will develop in various scenarios for the Danish economy.

Our econometric analysis shows a clear correlation between a family's finances and the probability that the family will fall behind on its mortgage payments, even when controlling for a number of family-specific conditions. The smaller the family's disposable amount, the greater its income loss in recent years, the larger an income share it uses to service the debt, the smaller its holdings of liquid assets and home equity, and the smaller its pension wealth – the higher the probability of the family falling into arrears will be. Statistically, the effects are highly significant, but they are limited in terms of size. For most families, changes in the key financial variables have very little impact on the probability of arrears. This reflects that mortgage arrears are very rare, even among families whose finances are under pressure.

Based on these results, we estimate the expected development in the number of families in mortgage arrears in the event that the Danish economy is affected by another setback such as rising unemployment, interest rate increases or falling house prices. Our results indicate that even severe setbacks would cause only a slight rise in the number of families in arrears. Hence, we expect the level of mortgage arrears to remain low, and there are no indications that the high level seen in the early 1990s will return, even in the event of a severe economic downturn. Consequently, in our assessment, this poses no serious threat to the credibility of the mortgage credit system.

It should be noted, however, that this article focuses solely on household debt to mortgage banks. Arrears on other forms of debt, including household debt to banks and corporate lending by mortgage banks, have not been analysed due to lack of data coverage. There is no doubt that an economic downturn of the magnitude considered in our stress scenarios would give rise to substantial loan impairment charges in the overall financial sector. Our results merely indicate that the loan impairment charges will not be seen primarily in the mortgage credit sector. On the other hand, the banks' loan impairment charges are likely to be considerable, which emphasises the importance of Danish banks having sufficient capital buffers. At the same time, it should also be noted that a severe economic downturn that includes pronounced falls in private consumption and investment could result in increased loan impairment charges on mortgage banks' lending to the corporate sector.

2. WHY ANALYSE MORTGAGE ARREARS?

When mortgage banks provide loans to Danish home-owning families, they incur a credit risk. The risk arises because the borrowers will not always be able to repay their loans on the agreed terms. In such cases, the mortgage banks are at risk of incurring losses. If the losses are too many and too large, it may reduce the security of the mortgage credit system and thus weaken investor confidence in the creditworthiness of mortgage bonds.

When a family gets behind on its mortgage payments, this may lead to the home being sold through enforced sale, cf. Box 1. If the proceeds from the sale are insufficient to cover the mortgage bank's claim, the mortgage bank will incur a loss. In principle, the mortgage banks should therefore write down the value of the loan once the borrower falls into arrears. Over the last 20 years, the level of arrears has been strongly correlated with both the number of enforced sales and the total loan

IMPLICATIONS OF ARREARS Box 1

When borrowers get behind on their mortgage payments, the mortgage bank will try to collect the debt. If this fails, the property may ultimately be sold through enforced sale. But in many cases, the mortgage bank will try to find a solution with the borrower. A study by the Danish Financial Supervisory Authority shows that for families who are cooperative and take an active part in a solution plan, the opportunities to get out of arrears or to draw up a plan for the future repayment of their debt are better than for families who do not respond to the mortgage banks' requests, cf. Danish Financial Supervisory Authority (2011).

In the cases where defaulting on loans results in enforced sale, the process is usually relatively short. It typically takes less than nine months from the payment becomes overdue until the property is sold, cf. Gundersen et al. (2011). The relatively short period of time contributes to limiting the mortgage bank's potential loss and it is thus in a strong position to collect the debt. If the mortgage bank's claim is not covered by the sale of the property, it retains a claim against the borrower. In other words, the borrower has strong incentives to service the mortgage debt and avoid enforced sale.

When a homeowner falls into arrears, this generally means that the mortgage bank must write down the loan in question. Arrears are regarded as a breach of contract on the part of the borrower, which means that there is objective evidence of impairment for loans. However, there may also be objective evidence of impairment for loans in other situations, e.g. if the borrower is deemed to be in substantial financial difficulties. Objective evidence of impairment for loans may thus exist although the borrower has not yet fallen into arrears. When there is objective evidence of impairment for a loan, it must be written down by the difference between the book value before the loan impairment charges and the present value of the expected future payments. If, despite being in arrears, the borrower is deemed to be capable of making future payments on time, the loan impairment charges will be very small (or 0). This could be the case, e.g. if the arrears are purely attributable to the borrower's oversight or a temporary liquidity problem. On the other hand, if it does not look as if the borrower will be able to repay the loan, the need for loan impairment charges must be based on an estimate of the sales value of the mortgaged property less expected realisation costs.

Realised losses are seen when defaulted loans are removed from the balance sheet. Defaulted loans do not directly entail losses to bond holders, since the credit risk is initially borne by the mortgage bank. So in the event of a defaulted loan, the mortgage bank incurs the loss, not the owners of the underlying bonds. Even if the mortgage bank defaults, the bond holders are ensured a high degree of protection against losses. Bond holders can assert a claim against the mortgage bank and they rank before unsecured creditors in the event of default.[1] However, it cannot be ruled out that the bond holders ultimately risk incurring a loss if the mortgage bank defaults. Hence, if confidence in a mortgage bank is undermined due to higher credit risk, this may affect the bond holder through falling mortgage bond prices.

In the same way as mortgage banks, banks can request that a property be sold through enforced sale if the borrower defaults on a bank loan against the property as collateral. This applies whether or not the borrower has serviced the mortgage loan.

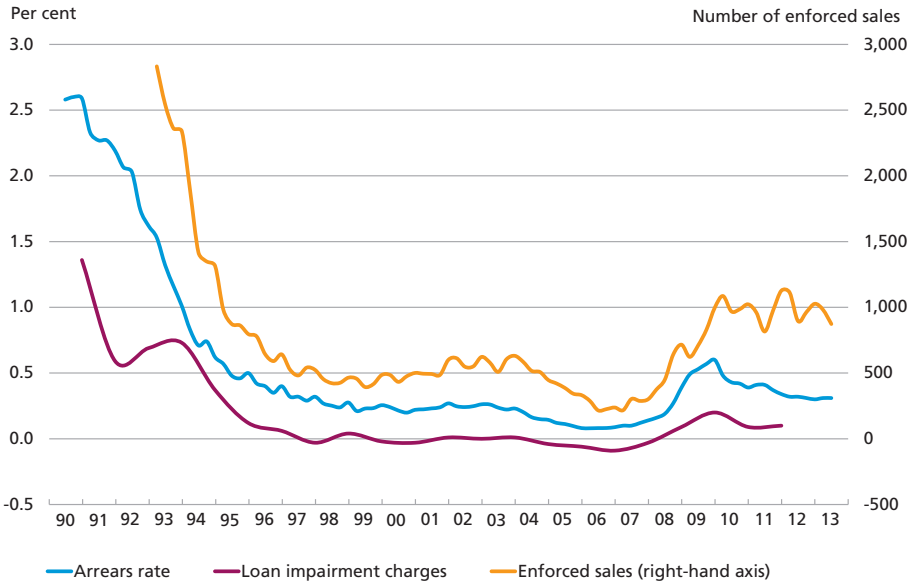
CONTINUED Box 1

However, banks are often less inclined to request enforced sale, since they take second place to the mortgage bank and are therefore subject to greater risk of not recovering their losses. Instead, banks typically wait for the value of the collateral to increase or for the mortgage bank to request that the property be sold through enforced sale.

[1] In the event of default, the mortgage bank's capital centres are divested from the insolvent estate and their operations continued by an administrator. The administrator is obliged under law – and has wide powers – to fulfil the mortgage bank's obligations to the bond holders. Since bonds and loans are issued according to the match funding principle, the payments of interest and instalments on the loans will correspond to the payments of interest and instalments on the bonds throughout the maturity of the loan for loans that are not to be refinanced. For loans that must be refinanced, the administrator is legally entitled to perform such refinancing. The borrower's rights remain unchanged, i.e. the loan still cannot be terminated by the mortgage bank/capital centre whereas the borrower can still redeem the loan.

impairment charges of the mortgage banks, cf. Chart 1. For example, the drop in arrears in the early 1990s was followed by a drop in both enforced sales and loan impairment charges, and the increase in arrears that began in 2007 was also followed by an increase in the number of

ARREARS, ENFORCED SALES AND MORTGAGE BANKS' TOTAL LOAN IMPAIRMENT CHARGES Chart 1



Note: The arrears rate indicates the percentage of the total payments that had not been made three and a half months after the due date. The calculation includes lending by all mortgage banks for owner-occupied dwellings and summer cottages. The calculation of the number of enforced sales includes single-family houses, owner-occupied flats and summer cottages only. Total loan impairment charges comprise lending to retail and corporate customers and are stated as a percentage of total loans and guarantees.

Source: Association of Danish Mortgage Banks, Danish Mortgage Banks' Federation and Statistics Denmark.

HOUSEHOLDS' ASSESSMENTS OF THE HOUSING BURDEN Table 1

Per cent	2005	2006	2007	2008	2009	2010	2011
Share of households stating that housing costs are "a heavy burden"	6	6	6	6	8	7	8
Share of households stating that housing costs are "a considerable burden"	20	21	22	24	24	23	24

Note: In the calculation, the share of households is weighted by the number of members.
Source: Statistics Denmark.

enforced sales and larger loan impairment charges.[1] The close correlation between arrears and loan impairment charges implies that the level of arrears is a relevant indicator of the soundness of the mortgage credit sector.

On the other hand, the share of families that are behind on their mortgage payments is a less suitable indicator of the number of families whose finances are squeezed. While a family in mortgage arrears is highly likely to be in a financial squeeze, the opposite is not necessarily true.[2] The share of families who subjectively perceive their own housing burdens as heavy is far larger than the aggregate arrears rate, cf. Table 1. One reason may be that most families with squeezed finances will attempt to remedy the problem by e.g. taking on extra work or cutting down on consumption before defaulting on their debt.

Mortgage arrears are also far less common than arrears on other forms of debt. Presumably, one reason is that banks are less inclined to require a property to be sold through enforced sale than mortgage banks, cf. Box 1. So from the borrower's point of view, the consequences of defaulting are greater for mortgage debt than for other debt, and the mortgage loan will typically be the last debt item on which a family chooses to default.

Due to the higher incidence of arrears on other debt, the level of loan impairment charges is substantially higher in banks than in mortgage

1 There is a certain time lag between changes in the arrears rate and changes in the number of enforced sales. This is because it typically takes a while before the mortgaged property is sold through enforced sale.

2 D'Alessio and Iezzi (2013) use microdata for Italian households to evaluate various indicators of a household's "over-indebtedness". Among the households that are more than three months behind on their debt, more than 80 per cent state that they find it "difficult" or "very difficult" to make ends meet. On the other hand, only just over 3 per cent of the households giving these answers have been in arrears for minimum three months.

banks, cf. Abildgren and Kuchler (2013), and cyclical fluctuations in the loan impairment charge ratio are also much more pronounced in banks. Arrears on families' debt to banks are not analysed in this article due to lack of data. Instead, the article focuses solely on the mortgage credit sector. Hence, our analyses aim to examine the expected impact on that particular sector in various scenarios for the development in the financial situation of families.

3. RELATED LITERATURE

The analyses in this article are closely related to two recent studies of the financial robustness of Danish families with mortgage debt: Andersen et al. (2012b) and Ministry of Business and Growth (2013). The overall conclusion of both these analyses is that the finances of most families with mortgage debt are resilient to strong increases in interest rates as well as protracted periods of unemployment. In both cases, the conclusions are based on rules of thumb of when a family can be viewed as financially robust. Andersen et al. (2012b) categorise a family as robust if its disposable amount exceeds an estimated minimum budget. The Ministry of Business and Growth bases its definition of robustness on whether the family spends less than half of its disposable income on servicing its debt. It is difficult to assess the accuracy of such rules of thumb without data indicating whether the families are actually finding it hard to service their debt. Hence, the advantage of the approach in this article is that we use such data in the form of information about the families' mortgage arrears. This enables us to assess more accurately the number of families in mortgage payment difficulties, so that our analyses complement the previous studies.

As far as we know, no published studies based on microdata analyse the level of mortgage arrears in Denmark. However, this topic is closely related to a wide international literature on household debt repayment behaviour in a broader sense. The dominant approach in this literature is based on the *strategic default model*. According to that model, defaulting on loans should be viewed as an active household decision. The decision is based on a trade-off between the pros and cons of continuing to service the debt. Examples of theoretical models based on this approach can be found in e.g. Kehoe and Levine (2001), Chatterjee et al. (2007) and Livshits et al. (2007).

The influence of the strategic model has caused a considerable part of the empirical literature to focus on measuring the potential gains that a household can achieve by defaulting on its loan. Fay et al. (2002) con-

EMPIRICAL STUDIES OF HOUSEHOLD MORTGAGE ARREARS IN OTHER COUNTRIES Box 2

Duygan-Bump and Grant (2009) use data from the European Community Household Panel to analyse the incidence of arrears across a number of European countries. From a Danish perspective, it is relevant to note that Denmark is clearly at the low end as regards the share of households in mortgage arrears, despite the fact that the share of households with mortgage loans is higher in Denmark than in the other countries in the survey. The authors demonstrate a clear correlation between the incidence of mortgage arrears and the institutional conditions which provide the framework for the legal process in connection with housing loan defaults. Households that are hit by negative shocks to e.g. income are less inclined to go into arrears in countries where the institutional framework ensures a fast and effective process. It is worth noting that Denmark – according to the authors' indicators – differs from most other countries in the survey by having a fast and cost-effective process in place. This may help explain the limited incidence of arrears in Denmark, as the consequences of mortgage default are felt by borrowers fairly quickly and are difficult to evade.

Aron and Muellbauer (2010) analyse mortgage arrears in the UK. Using aggregate data, they estimate a model for the level of arrears and use it to forecast future trends in various scenarios where e.g. the level of interest rates and unemployment are exposed to shocks. The model includes LTV ratios and a debt service ratio. The scenarios show that even relatively small interest-rate increases may lead to relatively large increases in the arrears rate, while rising unemployment has a smaller, but not immaterial impact on arrears.

Gathergood (2009) uses microdata to examine the mortgage arrears level among UK households. He finds that unemployment, long-term illness and divorce or the loss of a spouse give rise to the most serious problems. Moreover, he concludes that the majority of problem loans are relatively new, and that many households in arrears were already having problems at the time they took out the loans. Part of the arrears issue is consequently related to the screening of new borrowers.

Li et al. (2011) analyse the development in default on US mortgage loans in the wake of a reform of US legislation on personal bankruptcy in 2005. The reform restricted access to debt relief for unsecured debt, i.e. debt that is not secured by mortgage. The authors argue that US homeowners were thus deprived of a frequently used option to improve their liquidity position. According to the authors, this option was the only alternative to mortgage default for many households. Their empirical results support the finding that the reform contributed to a considerable rise in the mortgage default rate.

Lydon and McCarthy (2011) investigate Irish mortgage loans based on data from four Irish banks. They find that mortgages taken out for buy-to-let purposes, high LTV ratios and high repayment burdens lead to a higher probability of arrears.

Alfaro et al. (2010) analyse household debt default in Chile. They distinguish between mortgage default and default on unsecured consumer loans. The degree to which the two types of debt default are dependent on the variables applied differs considerably. Household income is the only variable that has the same effect on both types of default. Conversely, higher levels of education reduce the probability of mortgage default, but not of default on consumer loans.

struct a measure of the gain and find a positive link to the frequency of bankruptcy filings among US households.[1]

Other empirical studies focus on the importance of liquidity constraints and unexpected events such as unemployment. Elul et al. (2010) examine the role of illiquidity, unemployment and the loan-to-value ratio for homes in terms of the probability of mortgage default among US homeowners. Like Cohen-Cole and Morse (2010) and others, the authors conclude that illiquidity plays a key role in the households' tendency to default on their mortgage loans. Results of this kind are occasionally interpreted as being in conflict with the strategic default model. But the model specifically predicts that the probability of default will increase if the borrower becomes liquidity constrained, since there is a strong increase in the cost of continued payments in this situation, as pointed out by Elul et al. (2010).

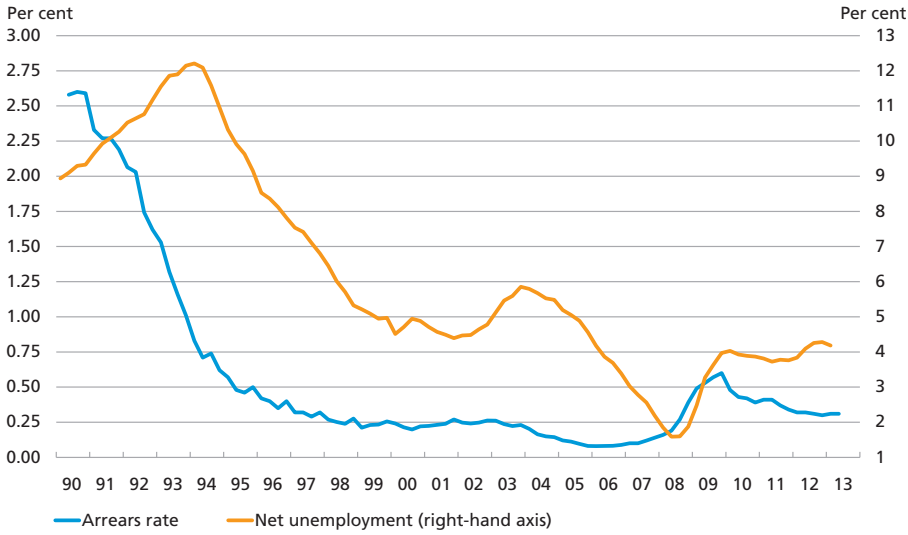
In Box 2, we briefly describe examples of other empirical studies of mortgage arrears in various countries.

