ANALYSIS

LOW FOR LONG

DANMARKS NATIONALBANK

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What's the story behind Danish households' rising debt?

- A new measure of households' structural debt level indicates that higher debt is linked to rising wealth, higher incomes and lower borrowing costs. Over the course of four decades, lower interest rates and regulatory easing have contributed to higher debt levels.

- Up to the financial crisis, debt accumulated faster than the development of the underlying incomes, interest rates and wealth. The development attests that large imbalances may emerge quickly. The subsequent consolidation, where households have been using their rising incomes to save rather than consume, has taken time.

- Risks might be building up even when the aggregate credit level can be explained by structural factors. The general trend may conceal significant differences among households. Some households may incur heavy debt burdens, although the overall debt level is only rising moderately.

Lower interest rates

Decreasing interest rates have supported higher debt relative to income

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More lenient regulation

New regulatory measure shows the impact of regulation on borrowing costs

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Rising wealth

Increasing housing wealth and pension savings have contributed to higher debt

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LOW FOR LONG

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Denmark was the first country to introduce negative monetary policy rates in 2012. Since then, Switzerland, Sweden, Japan and the euro area have followed suit.

Very low and in some cases negative interest rates have characterised the past decade across the advanced economies. There are several reasons why interest rates have fallen to the current low levels. Low interest rates reflect the fact that inflation has been subdued in many countries, but structural changes in household and corporate savings and investment behaviour are also part of the explanation.

These developments have brought monetary policy and the economy into uncharted waters, which is why Danmarks Nationalbank will be issuing a series of analyses on the topic.

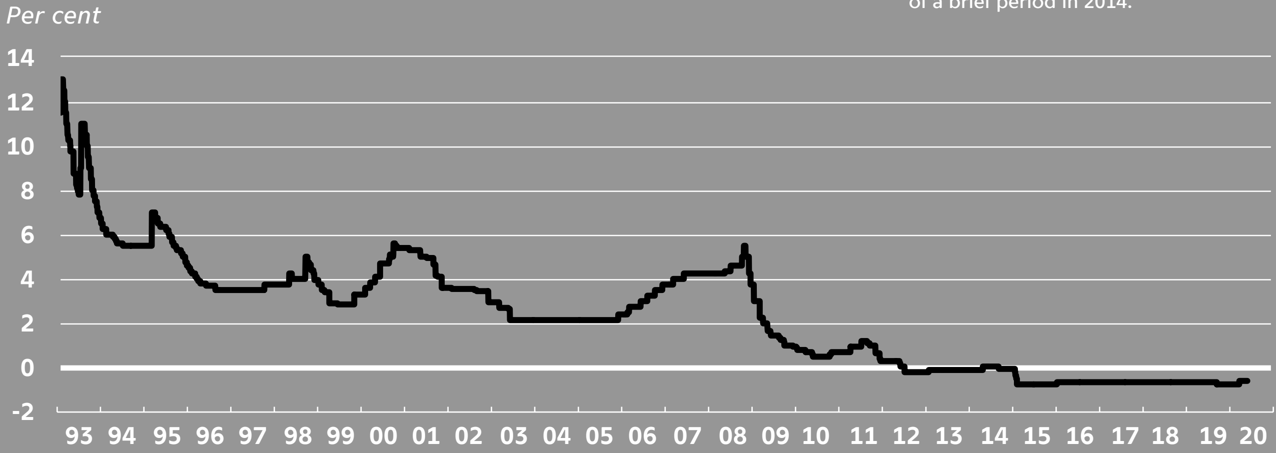
What's the story behind Danish households' rising debt levels?

Danes' debt levels have risen significantly over the past decades, but at the same time, incomes and wealth have also increased, while interest rates have gone down.

Rising debt not only reflects temporary fluctuations in the economy, such as the extensive house price growth prior to the financial crisis. Structural factors such as lower interest rates are also part of the explanation for the development.

Danmarks Nationalbank's interest rate

Danmarks Nationalbank's key interest rate has been negative since the summer of 2012, with the exception of a brief period in 2014.