4. ARREARS AND MACROECONOMIC DEVELOPMENT

As mentioned in the introduction to this article, mortgage arrears were much more common among Danish families in the early 1990s than they are today. The difference between then and now should to a large extent be viewed in the light of the macroeconomic development in the intervening period. First, unemployment was considerably higher in the early 1990s than it is today, cf. Chart 2. This was followed by a major drop in both unemployment and the arrears rate. When unemployment rose again in the wake of the financial crisis, the arrears rate also went up. Neither variable returned to the high level of the early 1990s, however. It should be noted that there is a certain time lag between changes in unemployment and changes in the arrears rate. In the 1990s as well as in 2008-09, the changes in the arrears rate preceded the changes in unemployment, reflecting the typical cyclical phenomenon that it takes some

[1] In empirical studies of housing loan defaults, the difference between the remaining balance on the loan and the property value is often interpreted as a measure of the borrower's gain from defaulting on the loan. This makes good sense in studies of US housing loans in particular, as US homeowners are usually not personally liable for their loans. So if the property value is lower than the remaining debt on the loan, borrowers can, in principle, obtain a capital gain by defaulting on their obligations and letting the lender take over the home. For the same reason, falling house prices are often mentioned as an important explanation of the rising number of mortgage defaults in the USA in the years preceding the financial crisis, cf. e.g. Bajari et al. (2008) and Mayer et al. (2009). These arguments cannot be directly applied to Danish mortgage loans, however. For Danish mortgage borrowers, it is not possible to obtain a capital gain by defaulting on the loan, since the mortgage bank can maintain a claim against the borrower even after the home has been sold. But this does not mean that the development in Danish house prices is irrelevant to the mortgage arrears rate; all other things being equal, higher house prices result in larger home equity for homeowners. In many cases, positive home equity can be used as a financial buffer, cf. also the next section.

ARREARS AND UNEMPLOYMENT, 1990-2013 Chart 2



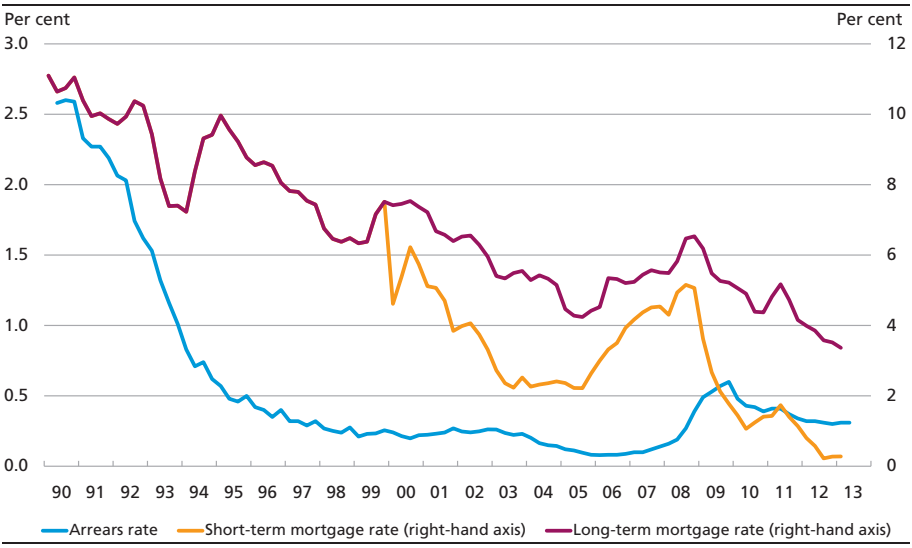
Note: The arrears rate indicates the proportion of the total payments that had not been made three and a half months after the due date. The calculation includes lending by all mortgage banks for owner-occupied dwellings and summer cottages.

Source: Association of Danish Mortgage Banks, Danish Mortgage Banks' Federation and Danmarks Nationalbank.

time before changes in economic activity pass through to unemployment.

Interest rates on mortgage loans have also fallen considerably since the early 1990s, cf. Chart 3. The actual *level* of interest rates will not necessarily impact the families' ability to service their debts to any great extent, since lower interest rates will typically be matched by higher house prices and thus a higher borrowing requirement. For those homeowners who have already taken out a mortgage, on the other hand, *changes* in the level of interest rates will have a strong impact. So, all else being equal, falling interest rates lead to reduced mortgage payments, which could make it easier for borrowers to meet their obligetions. The significance of this has grown in step with the more widespread use of adjustable-rate loans, which were introduced in 1996. This is illustrated by a relatively close correlation between the short-term mortgage rate and the arrears rate in the last couple of years, although the changes in the latter seem to occur with a certain lag. The time lag reflects firstly that, due to different fixed-interest periods, it takes some time for interest-rate changes to fully pass through to the finances of mortgage customers, and secondly that it may take a while from the time of the economic changes until the borrowers find themselves in financial difficulties and fall behind on their mortgage payments.

MORTGAGE INTEREST RATES AND ARREARS, 1990-2013 Chart 3



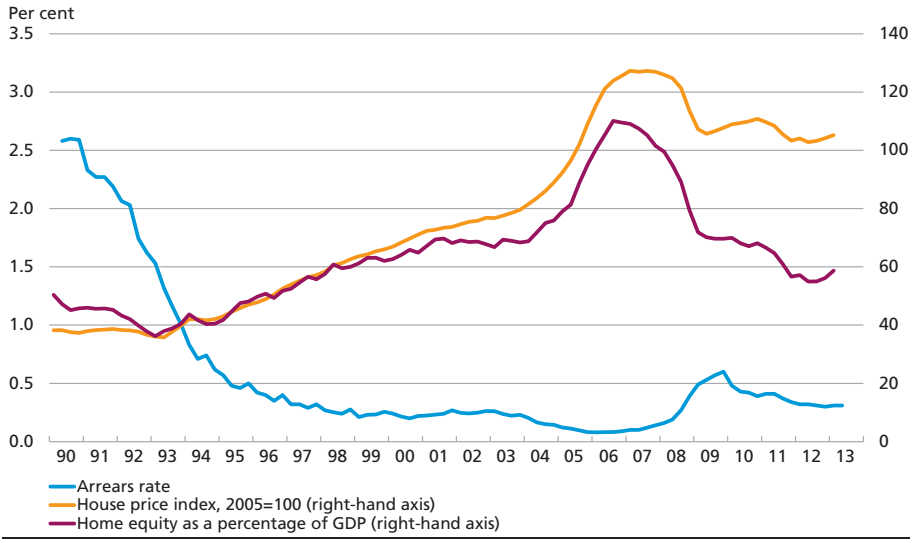
Note: The short-term mortgage rate was not compiled before 2000. The arrears rate indicates the proportion of the total payments that had not been made three and a half months after the due date. The calculation includes lending by all mortgage banks for owner-occupied dwellings and summer cottages.
Source: Association of Danish Mortgage Banks, Danish Mortgage Banks' Federation and Danmarks Nationalbank.

House price developments may also have a bearing on the frequency of mortgage arrears. All other things being equal, rising house prices lead to increased home equity in mortgaged properties. In some cases, positive home equity can be used as a financial buffer to soften the impact of temporary fluctuations in e.g. income. One reason is that it will often be possible to borrow against any home equity. In addition, positive home equity provides better options for converting mortgage debt into loans with lower payments here and now. For example, if the debt amounts to less than 80 per cent of the property value, it is frequently possible to convert to deferred-amortisation loans. This could counter a temporary loss of income.

If the debt exceeds 80 per cent of the property value, on the other hand, such conversion is not possible. The negative correlation between house prices and home equity on the one hand and the arrears rate on the other has been particularly evident in recent years, cf. Chart 4. In the period 2005-07, when house prices soared, the arrears rate thus bottomed out. When house prices subsequently dived, the arrears rate rose during 2008 and 2009, to the highest level since the mid-1990s.

In addition to the macroeconomic factors mentioned here, certain structural conditions also contributed to the arrears rate reaching an unusually high level in the early 1990s. The taxation value of interest costs was substantially reduced as part of the tax reform in the mid-1980s.

HOUSE PRICES, HOME EQUITY AND ARREARS, 1990-2013 Chart 4



Note: The development in property prices is not adjusted for inflation. Property prices are stated as an index where 2005=100. Home equity is calculated as a percentage of GDP, given in current prices. The arrears rate indicates the proportion of the total payments that had not been made three and a half months after the due date. The calculation includes lending by all mortgage banks for owner-occupied dwellings and summer cottages.
Source: Association of Danish Mortgage Banks, Danish Mortgage Banks' Federation and Danmarks Nationalbank.

Combined with a lower rate of inflation, this led to a sharp increase in real after-tax interest rates. At the same time, lending was restricted to 20-year mixed loans. In all probability, those initiatives led to more homeowners finding it difficult to service their debt in the ensuing period. The subsequent drop in the arrears rate – and the low level of the following years – should also be viewed in the light of structural changes. Cases in point include improved mortgaging access within the limit of 80 per cent of the property value in 1992, access to 30-year annuity loans in 1993 and the introduction of deferred-amortisation loans in 2003. All these initiatives may have contributed to keeping the arrears rate at a low level. We will get back to the importance of these and other structural conditions later in the article.

5. MICRODATA FOR FAMILIES' FINANCIAL SITUATION AND MORTGAGE ARREARS

The analyses in this article are based on detailed data about all outstanding mortgage loans for owner-occupied dwellings and summer cottages calculated at the end of 2009, 2010 and 2011. The information has been merged in an anonymised form with background data on the borrowers from Statistics Denmark and then aggregated at family level.

The merged data set enables us to identify approximately 4,700 families who were at least three and a half months behind on their mortgage payments in 2009. For 2011, the corresponding figure is around 3,350 families, or 0.31 per cent of the total number of families with mortgage debt.

Mortgage loans and arrears

The information about mortgage loans was provided by the mortgage banks and made available to Danmarks Nationalbank and the Ministry of Business and Growth, among others. A wide range of information is available for each loan, including on the remaining balance, the loan type and the maturity of the loan.[1] Moreover, the information includes the mortgage banks' assessments of the size of the remaining debt relative to the sales value of the property provided as collateral for the loan (LTV ratio). The mortgage banks use different methods to assess the property value. The methods have been approved by the Danish Financial Supervisory Authority.

Finally, the mortgage banks report any 105-day arrears on the June instalment, i.e. the amount owed by the borrower approximately three and a half months after the June due date. Only arrears exceeding kr. 1,000 are included, however. At the end of 2011, there were 4,240 outstanding loans that had been subject to 105-day arrears exceeding kr. 1,000 on the June instalment of 2011, cf. Table 2. This corresponds to 0.29 per cent of the total number of outstanding loans.

The information on arrears can be used to identify borrowers in mortgage arrears in a given period, i.e. from June of the year concerned and approximately three and a half months ahead. It should be noted, however, that with the information available it is only possible to identify *some* and not *all* of the borrowers who were behind on their mortgage payments during the year. The information from the mortgage banks does not include arrears relating to the other instalments of the year. If, for example, a borrower falls behind on his payment for the March instalment, but makes the June payment on time, the borrower will not be registered as being in arrears in the year concerned.[2]. Furthermore as previously mentioned, the mortgage information is reported at year-end. This means that information is only available about the loans still outstanding at the end of the year. If a borrower fails to make his

1 For a more detailed description of the material, see Andersen et al. (2012b).

2 In addition to 105-day arrears on the June instalment, most of the mortgage banks also provided information about any 45-day arrears on the September instalment. However, a delay of 45 days can be caused by many factors that do not necessarily have anything to do with an actual inability to meet payment obligations, and we consequently chose to focus on the 105-day arrears in this article.

MORTGAGE LOANS IN 105-DAY ARREARS ON THE JUNE INSTALMENT Table 2

	2009	2010	2011
Number of loans	5,886	4,947	4,240
Share of total number of outstanding loans, per cent	0.41	0.34	0.29

Note: The top row of the table shows the number of outstanding loans at year-end in 105-day arrears on payments exceeding kr. 1,000 for the June instalment of the year under review. The bottom row of the table shows how large a percentage of the total number of outstanding loans for owner-occupied dwellings and summer cottages these loans made up at the end of the year under review.
Source: Mortgage banks and own calculations.

mortgage payments in the month of June, and the loan is then settled by year-end, e.g. through enforced sale, the information about the arrears on the June instalment for the loan in question will not be included in the data material. Despite these limitations, we believe that the information available provides a reasonable basis on which to assess the extent of and reasons for mortgage arrears.[1]

Income, wealth and socio-economic background variables

The data material from the mortgage banks has been merged in an anonymous form with personal data from Statistics Denmark's personal and family income registers. The latter data is mainly based on information from the Danish Customs and Tax Administration (SKAT) and includes income, tax, wealth and debt. The content of the wealth and debt data is described in more detail in Box 3. Furthermore, we use a number of socio-economic variables from the population and education registers and the Integrated Database for Labour Market Research (IDA). Finally, we supplement the data with information on admissions to hospital from the register on hospitalisation rates.

Organisation and delineation

The economic unit of interest in this article is the *family*, and the data is consequently organised at family level. The statistical definition of a family appears from Box 4. For most variables, conversion from individual to family level is easy. For example, the family's income is calculated as the sum of the incomes of each member of the family. In terms of mortgage arrears, all loans for which the family members are liable

[1] In October 2011, the Association of Danish Mortgage Banks estimated that for the 2nd quarter of 2011, payments on around 6,000 loans were in arrears by 105 days. This number is somewhat higher than the 4,200 loans recorded in our data. Danmarks Nationalbank is currently cooperating with the mortgage banks and Statistics Denmark to compile detailed microstatistics for mortgage loans, including more exhaustive information about arrears, among other things.

REGISTER INFORMATION ON ASSETS AND LIABILITIES Box 3

Statistics Denmark's registers of personal income contain information on a number of debt items, including debt to banks and mortgage banks, debt to the Mortgage Bank of the Kingdom of Denmark, financing companies and local government as well as charge card debt and mortgage deed debt. The registers do not include information on debt to private individuals.

On the asset side, the registers contain information on deposits in banks, the market value of stocks and bonds, and mortgage deeds in the custody of a bank. They also contain information about the public valuation of real property.

The income registers have no information on a number of assets, including, notably, pension wealth. But individual pension wealth can be estimated on the basis of information from the Welfare Commission, Statistics Denmark and ATP statistics, among others, cf. Andersen et al. (2012a). In addition, the registers contain no information on cash holdings and the value of consumer durables, including cars, boats, household effects and art. Nor do they contain information on the value of private cooperative housing. This reflects that most data on income and wealth is derived from notices of assessment for individual persons, which do not contain information about such assets. Any debt incurred in connection with the acquisition of the above-mentioned assets will be included on the liabilities side of the registers, however.

STATISTICAL DEFINITION OF A FAMILY Box 4

The analyses in this article are based on Statistics Denmark's definition of "E-families".

According to this definition, a family consists of either one or two adults and any children living at home. Two adults are regarded as members of the same family if they are living together and meet at least one of the following criteria:

- Are married to each other or have entered into a registered partnership
- Have at least one common child registered in the Civil Registration System (the CPR)
- Are of opposite sex and have an age difference of 15 years or less, are not closely related and live in a household with no other adults.

Adults living at the same address who do not meet at least one of the above criteria are regarded as singles. Children living at home are regarded as members of their parents' family if they are under 25, live at the same address as minimum one of their parents, have never been married or entered into a registered partnership and do not themselves have children who are registered in the CPR.

A family meeting these criteria can consist of only two generations. If three or more generations live at the same address, the two younger generations constitute the family.

FAMILIES IN ARREARS Table 3

	All families			Families with no self-employed members, with full tax liability and with an annual income after tax of more than kr. 25,000		
	2009	2010	2011	2009	2010	2011
Number of families with June arrears	4,731	3,954	3,353	3,700	3,211	2,783
Share of total number of families with mortgage debt, per cent	0.44	0.37	0.31	0.38	0.33	0.29
Average amount of arrears among families in arrears, kr.	28,570	22,343	20,383	27,261	21,554	19,327
Total mortgage debt for families in arrears, kr. billion	6.9	5.4	4.5	4.8	3.9	3.4
Share of total mortgage lending for owner-occupied dwellings and summer cottages, per cent	0.53	0.40	0.33	0.43	0.33	0.29

Note: The table shows descriptive statistics for families in arrears by 105 days on payments exceeding kr. 1,000 for the June instalment.
Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

are aggregated. The family is deemed to be in arrears if it is 105 days behind on payments exceeding kr. 1,000 on just one of those loans.[1]

According to our data, just over 4,700 families met this criterion in 2009, cf. Table 3. In 2011, the number had fallen to approximately 3,350, or 0.31 per cent of the total number of families with mortgage debt. These families accounted for a total mortgage debt of just under kr. 5 billion at the end of 2011, corresponding to 0.33 per cent of total mortgage lending for owner-occupied dwellings and summer cottages. As pointed out above, however, it is not possible to identify all the families who were behind on their mortgage payments for the June instalment. Hence, the actual number of families in arrears may be higher than indicated by the figures in Table 3.

For certain groups of families, the quality of the data on key financial variables such as income and wealth is lower than for other families. Accordingly, the following analyses include only families in which no adult members are self-employed, all adult members are liable to Danish income tax, and the total family income after tax is minimum kr.

[1] In the analyses in the following sections we sometimes need to be able to follow the individual families over time. In those cases the conversion to family level is not always that easy, because the family is not a constant unit. Existing families cease to exist, e.g. due to divorce, and new families are established when couples move in together or when children leave home. So when in the next sections we look into a family's arrears in previous and subsequent years, we base our analysis on the individual family members and follow them over time. If, say, just one of the present members can be associated with a loan in arrears in a subsequent year, the family is regarded as being in arrears that year, whether or not the family still exists as a unit at that time.

AVERAGE INCOME, WEALTH AND DEBT FOR FAMILIES IN THE DELINEATED DATA SET VERSUS OTHER FAMILIES, 2011 Table 4

Kr.	Families in the delineated data set	All families
Income after tax per adult	254,804	205,369
Liquid assets	278,028	315,426
Housing wealth, public valuation	1,777,958	1,075,200
Total debt	1,538,574	840,790

Note: The delineated data set includes the families with mortgage debt at the end of the year, with no family members who are self-employed, with full tax liability in Denmark and with a total annual income after tax of minimum kr. 25,000. Liquid assets consist of deposits in banks and the market value of stocks, bonds and mortgage deeds in the custody of a bank. Here, housing wealth is calculated on the basis of the public property valuation. Elsewhere in this article we use the mortgage banks' assessment instead. That is not the case here because the mortgage banks' assessments are only available for properties on which mortgages have been taken out, and comparisons across the two groups of families are therefore not possible on the basis of this calculation. In contrast, the public valuation is available for all properties.

Source: Statistics Denmark and own calculations.

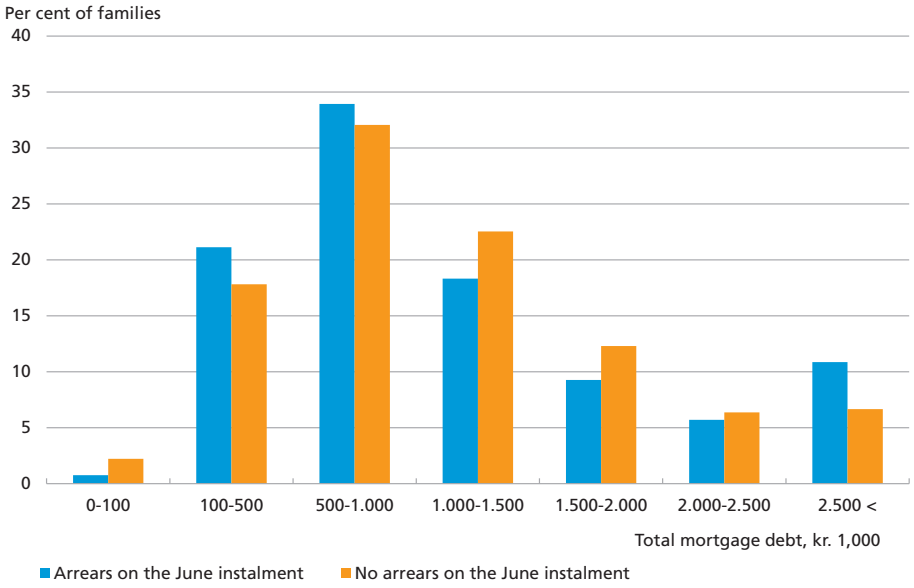
25,000. After this delineation, our data set includes almost 975,000 families in 2011, of which just under 2,800 families were in arrears by 105 days on the June instalment. The families in the delineated data set differ from the rest of the population in a number of respects. For example, they have higher income and wealth than the average family, cf. Table 4. At the same time, they have considerably more debt than the rest of the population. This is not surprising, since our specific focus is on the group of families with mortgage debt.

6. PORTRAIT OF FAMILIES IN ARREARS

For the families who were in arrears by 105 days on the June instalment of 2011, the average remaining debt on their mortgage loans more or less equalled that of other families with mortgage debt. But the size of the remaining debt varied slightly more among the families in arrears, cf. Chart 5. Hence, the percentage of families whose remaining debt was under kr. 1,000,000 at the end of 2011 was slightly higher in this group than among the families who were not in arrears. On the other hand, almost 11 per cent of the families in arrears had mortgage debt of more than kr. 2.5 million. Among the families not in arrears the corresponding figure was just under 7 per cent.

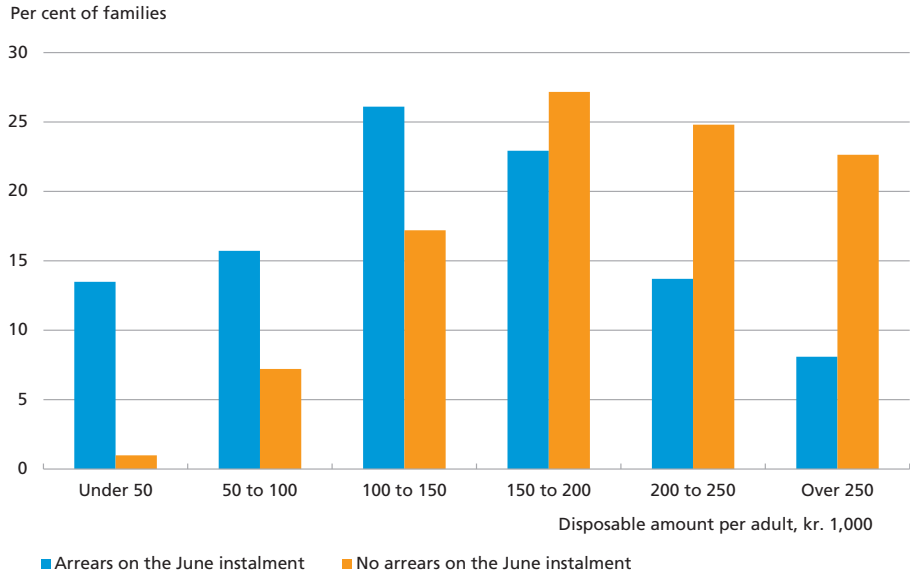
Families in arrears on the June instalment typically have a lower disposable amount per adult than the other families with mortgage debt, cf. Chart 6. In 2011, 13 per cent of the families in arrears had an annual disposable amount per adult of less than kr. 50,000, and more than half of the families in this group had a disposable amount of less than kr. 150,000 per adult. Among the families paying their mortgages for the June instalment on time, only around 2 per cent had a disposable amount

DISTRIBUTION OF REMAINING DEBT ON MORTGAGE LOANS, 2011 Chart 5



Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

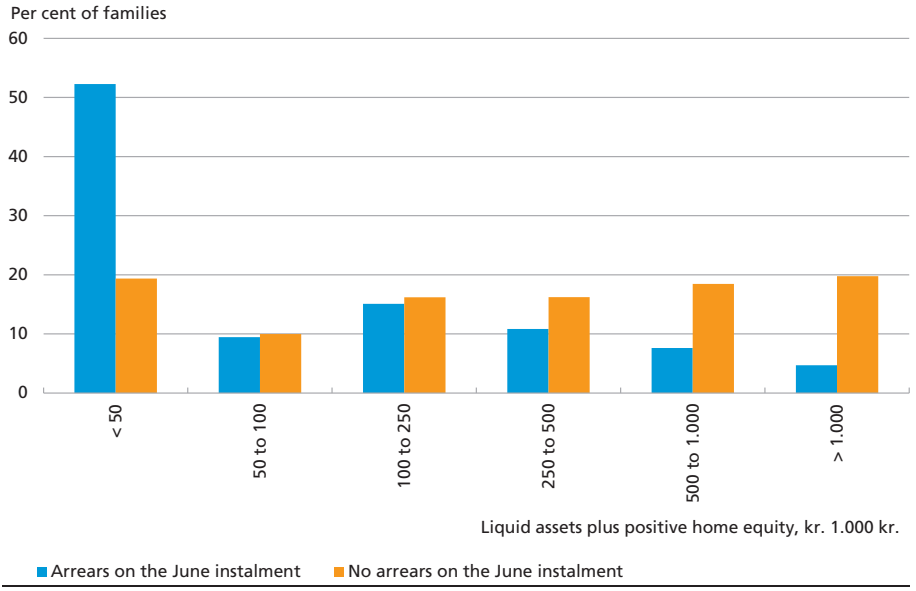
DISTRIBUTION OF DISPOSABLE AMOUNT PER ADULT AMONG MORTGAGE CUSTOMERS, 2011 Chart 6



Note: The disposable amount per adult is calculated as the family's total annual income less tax, interest payments, maintenance payments, repayment of social benefits, administration margins payable to mortgage banks and any principal payments on mortgage debt – divided by the number of adults in the family.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

DISTRIBUTION OF LIQUID ASSETS PLUS POSITIVE HOME EQUITY IN MORTGAGED PROPERTIES, 2011 Chart 7



Note: Liquid assets consist of the family's deposits in banks and the market value of bonds, mortgage deeds, stocks and investment certificates in the custody of a bank. Home equity is calculated as the difference between 80 per cent of the property valuation (60 per cent for summer cottages) and the amount of mortgage debt on the property.
Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

per adult of less than kr. 50,000 kr., and approximately 27 per cent had less than kr. 150,000 per adult at their disposal. Similar differences between the two groups applied in 2009 and 2010.

In terms of wealth, there is also a big difference between the two groups of mortgage customers, cf. Chart 7. Among the families who were behind on their mortgage payments for the June instalment of 2011, more than half had liquid assets of less than kr. 50,000 at the end of the year. This includes any positive home equity in the family's mortgaged property/properties.[1] Among the other families with mortgage debt, this applied to just under 20 per cent. At the opposite end of the scale, less than 5 per cent of the families in arrears had liquid assets and positive home equity of more than kr. 1 million compared with 20 per cent among the families with no arrears. In Box 5, we take a closer look

[1] Home equity is calculated for each property on which the family has taken out a mortgage. For owner-occupied dwellings, it is calculated as the difference between 80 per cent of the property valuation and the remaining debt on the property. For summer cottages, it is calculated as 60 per cent of the property value less the remaining debt. The reason is that it is possible to raise mortgage loans against up to 80 per cent of the value of owner-occupied dwellings, while the limit is 60 per cent for summer cottages. Only mortgage debt can be subtracted in the calculation since, due to a lack of data, it is not possible to take into account any bank loans raised against the property as collateral.

ARREARS AND PENSION WEALTH Box 5

Large holdings of assets can be used as financial buffers against e.g. temporary low-income periods. This is particularly true of liquid assets such as cash, bank deposits and securities. In many cases, any home equity can also be used, since, as previously mentioned, it is possible to raise loans against home equity.

Some assets are less liquid, however, so they are not always equally obvious to use in the event of difficulties in servicing mortgage debt. Pension wealth is a case in point. On the one hand, it is both difficult and costly to access accumulated pension contributions before the time of retirement. On the other hand, it seems unlikely that large pension wealth – and the resulting credit standing – makes no difference to a family's ability to get through a period of temporary financial difficulties.

In 2011, only few families in mortgage arrears had large pension wealth, cf. Table 5. The vast majority of families in arrears had total pension wealth of less than kr. 500,000 at the end of the year. This was particularly true of families with low disposable amounts or small holdings of liquid assets. Among this group, around one fourth of the families in arrears had pension wealth after tax of less than kr. 100,000.

FAMILIES IN ARREARS BROKEN DOWN BY PENSION WEALTH AFTER TAX, DISPOSABLE AMOUNT PER ADULT AND LIQUID ASSETS PLUS POSITIVE HOME EQUITY, 2011 Table 5

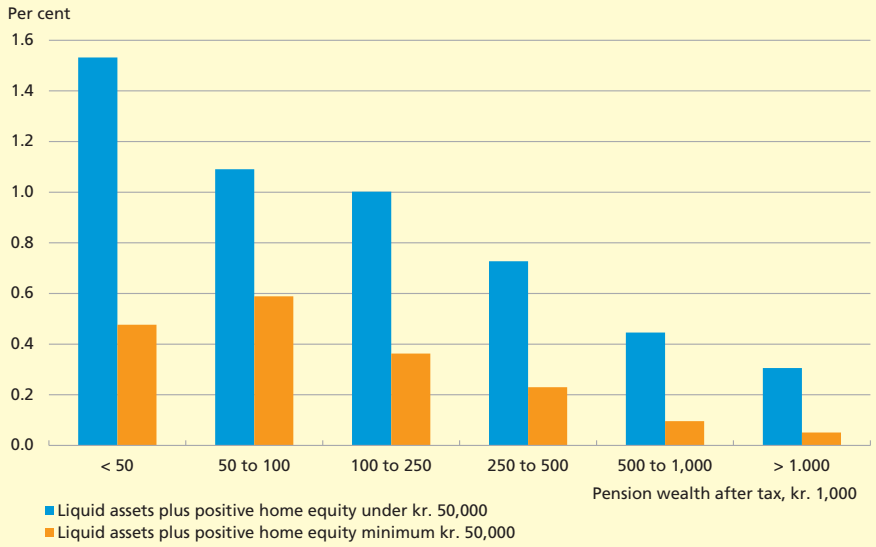
	Pension wealth after tax, kr. 1,000						
Total number of families	Under 50	50 to 100	100 to 250	250 to 500	500 to 1,000	Over 1,000	Total
Total	313	299	760	809	430	171	2,782
Annual disposable amount per adult under kr. 50,000	68	52	111	82	41	21	375
Annual disposable amount per adult minimum kr. 50,000	245	247	649	727	389	150	2,407
Liquid assets plus positive home equity under kr. 50,000	196	152	428	428	203	48	1,455
Liquid assets plus positive home equity minimum kr. 50,000	117	147	332	381	227	123	1,327

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

The same pattern is seen if we compare the number of families in arrears with the total number of families with mortgage debt in each group: The share of families in arrears is much larger among families with little or no pension wealth than among families with large pension wealth, cf. Chart 8. The difference is particularly pronounced among families with few liquid assets.

CONTINUED Box 5

SHARE OF FAMILIES IN MORTGAGE ARREARS BROKEN DOWN BY PENSION WEALTH AFTER TAX, 2011 Chart 8

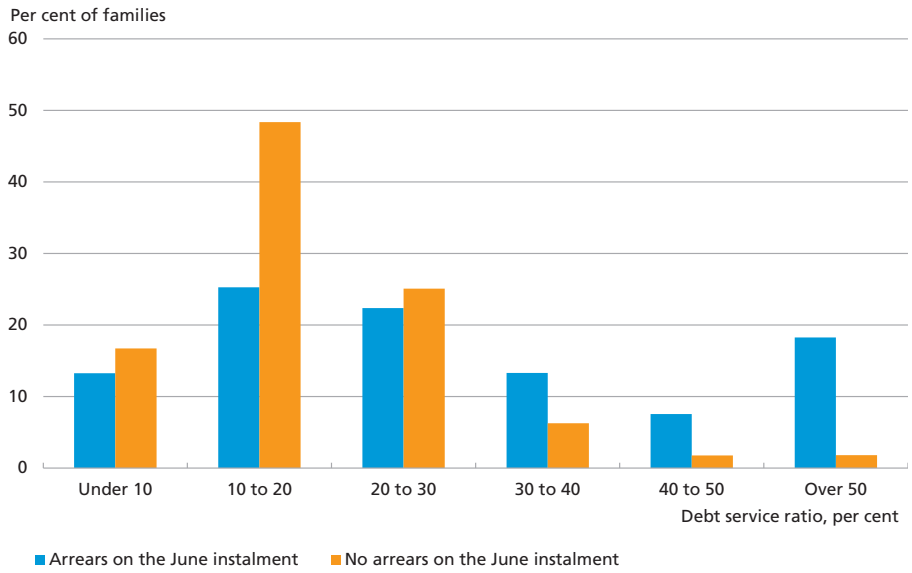


This correlation between the amount of pension wealth and the incidence of mortgage arrears may be attributable to several factors. One possible interpretation is that there is an actual causal effect of the amount of pension wealth on the probability of falling into arrears. But the correlation may also indicate that families with large pension wealth differ from families with little pension wealth in other ways. For example, families with large pension wealth often have high incomes and/or a strong propensity to save, and such underlying properties may be the cause of the correlation observed. We will get back to the impact of pension wealth on the probability of arrears in section 7, in which we explicitly control for a number of family-specific factors correlated with the amount of pension wealth that may impact the probability of a family falling into mortgage arrears.

at the relationship between the families' other types of wealth and the incidence of arrears.

Hence, the general picture is that families in arrears have a lower disposable amount and fewer liquid assets than other families with mortgage debt. That said, it is still remarkable that a number of families who are in arrears with their mortgage payments seem to have robust finances. In 2011, for example, approximately 20 per cent of the families in arrears had a disposable amount per adult of minimum kr. 200,000,

DISTRIBUTION OF DEBT SERVICE RATIO, 2011 Chart 9



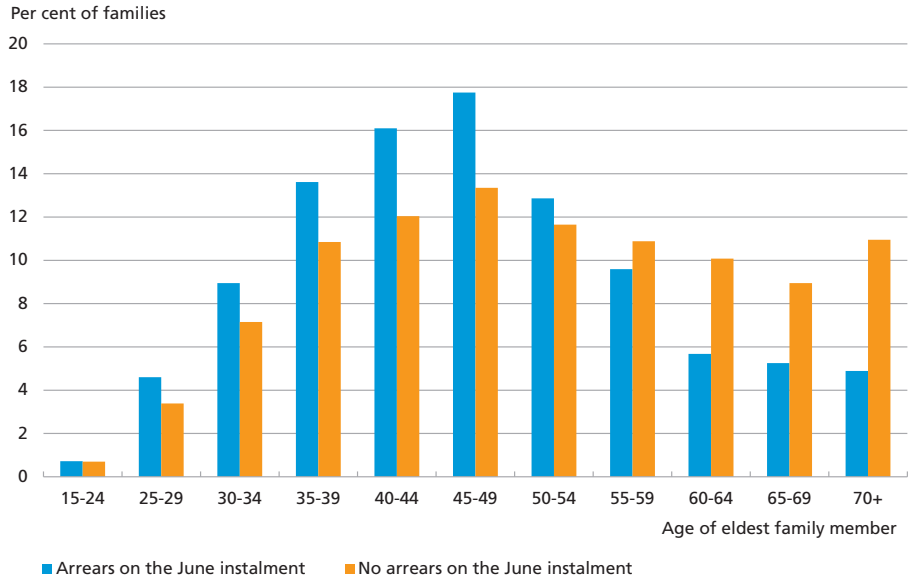
Note: The debt service ratio indicates the share of the family's income after tax that it uses to service its mortgage debt and pay interest on other debt.
Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

and 20 per cent had liquid assets and positive home equity of minimum kr. 250,000 at the end of the year. This emphasises that tight finances are not the only possible reason why families with mortgage loans fall behind on their mortgage payments. When happening to families who seem to have robust finances, this is presumably attributable to social events such as divorce or illness. We will get back to the importance of such events later in the article.

Families in mortgage arrears typically spend a higher percentage of their income on servicing their debt than families who are not in arrears, cf. Chart 9. In 2011, approximately 26 per cent of the families in arrears spent minimum 40 per cent of their annual income after tax on mortgage payments and payments of interest on other debt. Less than 4 per cent of the families not in arrears spent such a large percentage of their income after tax on servicing their loans.