Higher debt reflects higher incomes, greater assets and lower borrowing costs

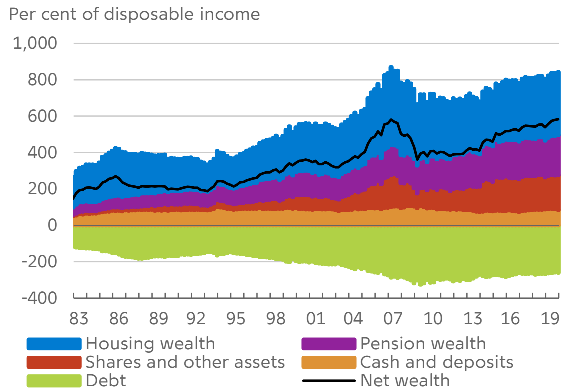
High debt levels and heavy debt accumulation can both be associated with greater fluctuations in GDP and private consumption and have implications for financial stability.[1] Danish household debt has risen dramatically in recent decades. The debt increase has coincided with rising household wealth and disposable income. However, over the past four decades, debt has increased significantly faster than incomes and today accounts for 260 per cent of the disposable income of Danish households, see Chart 1.

The development may be due to a number of temporary cyclical conditions, such as a sharp rise in house prices and housing wealth, as observed in the run-up to the financial crisis. At the same time, however, the credit level is also affected by structural conditions such as regulatory changes or structurally lower interest rates.[2]

The question of whether the development may be explained by temporary fluctuations (cyclical conditions) or structural conditions (trend) is key to the assessment of the macroeconomic development. For example, rapid credit growth – exceeding the rate that the structural economic conditions would imply – may indicate the build up of imbalances in economic development. In order to answer this question, it is necessary to distinguish between the cyclical part and the structural part of the development. This can be done by calculating a structural level of credit. The structural credit level cannot be observed directly, but must rather be estimated. There are several ways to define and estimate the structural credit level, see Box 1 and Appendix 1.

A common and simple way to estimate the structural credit level is used by the Bank for International Settlements, BIS. The structural credit level is approximated by a statistical trend. The trend is estimated solely on the basis of credit-to-GDP data, while a number of other relevant economic factors are not included.[3] Therefore, interpreting the trend as a structural credit level is not relevant.

Major expansion of household balance sheets in recent decades Chart 1



Note: 'Pension wealth' after tax, where the tax rate is assumed to be 40 per cent. 'Housing wealth' does not include farmland, commercial real estate owned by the household sector, cooperative housing and undeveloped land. Revision of the national accounts results in data break in Q4 2012. The disposable income has been adjusted for data breaks back in time and stripped of extraordinary tax revenue from the restructuring of capital pensions in 2013-15.
Source: Danmarks Nationalbank.

This analysis presents a measure of structural credit that takes into account a number of economic factors other than GDP and is based on an econometric model. Thus, the analysis sheds light on economic factors other than GDP that have contributed to credit increasing more than GDP over recent decades.

In this analysis, the structural credit level is defined as *the level of credit that can be explained by a number of*

1 See, for example, Danmarks Nationalbank (2013), Hviid and Kuchler (2017), Andersen et al. (2020).

2 In this analysis, 'debt' and 'credit' are used interchangeably.

3 With this method, the trend is also influenced by periods of rapid credit growth, such as in the run-up to the financial crisis. The trend will therefore remain at a higher level for a long time.

What is the structural credit level?

Box 1

There are different definitions of structural credit depending on the questions to be answered. In this analysis, structural credit is defined as the level of credit that can be explained by a number of structural economic factors. This definition is closest to the first definition presented here, but uses structural variables instead of actual variables in the calculation of the structural debt level.

Is the household debt level in line with economic factors?
The structural level of credit is estimated based on a number of economic factors. Those may include: household income, interest rates and house price growth rates.

Is the household debt level sustainable?
This definition is inspired by the literature on the sustainability of public finances. In addition to the expected development in income and interest rates, expected household consumption must be taken into account. If the expected development in interest rates, income and consumption implies an ever rising debt level, this is regarded as an unsustainable development.

Is debt at a level where households will cut back consumption in an economic downturn?
The experience of previous financial crises points to a close correlation between increased indebtedness and a greater decline in private consumption and, thus, economic growth than would otherwise have been the case. This definition aims to factor in this aspect. The structural debt level is thus the level of debt where negative shocks to the economy do not give rise to a sharp reduction in consumption.