The age distribution among the families with mortgage debt shows that younger families are overrepresented among families who are in arrears, cf. Chart 10. In more than 60 per cent of the families who were behind on payments for the June instalment of 2011, the eldest member was under 50 years of age. Among the other families with mortgage debt, the corresponding share was less than 50 per cent.

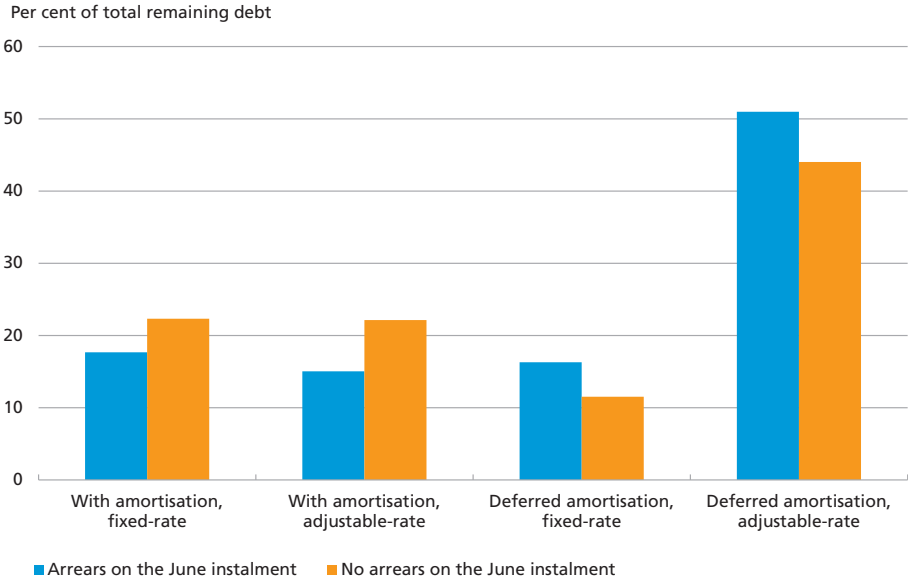
AGE DISTRIBUTION AMONG MORTGAGE CUSTOMERS, 2011 Chart 10



Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

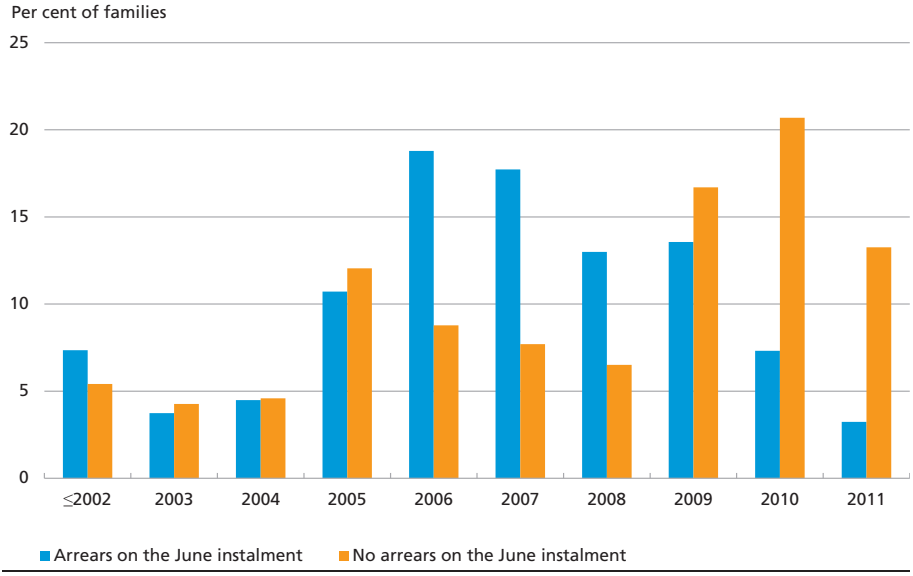
Chart 11 shows the families' total remaining mortgage debt at end-2011 broken down by loan type. Deferred-amortisation loans were somewhat more widespread among the families in arrears on the June instalment

MORTGAGE CUSTOMERS' REMAINING DEBT BROKEN DOWN BY LOAN TYPE, 2011 Chart 11



Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

YEAR OF RAISING MOST RECENT MORTGAGE LOAN, 2011 Chart 12



Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

than among other families. In the former group, around two thirds of the total remaining debt was associated with deferred-amortisation loans, while this was only the case for just over half of the remaining debt among the families not in arrears. The level of adjustable-rate loans, on the other hand, was more or less the same in the two groups of mortgage customers.

Chart 12 shows the distribution in terms of when the most recent mortgage loan was taken out for families in arrears and not in arrears, respectively, on the June instalment. Among the families in arrears, a very large percentage took out their most recent loan in either 2006 or 2007. This is due to the fact that house prices peaked in that period. Many of the families who purchased their homes at that time will consequently have seen major drops in the value of their properties, and many of them will not be able to repay their debt by selling the home.

In Table 6, we look into a number of characteristics of mortgage customers in arrears and not in arrears, respectively, on the June instalment of 2011. Compared with the other families with mortgage debt, the families in arrears comprise more singles, fewer persons with higher education and fewer pensioners. It is also worth noting that social events such as divorce, illness or prolonged unemployment occur more frequently among the families in arrears than among the other families.

PROPERTIES FOR FAMILIES WITH MORTGAGE DEBT, 2011 Table 6

Per cent	Families in arrears on the June instalment	Families not in arrears on the June instalment
Share with the following characteristics:		
- family with children	47.1	43.6
- two adults in the family	48.9	72.7
- at least one person with higher education in the family	21.5	44.8
- at least one pensioner in the family	10.5	21.0
- affected by divorce or the death of a spouse within the last two years	13.7	3.9
- affected by minimum six months' unemployment within the last two years	12.4	5.5
- at least one adult admitted to hospital during the last two years	27.3	24.2
- at least one adult received sickness or maternity benefits during the last two years	39.5	23.6
- residence in Copenhagen	5.9	7.0
- residence in Copenhagen's environs	7.8	8.3
- residence in North Zealand	9.5	9.4
- residence in East Zealand	5.7	4.9
- residence in West and South Zealand	25.4	12.4
- residence on Bornholm	1.0	0.9
- residence on Funen	7.6	9.2
- residence in South Jutland	9.7	13.3
- residence in East Jutland	11.6	15.3
- residence in West Jutland	5.3	8.0
- residence in North Jutland	10.6	11.3

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

Hence, in the group of families in arrears by 105 days on the June instalment of 2011, 46 per cent had been exposed to either divorce, the death of a spouse, admission to hospital or minimum six months of unemployment in 2010 and/or 2011. Among the other families, 31 per cent experienced at least one such event.

In many cases, social events such as the above have far-reaching consequences for a family's finances. It is therefore not surprising that a positive correlation is seen between those events and the incidence of mortgage arrears. The difference in frequency between the two groups is thus in accordance with the presumption that mortgage arrears are closely linked to tight finances.

Finally, Table 6 shows that the geographical distribution of the families in arrears on the June instalment differs somewhat from the corresponding distribution of other families with mortgage debt. What stands out is that around one fourth of all families in arrears on the June instalment of 2011 resided in West and South Zealand. In relative terms, only half as many of the other families with mortgage debt resided in

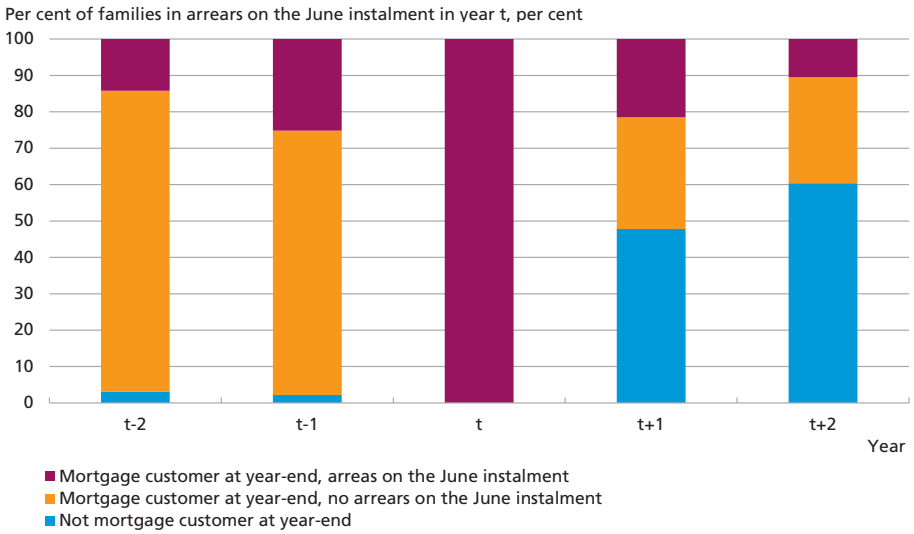
that part of Denmark. Families residing in Copenhagen, on Funen and in Jutland, on the other hand, are underrepresented among the families in mortgage arrears.

Falling into and out of arrears

The time dimension of the data from the mortgage banks can be used to examine the process for the families who fall behind on their mortgage payments for the June instalment of a given year. This enables us to analyse whether arrears on the June instalment is a recurring annual phenomenon for some families, or whether it is typically a one-off occurrence.

Among the families in arrears by 105 days on the June instalment of a given year in the period 2010-11, around one fourth were also in arrears on the June instalment of the previous year, cf. Chart 13. Of the remaining three fourths, the vast majority made their payments for the June instalment within 105 days in the previous year, while a small

MORTGAGE ARREARS IN PRECEDING AND SUBSEQUENT YEARS AMONG FAMILIES IN ARREARS IN THE CURRENT YEAR — Chart 13



Note: The chart shows the arrears history for families in arrears. The starting point is families in arrears by 105 days on payments exceeding kr. 1,000 for the June instalment in a given year *t*. The columns indicate the number of families who were behind on their payments in the preceding and subsequent years, the number of families who made their June payments on time, and the number of families who were not mortgage customers during those years. Column *t-2* is based on the families in arrears on the June instalment of 2011 and shows how many of them were behind on their payments for the June instalment of 2009. Column *t-1* is based on the families who were in arrears on the June instalment of 2010 and/or 2011 and how many of those were in arrears in June of the previous year. Similarly, column *t+2* is based on the families in arrears in June 2009, while column *t+1* is based on the families that were in arrears on the June instalment of 2009 and/or 2010. A family that was in arrears in year *t* is deemed to be in arrears in year *t+h* if just one of its adult members is part of a family that is behind on its payments for the June instalment of that year. This also applies if the original family no longer exists in year *t*+h, and similarly for preceding years.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

minority had not taken out a mortgage at the time and therefore had no payments to make. So only a minority among the families were in arrears in both years.

Looking ahead in time, a similar pattern is seen. Among the families in arrears by 105 days on the June instalment of 2009 or 2010, only around 20 per cent also fell behind by at least 105 daysin the following year. However, this does not mean that all the other families reverted to making their payments on time. Almost half of the families in arrears on the June instalment of 2009 or 2010 no longer had a mortgage loan at the end of the following year. And one year further ahead, this share grows: Of the families in arrears in June 2009, only 40 per cent still had a mortgage loan at the end of 2011.

Unfortunately, the available data does not allow us to examine what happens to the families in arrears who are no longer mortgage customers in a subsequent year. But it is fair to assume that at least some of them see their home sold through enforced sale or have to sell their home against their own wishes. The high proportion of families in arrears who "disappear" from the mortgage credit market within just one year is thus consistent with the view that, for many families, the consequences of defaulting on mortgage loans set in fairly quickly.

7. WHY DO FAMILIES FALL INTO ARREARS ON THEIR MORTGAGE DEBT?

In this section we present an econometric model describing the probability of a family falling into arrears as a function of selected socio-economic variables. The primary purpose of the model is to calculate the change in the probability of falling into arrears when financial variables such as the family's disposable amount and holding of liquid assets change. This enables us to assess the total number of families in arrears under different assumptions pertaining to developments in their financial situation. In section 8 we present examples of such assessments based on specific macroeconomic scenarios.

Model specification and variables

The probability of arrears is estimated using a probit model. This section provides an overall description of the model and the variables included in it. Box 6 contains a more detailed description.

The model describes the relationship between the probability of a family falling at least 105 days behind on its payments for the June instalment and a number of explanatory variables. Among the explanatory variables, we are particularly interested in the following: The disposable amount per adult in the family is, as previously mentioned, closely

THE PROBIT MODEL: MODEL SPECIFICATION AND VARIABLE DEFINITIONS Box 6

The probit model describes the probability that a family will fall into arrears on the June instalment, conditional on a number of family-specific variables. Mathematically, the model is given by

$$\Pr(y_{it+1} = 1|x_{it}) = \Phi(x_{it}\,\beta),$$

where y_{it+1} is an indicator variable that assumes the value 1 if family *i* is in arrears by 105 days on payments exceeding kr. 1,000 for the June instalment of year *t*+1, and otherwise 0; x_{it} is a vector of explanatory variables for family *i* in year *t*; β is a vector of parameters; and $\Phi()$ is the distribution function for the normal distribution. The model is a standard model in applied econometrics and can be estimated using maximum likelihood estimation, cf. e.g. Wooldridge (2002).

The vector x_{it} contains the following explanatory variables:

Disposable amount per adult: The family's disposable amount is calculated as annual income after tax less interest costs, maintenance payments, repayment of social benefits, administration margins payable to mortgage banks and any principal payments on mortgage debt. Repayment on other debt is not deducted due to lack of data. The disposable amount is in kr. 10,000. For families with two adults, the amount is also divided by two. In the model specification, the disposable amount is interacted with a total of six dummy variables for the family's holding of liquid assets plus positive home equity. These dummy variables are described below. To avoid perfect multicolinearity (the "dummy variable trap"), the disposable amount is not included directly, i.e. without interaction terms.

Relative change in income after tax and interest: The family's income after tax and interest is calculated in year *t* and in each of the three preceding years. Each year, only income from the adult members of the family in year *t* is included. In this way, we avoid including family income fluctuations resulting from changes in the size of the family caused by, say, a child leaving home. The relative change in the family's income after tax and interest is calculated relative to the peak in the preceding three years. In the model, the variable is represented by a set of four dummy variables, representing loss of income after tax and interest of 0 to 10 per cent, 10 to 25 per cent, 25 to 50 per cent and more than 50 per cent, respectively. The reference category thus consists of families whose income after tax has either been unchanged or going up. In addition, we also include all families with retired members in the reference category. The purpose is to avoid a mix-up of the expected loss of income that is usually connected with retirement and loss of income attributable to e.g. unexpected unemployment.

Liquid assets plus positive home equity: Liquid assets consist of the family's deposits in banks and the market value of bonds, mortgage deeds, stocks and investment certificates in the custody of a bank calculated at year-end. Home equity is calculated at property level and then aggregated for the family's mortgaged properties. For owner-occupied dwellings, home equity is calculated as the difference between 80 per cent of the property value and the total remaining debt on the property at year-end. Only mortgage debt is included. For summer cottages, home equity is calculated as the difference between 60 per cent of the property value and the total remaining debt. The reason is that it is possible to raise mortgage loans against up to 80 per cent of the value of owner-occupied dwellings, while the limit is 60 per cent for summer

CONTINUED Box 6

cottages. The mortgage bank's assessment of the property is used as the property value, and properties on which no mortgages have been taken out are consequently not included in the calculation of home equity

Only positive home equity is included in the aggregation of liquid assets. To allow for any non-linearity in the relationship between liquid assets plus positive home equity and the incidence of arrears, the variable is represented by a number of dummy variables, each representing a particular interval. More specifically, we construct dummy variables for each of the intervals kr. 0 to 50,000, kr. 50,000 to 100,000, kr. 100,000 to 250,000, kr. 250,000 to 500,000, kr. 500,000 to 1 million, and kr. 1 million or more. The first dummy is excluded and used as a reference category.

Pension wealth after tax: The family's pension wealth is estimated using the method described in Andersen et al. (2012a). It is calculated after taxation, i.e. less the estimated future income tax on pay-outs. To increase comparability with the liquid assets plus positive home equity, we have chosen to include pension wealth in exactly the same way as the first variable, i.e. in the form of a number of dummy variables, each representing a particular interval. The intervals and the reference category are exactly the same as for liquid assets plus positive home equity.

Debt service ratio: The debt service ratio is calculated as the sum of interest, administration margins payable to mortgage banks and any principal payments on mortgage debt as well as interest on other debt, stated as a percentage of the family's annual income after tax. Due to lack of data, repayments on other forms of debt are not included in the calculation.

Homeowner: Dummy variable that assumes the value 1 if the family lives in an owner-occupied dwelling, and otherwise 0.

Two-adult family: Dummy variable that assumes the value 1 if there are two adults in the family, and otherwise 0.

Age of eldest family member: The age is stated at year-end.

Number of children: The number of children under the age of 25 who live at home.

Higher education in the family: Dummy variable that assumes the value 1 if at least one of the adults in the family has completed higher education, and otherwise 0.

Number of years since taking up residence: States the number of years since the family took up residence at the address where it is living at the end of year t. The number of years is stated at the end of year t.

Prolonged unemployment: Dummy variable that assumes the value 1 if at least one of the adult members of the family has been unemployed for minimum three months in the year under review, and otherwise 0.

Divorce or the death of a spouse: Dummy variable that assumes the value 1 if at least one of the adult members of the family has been exposed to divorce or the death of a spouse in the year under review, and otherwise 0.

Admission to hospital: Dummy variable that assumes the value 1 if at least one of the adult members of the family has been admitted to hospital during the year under review, and otherwise 0.

Disbursement of sickness benefits: Dummy variable that assumes the value 1 if at least one of the adult members of the family has received sickness or maternity benefits in the year under review, and otherwise 0.

CONTINUED Box 6

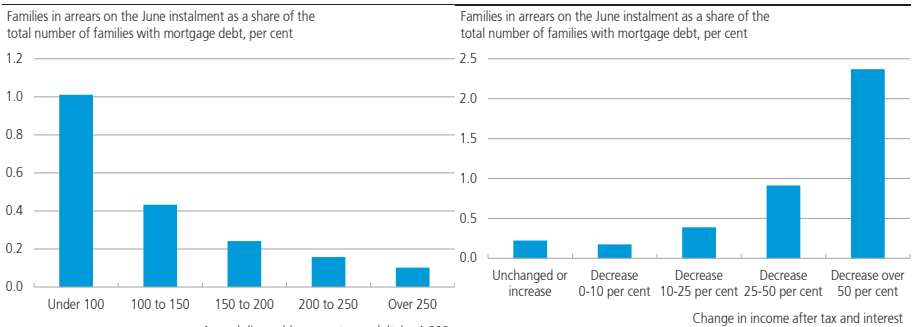
Area of Denmark: We construct a set of dummy variables for a total of 11 areas. Each variable assumes the value 1 if the family resides in the area under review, and otherwise 0. The dummy variable for Copenhagen is excluded and used as a reference category.

For a small number of families, the explanatory variables assume extreme values, often due to incorrect data. Although this applies to few families, very extreme values for key variables such as disposable amount and the debt service ratio may affect the estimates, blurring the actual relationship between these variables and the incidence of arrears. To avoid this, we exclude observations where the family's disposable amount is either under kr. -500,000 or over kr. 5 million; where the amount of liquid assets plus positive home equity exceeds kr. 20 million; or where the debt service ratio exceeds 1,000 per cent. This delineation reduces the number of observations by just over 1,000, or less than 1 per thousand of the total number of observations.

linked to the family's ability to service its debt, and we consequently expect a negative relationship between the size of the amount and the probability of falling into arrears. Indeed, such a relationship is clearly seen in a simple plotting of the two variables, cf. Chart 14 (left).

The strength of the above relationship may depend on the family's holding of liquid assets. For a family with substantial liquid assets, e.g. in the form of cash, equities or bonds, the size of the disposable amount will not necessarily affect the probability of arrears very much, since the family is able to compensate for a modest disposable amount by using its assets. This could also be the case if the family has considerable home equity, which it may pledge as collateral. Conversely, it is easy to imagine that the size of the disposable amount has a much greater impact

ARREARS RATE BROKEN DOWN BY DISPOSABLE AMOUNT PER ADULT AND RELATIVE CHANGE IN INCOME AFTER TAX AND INTEREST Chart 14



Note: The disposable amount per adult is calculated as the family's total annual income less tax, interest payments, maintenance payments, repayment of social benefits, administration margins payable to mortgage banks and any principal payments on mortgage debt – divided by the number of adults in the family.

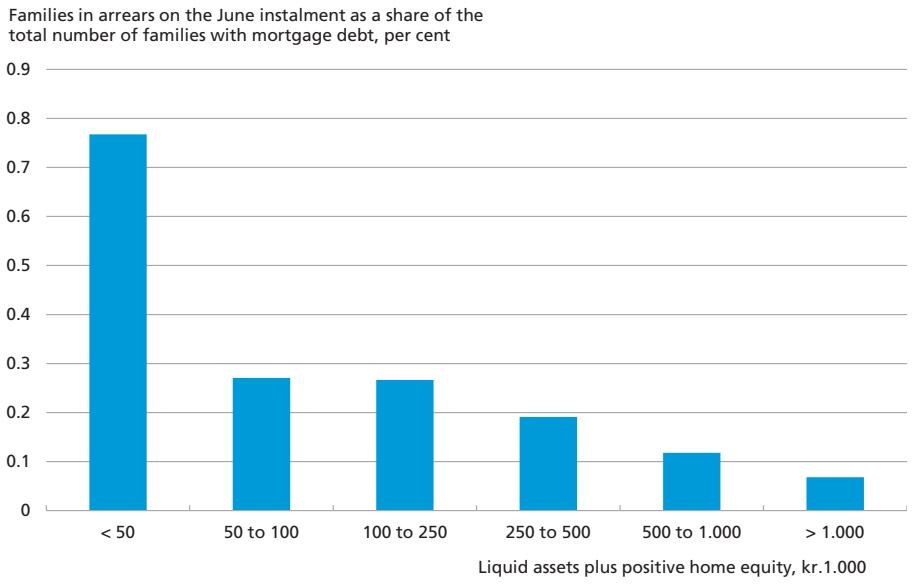
Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

on the probability of arrears for families with few or no liquid assets and home equity. To capture such a difference, we include interaction terms between the family's disposable amount per adult and the family's holding of liquid assets plus any positive home equity in its mortgaged properties.

It is easy to imagine that not only the *level* of the disposable amount, but also the *change* therein may affect whether a family falls into arrears. A family that has had a large disposable amount for several years will presumably find it more difficult to adjust to a more modest amount of a given size than a corresponding family that has not been used to such a large disposable amount. To allow for this, we include variables indicating the relative change in the family's total income after tax and interest relative to the peak in the preceding three years. Chart 14 (right) shows a clear correlation between the relative change in income and the proportion of families in mortgage arrears when no adjustment is made for other explanatory variables.

As described above, we include the family's holding of liquid assets and any positive home equity interacted with the disposable amount. Obviously, the family's holding of assets may also have a separate impact on whether the family falls into arrears, as suggested in Chart 15. We

ARREARS RATE BROKEN DOWN BY HOLDINGS OF LIQUID ASSETS PLUS POSITIVE HOME EQUITY, 2011 Chart 15



Note: Liquid assets consist of the family's deposits in banks and the market value of bonds, mortgage deeds, stocks and investment certificates in the custody of a bank. Home equity is calculated as the difference between 80 per cent of the property valuation (60 per cent for summer cottages) and the amount of mortgage debt on the property.
Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

allow for this by also including the liquid assets plus any positive home equity directly with no interaction with the disposable amount. Likewise, we also include a measure of the family's total pension wealth after tax. Large pension wealth gives the family a higher credit standing and may presumably serve as a financial buffer in some cases. This implies a lower probability of arrears. But as a general rule, pension wealth is much less liquid than other financial assets, and that could make it difficult to use in situations of financial stress. We consequently expect the amount of pension wealth to have less impact on the probability of arrears than the holding of liquid assets and home equity.

As another explanatory variable we include the family's debt service ratio. This ratio indicates the share of the family's annual income after tax that it uses to service its debt. If a family needs to spend a very large part of its disposable income to service its debt, this may cause financial difficulties, so we expect a positive relationship between the debt service ratio and the probability of arrears.

As control variables we include the age of the eldest family member, the number of children in the family, the number of years since it took up residence at the current address, and dummy variables for homeowner status, two-adult family, and higher education in the family. Besides, we include dummy variables for divorce or the death of a spouse, prolonged unemployment and illness. As explained in section 6, we assume that such social events primarily affect the probability of arrears via the resultant consequences for the family's finances. Since we have already controlled for the family's disposable amount, assets and debt service ratio, there is not necessarily any reason to expect a significant correlation between the social events and the incidence of arrears. However, the social events may have consequences that are not captured by the financial variables already included, but which impact the probability of arrears. For example, a divorce may lead to unexpected costs of separation and possibly legal assistance, while illness may entail pharmaceutical expenses, among other things. Such additional effects will be captured by the inclusion of the above dummy variables.

Finally, we include a set of dummy variables for the part of the country in which the family resides. As was the case for the social events, there is not necessarily any reason to expect a significant relationship between the geographical variables and the probability of arrears. Presumably, the primary reason why some geographical areas have a larger concentration of families in arrears than others is that the former areas have a larger share of families with tight budgets. Hence, this difference should be captured by the financial variables in our model. On the other hand, it cannot be ruled out that other geographical factors also play a

role. They might include regional differences in mentality and traditions among both mortgage banks and their local customers.[1] Any such local factors extending beyond economic differences between various parts of the country will be captured by the geographical dummy variables.

To avoid uncertainties when interpreting the results of the model, the timing of the dependent variable relative to the explanatory variables requires careful consideration. The dependent variable should thus reflect the incidence of arrears *after* the time of calculation of the explanatory variables. Otherwise there is a risk that the actual effect of the explanatory variables will not be captured by the measure used on the left-hand side of the model.[2] Since the arrears variable is based on the June instalment of a given year, while the explanatory variables are typically calculated for the entire year or at year-end, it is necessary to use data from two different years for left-hand variables and right-hand variables, respectively. If the explanatory variables are calculated for year *t*, the binary arrears variable is thus based on data from year *t*+1 in all the reported estimations.

The time lag between the dependent variable and the explanatory variables means that data from one year is "lost" in the estimations. With data for each of the three years 2009-11, data from two years is available in the estimations, i.e. *t*=2009 and *t*=2010.

Estimation results

Table 7 reports average marginal effects for the explanatory variables in the model.[3] The marginal effects indicate the change in the probability of arrears when each of the variables is changed.[4] Column 1 in the table presents the results from our preferred estimation, in which we use data from both 2009 and 2010. In columns 2 and 3 we divide the sample and estimate the model separately for each of the two years.

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1 In a study of home purchase loans in New York City, Chan et al. (2013) find that the neighbourhood characteristics affect the mortgage default rate, even when adjustment is made for differences in the characteristics of the individual borrower. The authors interpret the results as evidence of a "contagion effect", because high default rates in an area reduce the social stigma associated with defaulting on a mortgage.

2 To illustrate this, we consider a hypothetical example in which a family is subjected to income loss in October of a given year and subsequently falls into mortgage arrears. If the variable on the left-hand side of an econometric model is based on arrears on the June instalment of the *same* year, it will obviously not capture the actual effect of the income loss.

3 We do not report the actual parameter estimates in this text. The reason is that it is difficult to explicitly interpret the parameter estimates, and we consequently choose to focus on the average marginal effects. The parameter estimates can be seen in the Appendix, however.

4 For continuous variables, the marginal effect indicates the change in the probability of arrears in the event of a marginal increase in the variable concerned. For the dummy variables in the model, the marginal effect indicates the change in the probability of arrears when the dummy is changed from 0 to 1. In both cases the marginal effects are *average* effects. In other words, we started by calculating a marginal effect for each family, evaluated at the actual values of the explanatory variables for the family in question. We subsequently calculated the average for all the families included in the estimation for each variable.

AVERAGE MARGINAL EFFECTS IN PROBIT MODEL — Table 7

Percentage points	2009 and 2010	2009	2010
Variable			
Disposable amount per adult, kr. 10,000	-0.013*** (0.001)	-0.016*** (0.001)	-0.010*** (0.001)
Decrease in income after tax and interest between 0 and 10 per cent	0.001 (0.010)	-0.005 (0.014)	0.016 (0.015)
Decrease in income after tax and interest between 10 and 25 per cent	0.078*** (0.013)	0.080*** (0.018)	0.086*** (0.020)
Decrease in income after tax and interest between 25 and 50 per cent	0.320*** (0.023)	0.287*** (0.029)	0.381*** (0.037)
Decrease in income after tax and interest over 50 per cent	0.787*** (0.048)	0.717*** (0.061)	0.869*** (0.076)
Liquid assets plus positive home equity between kr. 50,000 and kr. 100,000	-0.289*** (0.020)	-0.322*** (0.028)	-0.253*** (0.029)
Liquid assets plus positive home equity between kr. 100,000 and kr. 250,000	-0.338*** (0.017)	-0.352*** (0.024)	-0.324*** (0.025)
Liquid assets plus positive home equity between kr. 250,000 and kr. 500,000	-0.420*** (0.017)	-0.426*** (0.024)	-0.412*** (0.024)
Liquid assets plus positive home equity between kr. 500,000 and kr. 1,000,000	-0.486*** (0.017)	-0.497*** (0.024)	-0.473*** (0.024)
Liquid assets plus positive home equity over kr. 1,000,000	-0.550*** (0.016)	-0.556*** (0.023)	-0.544*** (0.023)
Pension wealth after tax between kr. 50,000 and kr. 100,000	-0.016 (0.024)	-0.009 (0.034)	-0.019 (0.034)
Pension wealth after tax between kr. 100,000 and kr. 250,000	-0.061*** (0.020)	-0.084*** (0.028)	-0.029 (0.029)
Pension wealth after tax between kr. 250,000 and kr. 500,000	-0.140*** (0.020)	-0.164*** (0.029)	-0.107*** (0.029)
Pension wealth after tax between kr. 500,000 and kr. 1,000,000	-0.224*** (0.021)	-0.237*** (0.030)	-0.205*** (0.029)
Pension wealth after tax over kr. 1,000,000	-0.259*** (0.022)	-0.283*** (0.032)	-0.230*** (0.031)
Debt service ratio, per cent	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Homeowner	-0.316*** (0.011)	-0.347*** (0.016)	-0.291*** (0.016)
Two adults in the family	-0.159*** (0.010)	-0.193*** (0.015)	-0.123*** (0.014)
Age of eldest family member	0.007*** (0.000)	0.006*** (0.001)	0.007*** (0.001)
Number of children	0.099*** (0.004)	0.104*** (0.007)	0.094*** (0.006)
Higher education in the family	-0.168*** (0.010)	-0.171*** (0.014)	-0.162*** (0.014)
Number of years since taking up residence	-0.003*** (0.000)	-0.004*** (0.001)	-0.003*** (0.001)

CONTINUED Table 7

Percentage points	2009 and 2010	2009	2010
Prolonged unemployment	0.039***	0.035*	0.035*
	(0.014)	(0.020)	(0.018)
Divorce or the death of a spouse	0.190***	0.169***	0.209***
	(0.019)	(0.028)	(0.025)
Admission to hospital	0.116***	0.127***	0.103***
	(0.010)	(0.015)	(0.014)
Disbursement of sickness benefits	0.098***	0.110***	0.086***
	(0.010)	(0.015)	(0.014)
Copenhagen's environs	0.061***	0.041	0.086***
	(0.019)	(0.028)	(0.027)
North Zealand	0.075***	0.059**	0.094***
	(0.019)	(0.027)	(0.026)
East Zealand	-0.005	-0.025	0.015
	(0.035)	(0.050)	(0.047)
West and South Zealand	0.186***	0.196***	0.178***
	(0.026)	(0.038)	(0.035)
Bornholm	0.276***	0.276***	0.277***
	(0.019)	(0.027)	(0.025)
Funen	0.012	-0.024	0.049**
	(0.017)	(0.024)	(0.024)
South Jutland	0.009	0.008	0.012
	(0.016)	(0.024)	(0.022)
East Jutland	0.007	0.000	0.016
	(0.016)	(0.023)	(0.022)
West Jutland	-0.020	-0.038	0.000
	(0.018)	(0.026)	(0.024)
North Jutland	0.046***	0.038	0.055**
	(0.017)	(0.026)	(0.023)
Estimation method	Pooled probit	Probit	Probit
Year, explanatory variables	2009-10	2009	2010
Year, dependent variable	2010-11	2010	2011
Avg. estimated probability of arrears, per cent	0.31	0.33	0.29
Number of observations	1,871,562	928,865	942,697

Note: The table shows the average change in the calculated probability of arrears in the event of a change in each of the explanatory variables. For continuous explanatory variables, marginal changes are considered. For dummy variables, the change is from zero to one. The average change is calculated by first calculating the marginal effect for each family, evaluated at the actual values of the explanatory variables for the family in question. The average is then calculated for all the families included in the estimation. Standard errors are denoted in parenthesis. *, ** and *** indicate levels of statistical significance of 10, 5 and 1 per cent, respectively.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

The marginal effects have the expected signs for all variables; in most cases the statistical uncertainty is small, and, overall, the magnitude of the effects is the same in all three columns. The level of the family's annual disposable amount per adult is negatively correlated with the prob-

ability of arrears. According to our estimates, reducing the disposable amount by kr. 10,000 per adult in the family will increase the probability of arrears by approximately 0.01 percentage point for an average family. Statistically, the effect is highly significant, but from an economic point of view it is very modest. This can also be said about changes over time in the family's income after tax and interest. Families that have seen a fall in income of more than 10 per cent relative to the peak in the preceding three years have a higher probability of falling into arrears than families whose income has remained unchanged or been rising, and statistically the difference is clearly significant. If the fall in income is between 10 and 25 per cent, however, the difference only amounts to approximately 0.08 percentage point. Even a sharp drop of minimum 50 per cent will, according to our estimates, entail an average increase in the probability of arrears of only around 0.8 percentage point.

Similar results are found for the family's liquid assets plus positive home equity: These estimates show a clear statistical correlation, as families with large assets have a lower probability of falling into arrears than families with no or few liquid assets. But the difference between the top category (more than kr. 1,000,000) and the bottom category (less than kr. 50,000) only amounts to just under 0.6 percentage point. As expected, we find a similar, yet slightly weaker correlation for less liquid pension wealth. For example, the probability of arrears for families with pension wealth of more than kr. 1 million is just 0.3 percentage point lower than for families with pension wealth after tax of less than kr. 50,000.

The family's debt service ratio also has a statistically clearly significant, but economically modest, effect on the probability of the family falling into arrears. On average, the probability of arrears increases by approximately 0.002 percentage point when this ratio increases by 1 percentage point.