Are measures to reduce the debt level needed?
The European Commission uses two definitions of structural credit. The first definition is based on economic factors that can affect the level of debt in an economy, and is closely related to the first definition presented here. The second definition is based on whether the credit development implies that risks to financial stability are mounting. This definition takes into account the resilience of the banking system.
The two definitions may result in two different estimates of structural credit and can be used to assess whether action is needed to reduce the actual debt level.

Source: Based on Barker (2009), Lindquist (2012), Juselius and Drehmann (2015), and European Commission (2017).

structural economic factors. The structural credit level is estimated using structural variables such as the natural interest rate and potential GDP. In practice, this means that temporary cyclical fluctuations, such as the sharp rise in house prices before the financial crisis, cannot affect the structural economic conditions of households and, hence, their structural debt level.

The measure of structural credit is estimated in an econometric model and reflects historical correlations between the structural factors. The structural credit level is thus an expression of the credit level that can be explained by potential GDP, the structural interest rate level and the structural household wealth level.

The measure can be used to answer a number of questions related to overall credit development, e.g.: Is the credit level according to the model in line with the structural conditions of the economy? How do structural factors affect the credit level? Is the credit level rising faster than the structural factors would imply?

The measure can also be used to calculate the deviation of actual credit from the structural level, i.e. the credit gap. Positive deviations in the credit gap can be used to identify periods when debt accumulates faster than suggested by developments in structural conditions . Conversely, negative deviations may signal that actual credit development over a period of time has been slower than structural conditions, which may indicate that households have been consolidating. However, a negative credit gap does not necessarily mean that there are no imbalances in the current credit development. Some households may choose to increase their debt, although the overall household debt level is lower than structural conditions would imply. While the measure can be used to explain the debt level, it is not suitable as basis for assessing whether the debt level is sustainable or optimal.

Households' wealth and debt servicing capacity affect the credit level

The measure of structural credit in this analysis is calculated by combining the economically intuitive approach of Juselius and Drehmann (2015) with the econometric approach of Lang and Welz (2018). A technical explanation of the estimation of the model and an overview of its explanatory variables can be found in Appendix 1. Additional characteristics of the model and robustness tests are described in Appendix 2.

The choice of factors to estimate the structural debt level is based on Juselius and Drehmann (2015), who point to two factors in particular that help determine household debt levels: the Debt-to-Assets ratio, DTA, and the Debt Service Burden, DSB.[4]

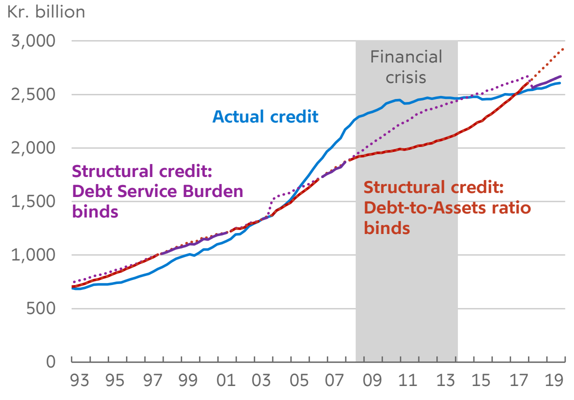
DTA expresses the relationship between total household debt and total wealth. DSB expresses the relationship between the total cost of borrowing (in particular payment of interest and amortisation) and income. The current and expected future income of the household must be sufficient to cover future payments of interest and amortisation on the debt.

Inspired by the approach used in Lang and Welz (2018), both DSB and DTA are estimated in the model in this analysis based on structural variables.

DTA is estimated on the basis of the structural level of housing wealth, pension wealth and household deposits and cash.

DSB is estimated on the basis of Danmarks Nationalbank's measure of the potential level of GDP as a structural measure of income. Borrowing costs are divided into an interest component and the impact of regulatory changes. The model thus allows for a distinction between changes in structural credit due to structurally lower interest rates and changes due to introduction of regulatory measures, e.g. the introduction of deferred amortisation loans. Thus it can be seen that the combination of structurally lower interest rates and the possibility of deferred amortisation allows homeowners to incur more debt relative to household income than previously. A natural interest rate is used as a measure of interest payments. In order to measure the impact of regulation, a measure for the minimum possible

Actual credit reflects structural factors Chart 2



Note: The full lines are the composite structural credit indicator. The dotted lines indicate structural credit calculated based on DTA and DSB, respectively.
Source: Danmarks Nationalbank and own calculations.

first-year debt servicing costs for a first-time home buyer is used. The regulation measure also reflects factors such as the tax deductability of interest expenses, which also influence the debt servicing costs, see Box 2. Both DTA and DSB determine the level of household debt.