The marginal effects of the control variables show, among other things, that mortgage arrears are less frequent among homeowner families and families with two adults than among non-owners and singles, and that higher education is associated with a lower probability of arrears. The marginal effects of illness and divorce or the death of a spouse are clearly statistically significant. This indicates that such social events increase the probability of getting into financial difficulties, not only through their impact on the financial variables included in our model, but also through derived effects not captured by our other explanatory variables. Prolonged unemployment is also positively correlated with the probability of arrears, but the marginal effect is modest, and a highly significant result is achieved only when we use data from

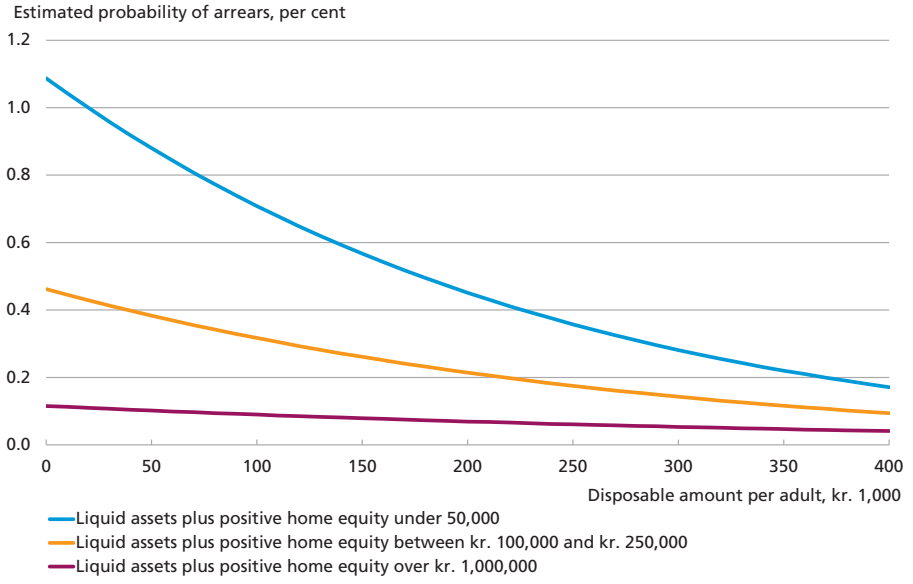
both 2009 and 2010. We interpret this as evidence that the most important effects of unemployment are captured by our key financial variables.

Finally, the estimates for the geographical variables show clear regional differences in the incidence of arrears, even when allowing for differences in the families' finances. The most pronounced cases in point are West and South Zealand and Bornholm where the probability of arrears for an average family is 0.2 and 0.3 percentage points higher, respectively, than for a family in Copenhagen with the same characteristics. It should be emphasised again that these differences cannot be explained by differences in the families' disposable amounts, debt service ratios, holdings of liquid assets and positive home equity or pension wealth, as we have controlled for precisely those factors. So the estimated regional differences must be attributed to geographical variation in conditions that are not captured by our control variables. This could be geographical patterns in the families' behaviour or variation in terms of how the mortgage banks handle the financial difficulties of customers in different parts of the country. They may also be attributable to differences in the state of the housing market: In areas with stagnant markets it may take a long time to sell a home. If they have difficulties servicing their debt, families in such areas may find it harder to solve the problems by selling their homes than families in areas with more activity in the housing market.

As mentioned, the marginal effects of the key financial variables are modest. To illustrate this, let us suppose that 10,000 randomly selected families are replaced by a corresponding number of families that are completely identical in all respects, except that their annual disposable amount is kr. 10,000 lower. According to our estimates, the expected effect will be a rise of one in the number of families in arrears. Among other things, the modest marginal effects reflect that the share of families in arrears on their mortgage debt is very small, even among those groups of families whose finances can be said to be tight.

It is worth remembering, however, that the reported effects are the *average* effects among all the families in the analysis. For some groups of families a smaller disposable amount may thus give rise to a considerably larger increase in the probability of arrears than suggested by Table 7. This is illustrated in Chart 16. Here, the average estimated probability of arrears is plotted as a function of the family's disposable amount per adult, subject to the size of the family's liquid assets plus positive home equity. Firstly, the chart illustrates that families with no or few liquid assets generally have a higher probability of falling into arrears than families holding substantial assets. In addition, the chart shows that the

DISPOSABLE AMOUNT AND ESTIMATED PROBABILITY OF ARREARS Chart 16



Note: The chart shows the average calculated probability of arrears for various combinations of disposable amount and holdings of liquid assets plus positive home equity. For each combination, an estimated probability of arrears is calculated for each individual family, given the family's other characteristics. The probability is calculated under the assumption that the family has had the disposable amount in question (or less) for minimum three years, so that the dummy variables for income loss all assume the value zero. After the probability of arrears has been calculated, the average for all families is calculated.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

impact of the disposable amount on the probability of arrears is greater, the smaller the holding of liquid assets is. For a family whose liquid assets and home equity totals less than kr. 50,000, the average calculated probability of arrears thus amounts to less than 0.2 per cent when the disposable amount exceeds kr. 370,000, but it increases to just over 1 per cent as the disposable amount approaches zero. On the other hand, the calculated probability of arrears for families with liquid assets plus positive home equity of more than kr. 1 million remains largely unchanged when the disposable amount is reduced. As expected, the relationship between the disposable amount and the probability of arrears is stronger, the smaller the holding of liquid assets and home equity is. Hence, a given change in the disposable amount will affect some families more than others.[1]

[1] In the model estimation this is reflected by the fact that the parameter estimates for the coefficients on the interaction between the disposable amount and liquid assets plus positive home equity are numerically greater for the lowest categories of liquid assets, cf. Table A.1 in the Appendix. Formal statistical tests show a clear significant difference between the coefficients on the interaction terms. A null hypothesis of identical coefficients on the first two interaction terms cannot be rejected, however. The same applies to the null hypothesis of identical coefficients on interaction terms 3, 4 and 5.

Robustness test and out-of-sample predictions

One potential problem concerning the above estimations is that the families themselves exercise some influence over the size of their disposable amount in a given year. For example, restructuring debt from mortgage loans with amortisation to deferred-amortisation loans may lead to a substantial increase in the disposable amount, and some families will also have the option of taking on extra work if they need a higher income. It seems likely that families who find it difficult to pay their mortgage debt will be more inclined to take such initiatives than other families. If the mortgage payment difficulties occurred already in year *t* – the year in which we measure the key financial variables – this may give rise to problems of reverse causality, making it hard to identify the actual effect of those key variables. As a robustness check, we therefore estimate the model without including the families who were 105 days in arrears on their mortgage debt in June of year *t.* The main results of this estimation are seen in column 2 of Table 8. To facilitate comparison with the main results of our preferred estimation, these are presented in column 1 of the table. The marginal effects reported in column 2 are generally weaker than the corresponding effects in our preferred estimation. The estimates all have the same sign in the two estimations, however, and they are also of more or less the same size in all cases. So the

MARGINAL EFFECTS IN ALTERNATIVE ESTIMATIONS — Table 8

Percentage points	Basic specification	Conditional on no arrears in year *t*	Including families who are no longer mortgage customers at end-*t+1*
Disposable amount per adult, kr. 10,000	-0.013***	-0.009***	-0.024***
	(0.001)	(0.001)	(0.001)
Decrease in income after tax and interest between 0 and 10 per cent	0.001	-0.001	-0.018
	(0.010)	(0.009)	(0.013)
Decrease in income after tax and interest between 10 and 25 per cent	0.078***	0.067***	0.119***
	(0.013)	(0.012)	(0.016)
Decrease in income after tax and interest between 25 and 50 per cent	0.320***	0.245***	0.459***
	(0.023)	(0.020)	(0.026)
Decrease in income after tax and interest over 50 per cent	0.787***	0.567***	1,127***
	(0.048)	(0.041)	(0.053)
Liquid assets plus positive home equity between kr. 50,000 and kr. 100,000	-0.289***	-0.236***	-0.477***
	(0.020)	(0.018)	(0.023)
Liquid assets plus positive home equity between kr. 100,000 and kr. 250,000	-0.338***	-0.270***	-0.537***
	(0.017)	(0.016)	(0.020)
Liquid assets plus positive home equity between kr. 250,000 and kr. 500,000	-0.420***	-0.346***	-0.631***
	(0.017)	(0.015)	(0.020)

CONTINUED Table 8

Liquid assets plus positive home equity between kr. 500,000 and kr. 1,000,000	-0.486*** (0.017)	-0.405*** (0.015)	-0.727*** (0.020)
Liquid assets plus positive home equity over kr. 1,000,000	-0.550*** (0.016)	-0.452*** (0.015)	-0.822*** (0.019)
Pension wealth after tax between kr. 50,000 and kr. 100,000	-0.016 (0.024)	-0.023 (0.021)	0.004 (0.027)
Pension wealth after tax between kr. 100,000 and kr. 250,000	-0.061*** (0.020)	-0.051*** (0.018)	-0.060*** (0.022)
Pension wealth after tax between kr. 250,000 and kr. 500,000	-0.140*** (0.020)	-0.121*** (0.018)	-0.169*** (0.023)
Pension wealth after tax between kr. 500,000 and kr. 1,000,000	-0.224*** (0.021)	-0.186*** (0.019)	-0.293*** (0.024)
Pension wealth after tax over kr. 1,000,000	-0.259*** (0.022)	-0.204*** (0.020)	-0.349*** (0.026)
Debt service ratio, per cent	0.002*** (0.000)	0.002*** (0.000)	0.003*** (0.000)
Estimation method	Pooled probit	Pooled probit	Pooled probit
Year, explanatory variables	2009-10	2009-10	2009-10
Year, dependent variable	2010-11	2010-11	2010-11
Avg. estimated probability of arrears, per	0.31	0.24	0.52
Number of observations	1,871,562	1,859,349	1,929,586

Note: The table shows the average change in the calculated probability of arrears in the event of a change in each of the explanatory variables. The calculation method is as specified in Table 7. All estimations include the same control variables as specified in Table 7. Column 1 in the table presents results based on our preferred estimation, equivalent to column 1 in Table 7. Column 2 presents the results of an estimation in which families who are in arrears in year *t* have been excluded. Column 3 presents the results of an estimation in which families who were mortgage customers at the end of year *t*, but who were no longer mortgage customers at the end of *t+1* have been included. For those families, the arrears variable in year *t+1* is set at 1 if the family was 45 days behind on its mortgage payments for the September instalment of year *t*, and otherwise at 0.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

overall picture is not changed by the exclusion of families in arrears in year *t*.

Another potential problem arises because, as previously mentioned, we only have information about existing mortgage loans at the end of the three years for which data is available. This could give rise to a selection problem. The problem is that the variable analysed, i.e. the incidence of arrears, may have a systematic impact on whether or not the loan appears in our data set. Some of the families that fall into arrears in June are likely to sell their home by the end of the year, possibly through enforced sale, so the mortgage loan in the home concerned will no longer exist at the time of calculation of our data set. In that case our data will not reflect the actual number of families in arrears, and the remaining families in the data set will not necessarily be representative of the total group of families that were mortgage custo-

mers at the beginning of the year. As a result, the estimated probability of arrears may be too low, and we may underestimate the impact of financial variables on the incidence of arrears.

To address this problem, we perform an estimation which includes all families with mortgage debt at the end of year *t* – including the families with no mortgage debt at the end of year *t*+1. The problem with the latter group is that we have no information about whether they were in arrears on the June instalment in year t+1, and this raises the question of which value the explanatory variable should take on for those families. Here, we make use of the fact that most mortgage banks have reported the incidence of 45-day arrears on the September instalment, since mortgage payment difficulties in September are likely to be positively correlated with subsequent difficulties in June. So if the above-mentioned families were in arrears by 45 days on payments exceeding kr. 1,000 for the September instalment of year *t*, we set the indicator variable for 105-day arrears in June of year *t*+1 at the value 1, and otherwise 0. The main results of this estimation can be seen in column 3 of Table 8. It shows that the number of observations increases by almost 60,000 when families with no mortgage debt at the end of year *t*+1 are included. At the same time, the average estimated probability of arrears increases to 0.52 per cent, reflecting that a relatively large share of the newly added families were 45 days in arrears on the September instalment of year *t*. The marginal effects of the financial variables are now numerically greater than before. As expected, the estimated relationship between the financial variables and the incidence of arrears is somewhat stronger when we include the families who were no longer mortgage customers at the end of year *t*+1. The difference in relation to our basic specification is not enough to materially change the conclusions, however.

A third potential problem is related to the choice of estimation method. King and Zeng (1999, 2001) demonstrate that commonly used estimation methods such as logit models and the probit model used here may produce problematic results when used to analyse the incidence of relatively rare events. Since the share of families in mortgage arrears is less than 1 per cent, this may be a relevant objection to our results.[1] We consequently performed estimations allowing explicitly for this problem as suggested by Tomz et al. (1999) and King and Zeng (1999, 2001). The results, which for the sake of brevity we have chosen not to bring here,

[1] The problem is that the methods typically underestimate the real probability of such rare events occurring. This applies primarily to analyses with few observations, however, so with approximately 1.9 million observations it is hardly a major problem in our case.

are very close to the corresponding results of the probit model and thus do not lead us to change our conclusions.

As a final test of the model properties we investigate whether the model is capable of predicting the arrears level in years which are outside the estimation period (out-of-sample predictions). Since data is available for two years only, there is limited room for making such assessments, but it does give us some idea of the quality of the model. The procedure is as follows: First we estimate the model for *t*=2009, i.e. with explanatory variables from 2009 on the right-hand side and arrears in June 2010 as the dependent variable. We then combine the parameter estimates from this estimation with the actual values of the explanatory variables for the families in 2010. For each family this results in an estimated probability of the family being in arrears by 105 days on payments exceeding kr. 1,000 for the June instalment of 2011. We can then compare these estimated probabilities with the actual arrears from June 2011. The results of this exercise are shown in Table 9. Given the actual values of the explanatory variables in 2010, the average probability of arrears is estimated at 0.26 per cent. By comparison, the actual share of families in arrears on payments for the June instalment of 2011 was 0.29 per cent. Translated into the number of families, the results are 2,448 (estimated) and 2,738 (actual), respectively. These figures should be viewed in the light of the fact that among the families included in our analysis, 0.33 per cent, or 3,030 families, were in arrears by 105 days on

OUT-OF-SAMPLE PREDICTIONS BASED ON ESTIMATION WITH T=2009 Table 9

	Expected value based on estimation with *t*=2009 and actual values of explanatory variables in 2010	Actual realised value among the families in the analysis
Share of families 105 days behind on payments in June 2011, per cent	0.26	0.29
Number of families 105 days behind on payments in June 2011	2,448	2,738
Total mortgage debt for families 105 days behind on payments in June 2011, kr. billion	2.86	3.48
Avg. probability of arrears for families 105 days behind on payments in June 2011, per cent	1.97	100.00
Avg. probability of arrears for families not 105 days behind on payments in June 2011, per cent	0.25	0.00

Note: The figures in the first column are the predicted values based on the estimates from our model with t=2009, combined with actual values of the explanatory variables in 2010. The last two rows report the average calculated probabilities of the family falling into arrears in June 2011 for two groups of families, i.e. (1) the families that were actually in arrears in June 2011, and (2) the families that were not in arrears in June 2011. If the model had been able to predict the incidence of arrears perfectly, this would have resulted in a value of 100 per cent for the first group and a value of zero for the last group.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

the June instalment of 2010. So in this case, the model provides a correct prediction of a fall in the number of families in arrears from 2010 to 2011. But the predicted fall is somewhat greater than the actual development.

If, on the other hand, we focus on the predictions of the model for the *individual* family, Table 9 clearly shows that the model is far less informative at this level. This is evident first of all when we consider the families who actually fell into arrears in June 2011. If the model had been able to make a perfect prediction, the calculated probability of arrears would have been 100 per cent for all those families. However, the average predicted probability is only 2 per cent, so the model could not have predicted that these particular families would fall into arrears. All the same, the calculated probability is higher for the families who actually fell into arrears than for those who did not. For the latter group, the average calculated probability of arrears is 0.25 per cent. A model with perfect ability to predict would have resulted in a calculated probability of arrears of 0 for this group. So all things considered, the results indicate that the model is able to provide a fair assessment of *the number of* families that can be expected to fall into arrears, but not *which* particular families. From a macroeconomic perspective, however, the first question is the most relevant one.

8. HOW ROBUST ARE DANISH FAMILIES WITH MORTGAGE DEBT?

The estimated probit model can be used to calculate the change in the probability of arrears for each family when the explanatory variables change. Hence, we can use the model to assess how the number of families in arrears will change in different scenarios for the development in the Danish economy.

As a source of inspiration for such scenarios we have chosen to focus on two historical cases in which the Danish economy was subject to particularly strong turbulence. The first case is the oil crisis in the early 1970s and covers the period from the 2nd quarter of 1973 to the 1st quarter of 1975. Both unemployment and mortgage interest rates rose considerably during this period, while stock prices and real house prices fell. The second case covers the period from the 3rd quarter of 2008 to the 2nd quarter of 2010 during the financial crisis. This period was also characterised by falling house prices and rising unemployment, supplemented by substantial drops in equity prices. In Box 7 we provide a more detailed description of each case and of the macroeconomic scenarios they inspire. It should be emphasised that it is not our intention to draw

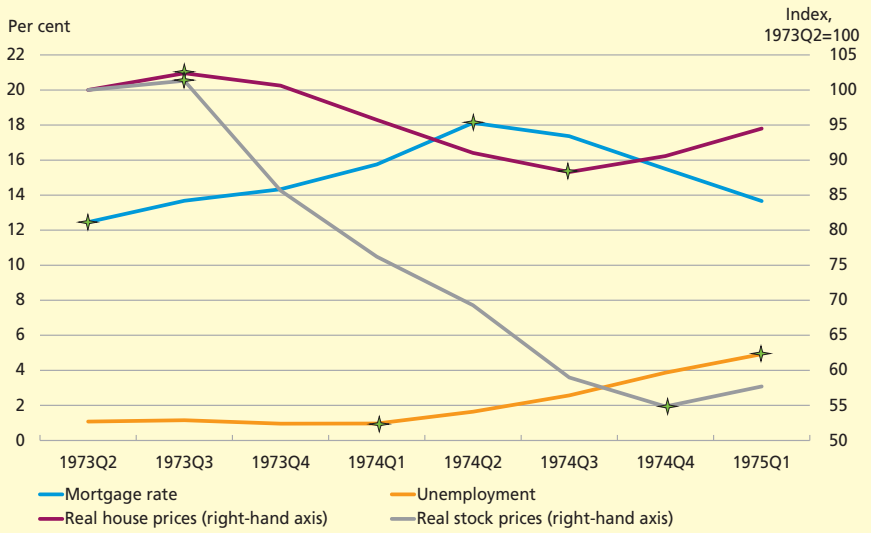
SETTING UP SCENARIOS OF DEVELOPMENT IN THE DANISH ECONOMY Box 7

We analyse the effect on the incidence of families' mortgage arrears in two scenarios. Both scenarios are based on the Danish economy in 2011. We then add hypothetical changes in four macroeconomic variables, i.e. interest rates, unemployment, house prices and stock prices. The changes are inspired by historical cases in which the Danish economy was subject to particularly strong turbulence.

Scenario 1: "Oil crisis scenario"

From the 2nd quarter of 1973 to the 2nd quarter of 1974, mortgage rates rose from approximately 12 per cent to approximately 18 per cent, cf. Chart 17. This was soon followed by a significant drop in stock prices to a level at end-1974 approximately 46 per cent below the peak in the 3rd quarter of 1973, adjusted for inflation. At the same time, real house prices fell by 14 per cent in the course of one year. After three quarters, the downturn was further aggravated as unemployment began to rise. From the trough of approximately 1 per cent of the labour force in early 1974, unemployment rose to almost 5 per cent in the course of one year.

HISTORICAL CASE 1: 2ND QUARTER OF 1973 – 1ST QUARTER OF 1975 Chart 17



Note: The stars indicate the peaks and troughs for each variable within the period under review.
Source: Danmarks Nationalbank and the MONA data bank.

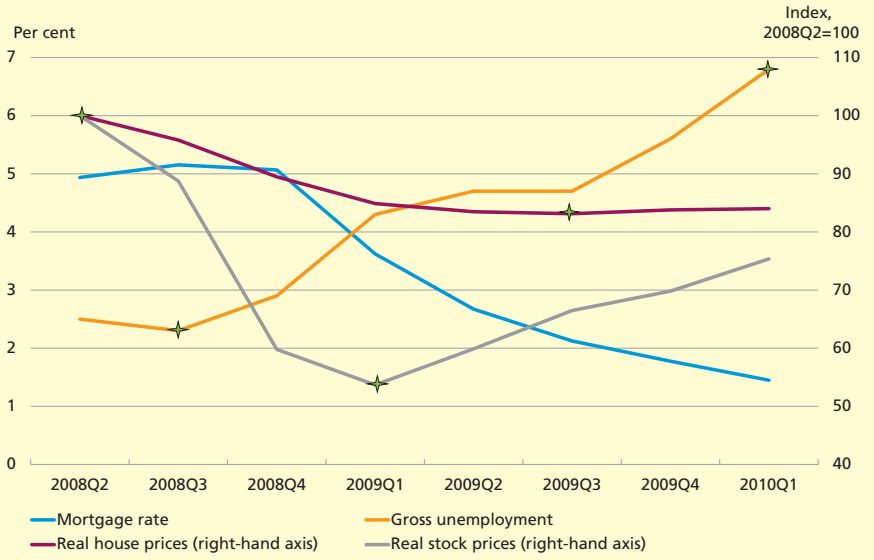
Based on developments in the early 1970s, we set up a scenario in which interest rates rise by 5.7 percentage points compared with the level at end-2011, and gross unemployment rises by 4 percentage points. At the same time, stock prices plummet by 46 per cent, while house prices fall by 14 pct.

Scenario 2: "Financial crisis scenario"

In the 3rd quarter of 2008, gross unemployment amounted to 2.3 per cent of the labour force, cf. Chart 18. 18 months later, in the 1st quarter of 2010, it had risen to 6.8 per cent. From the 2nd quarter of 2008 to the 1st quarter of 2009, stock prices, adjusted for inflation, plummeted by 46 per cent, while real house prices fell by 16.5 per cent from the 2nd quarter of 2008 to the 3rd quarter of 2009.

CONTINUED Box 7

HISTORICAL CASE 2: 2ND QUARTER OF 2008 – 1ST QUARTER OF 2010 Chart 18



Note: The stars indicate the peaks and troughs for each variable within the period under review.
Source: Danmarks Nationalbank and the MONA data bank.

Based on the above, we set up a scenario in which gross unemployment rises by 4.5 percentage points, while house prices and stock prices drop by 16.5 and 46 per cent, respectively. In the historical case serving as an inspiration to us, the changes in unemployment and stock prices described are offset by a significant drop in mortgage rates. But in view of the very low level of interest rates in 2011, it is not realistic to think that a fall of this magnitude could repeat itself. For this reason, interest rates are left unchanged in the scenario compared with the 2011 level.

direct parallels to the circumstances characterising the selected periods. The cases discussed only serve to illustrate that, historically, there have been examples of sudden concurrent changes in a number of macroeconomic variables, so it cannot be ruled out that changes of this magnitude may occur again.

Once the scenarios have been constructed, the next step is to translate the hypothetical developments in the macroeconomic variables into hypothetical values of the explanatory variables in the probit model for each family. This requires a number of assumptions concerning how the macroeconomic changes unfold at the micro level.

Changes in house and stock prices are assumed to be identical for all, so that all families experience the same percentage change in the value

of their homes and stock holdings. For the house prices, we thus ignore e.g. geographical asymmetries, which is a clear simplification. The changes in house and stock prices result in new hypothetical values for the families' holdings of liquid assets plus positive home equity.

A mortgage rate increase is assumed to affect all the families who have loans with fixed-interest periods of one year or less. However, we take into account that many variable-rate loans have interest-rate caps that limit the maximum increase in the rate of interest. For loans with fixed-interest periods of more than one year, on the other hand, the interest rate does not change unless the rate for the loan was actually adjusted in 2011. The results achieved thus reflect the immediate short-term effect of changes in the short-term mortgage rate. Furthermore, we assume that all other lending rates develop in parallel with the mortgage rate. This means that all other interest rates, including bank interest rates, change by the same number of percentage points as the mortgage rate. The change in interest rates affects payments on the families' debt, prompting calculations of hypothetical values for the disposable amount per adult, the relative change in income after tax and interest, and the debt service ratio. At the same time, it is taken into account that changing interest expenses will affect the families' tax payments.

Changes in unemployment are assumed to affect all families with the same probability, taking into account that only persons in employment can be hit by unemployment. In Box 8 we describe in more detail how a given increase in macro unemployment is modelled at the micro level. For those families who are hit by unemployment, we assume that the family's main income earner loses his/her earned income for 12 months. This is a very strong assumption which will, in many cases, not give a true and fair view of the situation for a typical family hit by unemployment. But the assumption serves as a useful benchmark, as it is a near-worst-case scenario for both the individual family and the overall effect of the rise in unemployment, cf. Box 8. The loss of earned income is assumed to be replaced by unemployment benefits if the main income earner is entitled to such benefits. This can be determined by unemployment insurance information from Statistics Denmark. For persons with no unemployment insurance, the rules on social benefits are applied to determine whether the main income earner is entitled to such benefits. The change in income prompts calculations of hypothetical values for the family's disposable amount per adult, the relative change in income after tax and interest, and the debt service ratio. When these variables are recalculated, the change in the main income earner's tax payments due to the change in income is also taken into account. In addition, the

MICROECONOMIC MODELLING OF RISING UNEMPLOYMENT Box 8

It is a particular complication of rising unemployment that it hits some families while others are unaffected. And unlike the case of interest-rate increases, we have no objective criteria for determining which families should belong to which group. Furthermore, a given rise in unemployment can be composed in many different ways. For example, a rise of 1,000 full-time equivalents may indicate that an additional 1,000 persons were unemployed throughout the year, or that 52,000 persons were unemployed for an extra week. So to translate a rise in macro unemployment to the micro level, we must determine both *how many* and *which* families are affected.

In the macroeconomic scenarios, the rise in unemployment is formulated as a change in the unemployment rate for the entire labour force. The first step is to translate this change into a number of full-time equivalents. This is done by multiplying the change in the unemployment rate by the number of persons in the labour force among the families included in the analysis.

The next step is to determine how to distribute the rise in the number of unemployed full-time equivalents on families. First, we assume that no more than one person in each family is hit by unemployment, thereby disregarding the possibility that both adults in a family may be hit by unemployment at the same time, which is obviously a simplification. Given this limitation, we must then determine whether the rise in unemployment should be composed as a short period of unemployment distributed on many families, or whether it should rather be modelled as a long period of unemployment for a smaller number of families. In order not to underestimate the importance of rising unemployment, we choose an approach that maximises the expected effect on the number of families in arrears. Consequently, we assume that the number of affected families is equivalent to the rise in unemployment in full-time equivalents. This means that a rise in unemployment of, say, 1,000 full-time equivalents is modelled by taking 1,000 families and having one person in each family who is unemployed throughout the year. This concentrates the rise in unemployment on a limited number of families, producing – due to the non-linear relationship between the disposable amount and the probability of arrears in the probit model – a greater overall effect than if the rise was spread over a larger number of families. To increase the effect, we also assume that in each of the affected families it is the person with the highest income who becomes unemployed. Based on these assumptions, we calculate the change in the arrears probability for each family hit by unemployment.

Finally, we must determine which families will be affected. By definition, it is only possible for persons in employment to become unemployed. Consequently, we assume that only families in which the main income earner was in full employment in 2011 can potentially be hit by unemployment. This is defined by the main income earner not having been unemployed, not having received pension, early retirement benefits, disability pension, sickness or maternity benefits, social benefits, unemployment benefits or student grants, and having a positive earned income. For the sake of simplicity, we also assume that the probability of being affected by unemployment is the same for all families in this category. Technically, the expected isolated effect of rising unemployment can then be calculated as follows: Let y_i^l denote the estimated probability of arrears for family *i* if the family is hit by unemployment, and let y_i^b denote the corresponding probability if the family is not hit by unemployment. The total effect of rising unemployment is then given by

CONTINUED Box 8

$$\sum_{i \in D} \delta_i (y_i^l - y_i^b)$$

where *D* is the number of families that can potentially be hit by unemployment, and δ_i is an indicator variable that assumes the value 1 if the family is hit by unemployment, and otherwise 0. Obviously, the exact value of the above expression depends on which families are hit by unemployment. But assuming that the probability is the same for all families, it is easy to calculate the *expected* value of the expression. Let that *n* denote the number of families to be hit by unemployment (equivalent to the rise in the number of full-time equivalents), and let that *N* denote the number of families that can potentially be hit. The expected effect of the rise in unemployment can then be calculated as

$$\frac{n}{N} \sum_{i \in D} (y_i^l - y_i^b).$$

The total expected effect on the number of families in arrears is then obtained by adding up the value of the above expression and the estimated effects of the other changes in the scenario.

dummy variable for prolonged unemployment is set at the value 1 when the family is hit by unemployment.

Overall, for each scenario, hypothetical values are calculated for five financial variables, i.e. the family's disposable amount per adult, the relative change in income after tax and interest, holdings of liquid assets plus positive home equity, the debt service ratio and the dummy variable for prolonged unemployment. All the other explanatory variables are assumed to be unchanged in relation to their actual values in 2011.[1]

The latter assumption entails that the families' wealth is not affected by changes in savings behaviour. This is clearly a simplifying assumption. Thus, in the event of a prolonged period of financial adversity, many families are likely to use their liquid assets and/or to borrow against any positive home equity, which will gradually reduce such assets. But it is extremely difficult to set realistic assumptions on how fast this process would be for each family, and we consequently disregard this effect. Coupled with the assumption that only loans with

[1] Therefore, the calculations should, strictly speaking, be viewed as a counterfactual assessment of the way the number of families in arrears would have developed if the Danish economy had been exposed to the described scenarios in 2011. But they could also reasonably be regarded as an assessment of the expected development in the incidence of arrears if the developments in the scenarios should occur today.

short fixed-interest periods are affected by the interest-rate changes this means that the changes in the explanatory variables should be perceived as the *immediate* consequences of the macroeconomic assumptions in the scenarios.

The hypothetical values of the explanatory variables can be combined with the parameter values from the estimated probit model so that we can calculate hypothetical probabilities of arrears for each family. The hypothetical probabilities can then be compared with corresponding probabilities based on the actual values of the explanatory variables. The difference between the two probabilities indicates the change in the family's probability of arrears in the scenario concerned. By aggregating this difference for all families in 2011, we achieve a measure of the expected rise in the number of families in arrears. Again, this is the *immediate* effect of the macroeconomic assumptions described.

In Table 10 we outline each of the two scenarios. The first scenario, in which both unemployment and interest rates are rising, while house prices and stock prices are going down, includes approximately 52,000 families who are hit by unemployment. For these families the average disposable amount per adult is reduced by approximately kr. 115,000, while the debt service ratio increases by almost 16 percentage points for the typical family in this group. For the families that are not hit by unemployment, the annual disposable amount is reduced by approximately kr. 16,000 on average. The average holdings of liquid assets plus positive home equity fall by around kr. 140,000 in this scenario. The changes in the families' financial position result in an increase in the average calculated probability of arrears of 2.1 percentage points for the families hit by unemployment and 0.2 percentage point for the rest. The expected number of families in arrears on payments for the June instalment consequently increases by around 2,800. The total mortgage debt for families in arrears by 105 days is expected to increase by kr. 5.3 billion. In relative terms, these figures are fairly large, representing almost a doubling of the arrears level. But in absolute terms, the effects are very modest. According to our calculations, total mortgage debt for the families in arrears will still amount to less than 1 per cent of total mortgage lending to households.

In scenario 2, the changes in unemployment and house prices are slightly greater than in scenario 1, while the change in real stock prices is the same. On the other hand, the interest-rate level is now assumed to remain unchanged. Overall, this results in less pronounced effects than in scenario 1. Hence, the expected rise in the number of families in arrears is now approximately 1,200. The difference in relation to scenario 1 reflects that changes in the level of interest rates have a fairly large im-

EXPECTED EFFECTS IN SCENARIOS — Table 10

	Scenario 1	Scenario 2
Macroeconomic assumptions		
Change in interest rates, percentage points	5.7	0.0
Change in gross unemployment, percentage points	4.0	4.5
Change in house prices, per cent	-14.0	-16.5
Change in stock prices, per cent	-46.0	-46.0
Changes in explanatory variables		
Number of families hit by unemployment	51,804	58,280
Average change in annual disposable amount per adult if the family is not hit by unemployment, kr.	-15,922	0
Average change in the annual disposable amount per adult if the family is hit by unemployment, kr.	-114,616	-94,752
Median change in debt service ratio if the family is not hit by unemployment, percentage points[1]	5.2	0
Median change in debt service ratio, if the family is hit by unemployment, percentage points[1]	15.6	5.95
Average change in holding of liquid assets plus positive home equity, kr.	-140,918	-158,679
Expected consequences		
Average change in probability of arrears for families not hit by unemployment, percentage points	0.19	0.04
Average change in probability of arrears for families hit by unemployment, percentage points	2.06	1.47
Average change in probability of arrears for all families taken as one, percentage points	0.29	0.13
Expected increase in the number of families in arrears by 105 days on the June instalment	2,816	1,236
Expected increase in total mortgage debt for families in arrears by 105 days on the June instalment, kr. billion	5.28	1.83

Note: The probabilities of arrears in each scenario are calculated by combining the parameter estimates from column 1 of Table A.1 with hypothetical values of the explanatory variables. The changes in the probabilities are measured in relation to a baseline scenario where the same parameter estimates are combined with the actual values of the explanatory variables in 2011. In the baseline scenario the average probability of arrears is 0.36 per cent, the expected number of families in arrears is 3,621, and the expected size of the total mortgage debt of the families in arrears is kr. 3.9 billion.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

[1] Both scenarios include a few families for whom the hypothetical income after tax will be very small when the main income earner of the family is assumed to be hit by unemployment. This results in very high debt service ratios for those families. Accordingly, the average value of this variable is not very informative, and we consequently report the median changes instead.

pact on the arrears rate, at least when compared with the other macroeconomic variables we have focused on.

In view of the magnitude of the macroeconomic changes in the two scenarios, the impact on the arrears level is very modest. This is because the coefficient estimates for the key financial variables in our preferred version of the probit model are numerically small. Accordingly, the estimated probability of arrears for a given family does not change very much when the values of the key financial variables change. As described in section 7, the estimates increase somewhat if instead we use a version of the probit model which includes the families who are no longer mortgage customers at the end of year t+1 in the analysis. But

even if we use these estimates instead, the expected consequences in the scenarios are still limited. In scenario 1, the expected number of families in arrears now increases by approximately 4,000, while the expected increase in scenario 2 is 1,600 families.

It is worth noting that the modest effects in the scenarios are in accordance with actual experience from recent years. Despite an unusually sudden slowdown in the Danish economy, the increase in the arrears level from 2008 to 2009 was moderate, and the aggregate arrears rate never reached the level of the early 1990s. Coupled with the microdata analyses in this article, this strengthens the presumption that even severe setbacks in the Danish economy will not lead to a surge in the number of families in arrears.

The question remains of why mortgage arrears are so much less common today than in the early 1990s. Since that period is not covered by our microdata for the incidence of arrears, it is hard to give a firm answer to this. Presumably, a number of different factors each contribute to explaining the difference. Firstly, the introduction of new loan types such as adjustable-rate loans and loans with deferred amortisation has given mortgage customers new opportunities to adjust to economic changes. Undoubtedly, this is also one of the reasons why some families have found it easier to cope with temporary periods of tight finances. Moreover, in 1992, access was granted to free mortgaging of the home within the 80 per cent limit of the property value. This enabled homeowners to draw on any positive home equity in case of temporary financial problems. In 1993, mortgage banks were again given access to provide 30-year fixed-rate annuity loans for owner-occupied dwellings. Since 1986, borrowing had taken place via 20-year mixed loans. In addition, mortgage banks tightened the procedures for customers in financial difficulties in the early 1990s. This may have contributed to a change in behaviour among some mortgage customers, since the consequences of defaulting on loans were now greater and set in more quickly.

Finally, there is a third potential explanation, which is related to the duration of the macroeconomic recession. The downturn in the late 1980s and early 1990s was the longest downturn in the Danish economy in the last 200 years, cf. Abildgren et al. (2011). A number of families therefore experienced a prolonged period of financial squeeze in those years, and, as previously mentioned, declining inflation and the tax reform in the mid-1980s contributed to a sharp increase in real after-tax interest rates. Undoubtedly, many homeowners' holdings of liquid assets were heavily reduced as a result of this. As stated, our calculations should be regarded as an assessment of the immediate effects of a sudden slowdown in the economy. On the other hand, it is extremely diffi-

cult to allow for the potential long-term effects resulting from the gradual wearing down of the families' financial buffers. Against this background it could be argued that in the longer term the number of families in arrears would rise more than envisaged in our results if the Danish economy were to be affected by a downturn of the same duration as in the early 1990s.

Another possible objection to our results is that non-linear effects of changes in the financial variables and/or interaction effects between different variables may exist which are not properly captured by our model. If the effects of various negative shocks to the economy reinforce each other in a way that the model does not take into account, there is a risk that our analysis underestimates the overall effect on the probability of arrears.

The above objections are both fair and relevant, but in our opinion neither has the potential to seriously change the main conclusion of the analysis: that even severe economic setbacks will lead to only a limited rise in the number of families in mortgage arrears. We therefore expect the arrears rate to remain at a considerably lower level than in the early 1990s, even in the event of a prolonged setback in the Danish economy.

In summary, we can conclude that the vast majority of Danish families service their mortgage loans on time – even when their finances become tighter. So a sharp increase in the incidence of mortgage arrears is not likely, and the threat to the credibility of mortgage bonds from that quarter is limited. However, this does not imply that the families' financial behaviour is immaterial to the overall credit risk in the mortgage credit sector. In an analysis of household consumption decisions, Bang-Andersen et al. (2013) find that private consumption responds strongly to changes in both house prices and the level of interest rates. A decline in private consumption will weaken Danish firms, potentially leading to increased losses on lending by mortgage banks to the corporate sector.

In addition, it is important to make it clear that we have solely reviewed the consequences for mortgage arrears. Hence, our results do not say anything about the expected consequences for the families' compliance with their debt commitments to e.g. banks. By combining the macroeconomic assumptions in our scenario 1 with estimation results from Abildgren and Damgaard (2012), it is possible to calculate an expected immediate increase in banks' loan impairment charges on lending to private households of approximately 1 per cent of total lending. The corresponding figure for scenario 2 is 1.2 per cent. Judging from these estimates, the consequences for banks will be considerably greater than for mortgage banks.

9. FROM DEFAULT TO MAINTENANCE – WHO MANAGE TO RESOLVE THEIR ARREARS?

Among the families included in our analyses, approximately 2,300 were 105 days behind on payments exceeding kr. 1,000 for the June instalment of 2010, but not on payments for the June instalment of 2009. Just under half of them were still mortgage customers at the end of 2011, and in 668 cases, the financial difficulties seemed to have been resolved as the family was not in arrears by 105 days on the June instalment of 2011. In contrast, 371 families had serious financial difficulties again in 2011, while 1,271 families were no longer mortgage customers at the end of the following year.

Why do some families manage to resolve their financial difficulties, while others do not? One obvious explanation could be that the difficulties were initially less serious for the former group. Indeed, this appears to be the case, since the average arrears amounts in 2010 were lower for the families with no arrears on the June instalment of 2011 than for the other families, cf. Table 11. For a larger proportion of the former families, the problems also appear to have been of short dur-

ARREARS STATUS IN 2011, INCOME DEVELOPMENT AND STRUCTURE OF DEBT FOR FAMILIES IN ARREARS ON THE JUNE INSTALMENT OF 2010 Table 11

	Families with mortgage loans at end-2011, not in arrears in June 2011	Families with mortgage loans at end-2011, in arrears in June 2011	Families with no mortgage loans at end-2011
Number of families	668	371	1,271
Avg. amount of arrears in June 2010, kr.	17,446	21,454	18,755
Share in arrears by 45 days on the September instalment of 2010, per cent	68.7	85.4	93.9
Avg. income after tax in 2009, kr.[1]	338,520	333,083	264,852
Avg. income after tax in 2011, kr.[1]	363,298	349,725	257,008
Share with adjustable rates on min. 50 per cent of mortgage debt at end-2009, per cent[1]	50.5	47.6	38.8
Share with adjustable rates on min. 50 per cent of mortgage debt at end-2011, per cent[1]	56.4	47.6	-
Share with deferred amortisation on min. 50 per cent of mortgage debt at end-2009, per cent[1]	44.6	54.3	55.3
Share with deferred amortisation on min. 50 per cent of mortgage debt at end-2011, per cent[1]	48.9	52.4	-

Note: Only families in arrears by 105 days on payments exceeding kr. 1,000 for the June instalment of 2010 are included. This is also conditional on the family being a mortgage customer at the end of 2009, and that it was not 105 days behind on its payments for the June instalment of that year. Families with members who are self-employed or not liable to tax are not included. The same applies to families with an annual income after tax of less than kr. 25,000 in 2010.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.

[1] Only families in which the composition of adult members is the same in 2009 and 2011 are included.

ation: 31 per cent of the families in this group were not in arrears by 45 days on the September instalment of 2010, even though they were more than three and a half months behind with the June mortgage payments in the same year. Among the remaining families, this only applied to around 15 per cent of the families who were still mortgage customers at end-2011, and only to around 6 per cent of the families who no longer had mortgage loans.

Another possible explanation is changes in the family's income. A comparison of income after tax in 2009 (i.e. the year *before* the family fell into arrears) with income after tax in 2011 (i.e. the year *after* the family fell into arrears) shows clear differences between the three groups of families in arrears. The families who managed to resolve their problems experienced an *increase* in their average income after tax of 7.3 per cent. For the families who found themselves in serious financial difficulties again in 2011, the average income increased by 5 per cent, while the families who were no longer mortgage customers at end-2011 experienced a *fall* in their average income after tax of 3 per cent.

Finally, there are indications that converting mortgage debt to other loan types may make a difference in terms of whether a family is able to resolve its financial difficulties. This can be seen e.g. by considering how large a share of the families in each of the three groups had adjustable-rate loans for more than half of their mortgage debt in 2011 compared with the corresponding share in 2009. Among the families who reverted to making their payments on time, this share rose from 51 per cent to 56 per cent over the two-year period. Among the families who continued to have payment problems, the share with adjustable-rate loans for more than half of their mortgage debt did not increase, however.

A similar difference applies to the use of deferred-amortisation loans. The share of families with deferred-amortisation loans for at least half of their debt increased considerably in the group who managed to resolve their problems, while the share was more or less unchanged for families with continued payment problems. Part of the explanation is that the use of deferred-amortisation loans was already more widespread in the latter group than in the former group in 2009, i.e. *before* the payment problems arose. Hence, the differences between the two groups indicate that the option of deferred amortisation may very well contribute to resolving sudden difficulties in servicing their mortgage loans – but only if the family did not fully exploit this option before the problems occurred.

10. LITERATURE

Abildgren, Kim, Birgitte Vølund Buchholst, Atef Qureshi and Jonas Staghøj (2011), Real economic consequences of financial crises, Danmarks Nationalbank, *Monetary Review*, 3rd Quarter, Part 2.

Abildgren, Kim and Jannick Damgaard (2012), Models for banks' loan impairment charges in stress tests of the financial system, Danmarks Nationalbank, *Monetary Review*, 1st Quarter, Part 2.

Abildgren, Kim and Andreas Kuchler (2013), Banks, credit and business cycles, Danmarks Nationalbank, *Monetary Review*, 2nd Quarter, Part 2.

Alfaro, Rodrigo, Natalia Gallardo and Roberto Stein (2010), The determinants of household debt default, Central Bank of Chile, *Working Paper*, No. 574.

Andersen, Asger Lau, Anders Møller Christensen, Nick Fabrin Nielsen, Sigrid Alexandra Koob, Martin Oxbjerg and Ri Kaarup (2012a), The wealth and debt of Danish families, Danmarks Nationalbank, *Monetary Review*, 2nd Quarter, part 2.

Andersen, Asger Lau, Anders Møller Christensen, Charlotte Duus and Ri Kaarup (2012b), Danish families' financial robustness, variable rates and amortisation, Danmarks Nationalbank, *Monetary Review*, 4th Quarter, Part 2.

Aron, Janine and John Muellbauer (2010), Modelling and forecasting UK mortgage arrears and possessions, *SERC discussion paper*, No. 52.

Bajari, Patrick, Chenghuan Sean Chu and Minjung Park (2008), An empirical model of subprime mortgage default from 2000 to 2007, *NBER Working Paper Series*, No. 14625.

Bang-Andersen, Jens, Tina Saaby Hvolbøl, Paul Lassenius Kramp and Casper Ristorp Thomsen (2013), Consumption, income and wealth, Danmarks Nationalbank, *Monetary Review*, 2nd Quarter, Part 2.

Chan, Sewin, Michael Gedal, Vicki Been and Andrew Haughwout (2013), The role of neighborhood characteristics in mortgage default risk: Evidence from New York City, *Journal of Housing Economics* (2013).

Chatterjee, Satyajit, Dean Corbae, Makoto Nakajima and José-Victor Ríos-Rull (2007), A quantitative theory of unsecured consumer credit with risk of default, *Econometrica*, Vol. 75, No. 6.

Cohen-Cole, Ethan and Jonathan Morse (2010), Your house or your credit card, which would you choose? Personal delinquency tradeoffs and precautionary liquidity motives, Federal Reserve Bank of Boston, *Quantitative Analysis Unit Working Paper*, No. QAU09-5.

D'Alessio, Giovanni and Stefano Iezzi (2013), Household over-indebtedness: definition and measurement with Italian data, Banca d'Italia, *Occasional Papers*, No. 149.

Duygan-Bump, Burcu and Charles Grant (2009), Household debt repayment behaviour: what role do institutions play?, *Economic Policy 24,* No. 57.

Elul, Ronel, Nicholas S. Souleles, Souphala Chomisengphet, Dennis Glennon and Robert Hunt (2010), What "triggers" mortgage default, *American Economic Review: Papers and Proceedings 100*.

Danish Ministry of Business and Growth (2013), *Vækstpolitisk Tema No. 2*: Gældsudgifter i husholdninger med realkreditlån (Debt expenses in households with mortgage loans – in Danish only).

Fay, Scott, Erik Hurst and Michelle J. White (2002), The household bankruptcy decision, *The American Economic Review*, Vol. 92, No. 3.

Danish Financial Supervisory Authority (2011), Banker og realkreditinstitutter, Undersøgelse af inkassosager 2011 (Banks and mortgage banks, survey of collection cases 2011 – in Danish only).

Gathergood, John (2009), Income shocks, mortgage repayment risk and financial distress among UK households, *Centre for Finance and Credit Markets working paper 09/03*, University of Nottingham.

Gundersen, Poul, Stig Secher Hesselberg and Sean Hove (2011), Danish mortgage credit, Danmarks Nationalbank, *Monetary Review*, 4th Quarter, Part 1.

Kehoe, Timothy J. and David K. Levine (2001), Liquidity constrained markets versus debt constrained markets, *Econometrica*, Vol. 69, No. 3.

King, Gary and Langche Zeng (1999), Estimating absolute, relative, and attributable risks in case-control studies, Department of Government, Harvard University, http://GKing.Harvard.Edu.

King, Gary and Langche Zeng (2001), Logistic regression in rare events data, *Political Analysis*, No. 9(2).

Li, Wenli, Michelle J. White and Ning Zhu (2011), Did bankruptcy reform cause mortgage default to rise?, *American Economic Journal: Economic Policy*, No. 3.

Livshits, Igor, James MacGee and Michèle Tertilt (2007), Accounting for the rise in consumer bankruptcies, *NBER Working Paper Series*, No. 13363.

Lydon, Reamonn and Yvonne McCarthy (2011), What lies beneath? Understanding recent trends in Irish mortgage arrears, Central Bank of Ireland, *Research Technical Paper*.

Mayer, Christopher, Karen Pence and Shane M. Sherlund (2009), The rise in mortgage defaults, *Journal of Economic Perspectives*, Vol. 23, No. 1.

Tomz, Michael, Gary King and Langche Zeng (1999), RELOGIT: Rare events logistic regression, Version 1.1, Cambridge, MA: Harvard University, October 1, http://gking.harvard.edu/.

Wooldridge, Jeffrey M. (2002), Econometric analysis of cross section and panel data, The MIT Press, Cambridge, Massachusetts.

APPENDIX

PARAMETER ESTIMATES IN PROBIT MODEL — Table A.1

	2009 and 2010	2009	2010
Disposable amount per adult, kr. 10,000			
x liquid assets plus positive home equity under kr. 50,000	-0.017*** (0.001)	-0.021*** (0.002)	-0.013*** (0.002)
x liquid assets plus positive home equity between kr. 50,000 and kr. 100,000	-0.020*** (0.002)	-0.023*** (0.003)	-0.019*** (0.003)
x liquid assets plus positive home equity between kr. 100,000 and kr. 250,000	-0.013*** (0.002)	-0.015*** (0.002)	-0.012*** (0.002)
x liquid assets plus positive home equity between kr. 250,000 and kr. 500,000	-0.015*** (0.002)	-0.018*** (0.003)	-0.013*** (0.002)
x liquid assets plus positive home equity between kr. 500,000 and kr. 1,000,000	-0.014*** (0.002)	-0.019*** (0.003)	-0.010*** (0.002)
x liquid assets plus positive home equity over kr. 1,000,000	-0.008*** (0.002)	-0.010*** (0.002)	-0.006*** (0.002)
Decrease in income after tax and interest between 0 and 10 per cent	0.001 (0.015)	-0.007 (0.021)	0.023 (0.022)
Decrease in income after tax and interest between 10 and 25 per cent	0.100*** (0.016)	0.101*** (0.021)	0.115*** (0.024)
Decrease in income after tax and interest between 25 and 50 per cent	0.314*** (0.017)	0.284*** (0.023)	0.364*** (0.025)
Decrease in income after tax and interest over 50 per cent	0.557*** (0.021)	0.518*** (0.029)	0.601*** (0.031)
Liquid assets plus positive home equity between kr. 50,000 and kr. 100,000	-0.177*** (0.039)	-0.221*** (0.054)	-0.108* (0.056)
Liquid assets plus positive home equity between kr. 100,000 and kr. 250,000	-0.324*** (0.031)	-0.365*** (0.045)	-0.278*** (0.045)
Liquid assets plus positive home equity between kr. 250,000 and kr. 500,000	-0.408*** (0.033)	-0.420*** (0.045)	-0.388*** (0.048)
Liquid assets plus positive home equity between kr. 500,000 and kr. 1,000,000	-0.542*** (0.033)	-0.533*** (0.047)	-0.539*** (0.048)
Liquid assets plus positive home equity over kr. 1,000,000	-0.792*** (0.035)	-0.784*** (0.049)	-0.802*** (0.051)
Pension wealth after tax between kr. 50,000 and kr. 100,000	-0.015 (0.022)	-0.008 (0.029)	-0.018 (0.033)
Pension wealth after tax between kr. 100,000 and kr. 250,000	-0.057*** (0.018)	-0.076*** (0.024)	-0.028 (0.027)
Pension wealth after tax between kr. 250,000 and kr. 500,000	-0.145*** (0.019)	-0.164*** (0.026)	-0.115*** (0.028)
Pension wealth after tax between kr. 500,000 and kr. 1,000,000	-0.265*** (0.022)	-0.266*** (0.030)	-0.259*** (0.032)
Pension wealth after tax over kr. 1,000,000	-0.328*** (0.027)	-0.345*** (0.038)	-0.307*** (0.038)
Debt service ratio, per cent	0.003*** (0.000)	0.002*** (0.000)	0.003*** (0.000)
Homeowner	-0.388*** (0.013)	-0.407*** (0.018)	-0.375*** (0.020)
Two adults in the family	-0.195*** (0.012)	-0.226*** (0.017)	-0.159*** (0.018)

CONTINUED Table A.1

	2009 and 2010	2009	2010
Age of eldest family member	0.008***	0.008***	0.009***
	(0.000)	(0.001)	(0.001)
Number of children	0.121***	0.122***	0.122***
	(0.005)	(0.007)	(0.008)
Higher education in the family	-0.206***	-0.201***	-0.209***
	(0.012)	(0.017)	(0.017)
Number of years since taking up residence	-0.004***	-0.005***	-0.004***
	(0.001)	(0.001)	(0.001)
Prolonged unemployment	0.048***	0.041*	0.045*
	(0.017)	(0.024)	(0.024)
Divorce or the death of a spouse	0.233***	0.198***	0.270***
	(0.023)	(0.032)	(0.032)
Admission to hospital	0.142***	0.149***	0.133***
	(0.013)	(0.018)	(0.018)
Disbursement of sickness benefits	0.120***	0.129***	0.111***
	(0.012)	(0.017)	(0.018)
Copenhagen's environs	0.085***	0.054	0.125***
	(0.027)	(0.036)	(0.039)
North Zealand	0.101***	0.075**	0.136***
	(0.026)	(0.035)	(0.038)
East Zealand	-0.008	-0.036	0.025
	(0.054)	(0.076)	(0.077)
West and South Zealand	0.216***	0.210***	0.228***
	(0.028)	(0.038)	(0.042)
Bornholm	0.291***	0.273***	0.316***
	(0.022)	(0.030)	(0.034)
Funen	0.018	-0.035	0.077**
	(0.026)	(0.035)	(0.039)
South Jutland	0.013	0.012	0.020
	(0.025)	(0.034)	(0.037)
East Jutland	0.011	0.000	0.027
	(0.024)	(0.033)	(0.036)
West Jutland	-0.031	-0.057	0.001
	(0.028)	(0.039)	(0.042)
North Jutland	0.065***	0.050	0.086**
	(0.025)	(0.034)	(0.037)
Constant	-2.248***	-2.087***	-2.438***
	(0.041)	(0.056)	(0.060)
Estimation method	Pooled probit	Probit	Probit
Year, explanatory variables	2009-10	2009	2010
Year, dependent variable	2010-11	2010	2011
Number of observations	1,871,562	928,865	942,697

Note: The table indicates the coefficient estimates in the probit model described in section 7. Standard errors are denoted in parenthesis. *, ** and *** indicate levels of statistical significance of 10, 5 and 1 per cent, respectively.

Source: Own calculations based on data from mortgage banks and from Statistics Denmark.