Danish households' credit level reflects structural economic conditions

Using the input set out above, two structural credit ratios are calculated: the structural DSB and the structural DTA, see Chart 2. The calculated structural credit level is an expression of the empirical correlation between credit and the different variables. The two estimated ratios are used to calculate a single composite structural credit indicator, see Chart 2. The composite indicator corresponds to the lowest of the two structural credit levels. In practice, this means that one of the debt ratios is the binding borrowing constraint at each point in time and therefore determines the credit level.

This approach is inspired by the economic literature on occasionally binding borrowing constraints in general equilibrium models. For example, Ingholt

4 The two relationships are widely used in economic literature as determinants of the credit development. See also Ingholt (2019) and Kiyotaki og Moore (1997).

(2019) examines the impact of borrowing constraints on the actual credit development of US households. According to Ingholt, the DTA is often binding during downturns when house prices are relatively low – and the loan value is thus also low. The debt service constraint is mostly binding during booms when mortgage interest rates, and thus interest payments, are relatively high.

A similar pattern can be seen in the indicator for Denmark. During the tentative recovery in the 2000s and the ensuing financial crisis and downturn, the DTA was binding and affected structural debt, while the DSB was binding during the boom leading up to the financial crisis, see Chart 2.

Positive credit gap may signal risk build-up
The deviation of actual credit from the structural level, the credit gap, can be viewed as a summary indicator of the credit cycle. A positive credit gap indicates that total debt is at a higher level than the structural economic conditions would imply.

Accordingly, a part of the development cannot be explained by the structural conditions, and might be a sign of risks building up. The credit gap is therefore often used as an indicator of the build-up of risks in the economy and the financial system.

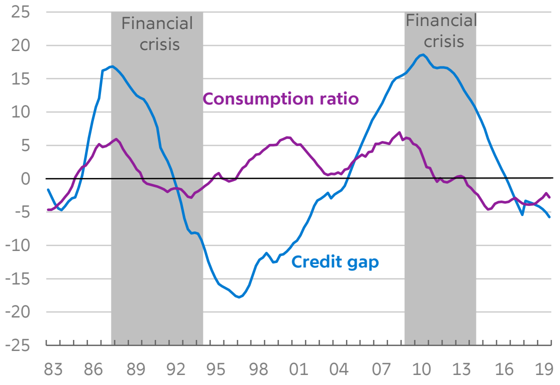
However, part of the development of the credit gap may be due to the cyclical development of the economy. Only a part of the positive deviations of actual credit from structural credit can therefore be interpreted as evidence of risk build up. The model presented does not distinguish between these two elements. This may complicate the interpretation of a positive credit gap. It is generally difficult to measure risks in the economy, and, in practice, many of the economic and financial indicators are too slow to signal risk build up. Therefore, central banks, including Danmarks Nationalbank, often use a broad information set to assess the build-up of risks.

At the end of 2019, actual credit was roughly in line with structural credit, see Chart 3. However, this has not been the case in all periods. Especially in the period leading up to the financial crisis from 2003 to 2008, actual credit differs significantly from structural credit and reflected the massive risk build-up that occurred during this period. The period was characterised by an economic upswing and significant house price increases. At the same time, credit standards were loosened, which resulted in credit growth exceeding what was warranted by economic trends.

Shrinking credit gap reflects household consolidation

Chart 3

Credit gap (per cent) and consumption ratio



Note: Credit gap based on the aggregate structural credit indicator. The composition of the composite indicator is described in Appendix 1. The consumption ratio shown here is deviation from the historical average.
Source: Danmarks Nationalbank and own calculations.

Households generally more resilient to economic downturn
According to the model, the credit gap was narrowing throughout the period after the outbreak of the financial crisis, see Chart 3. In practice, the narrowing credit gap is a result of the fact that actual credit has grown more slowly than structural credit. The extensive credit expansions before the financial crisis led to high DSB and DTA ratios, which subsequently had to be brought down. It was households with high debt in particular that chose to reduce their debt and their consumption.[5] At the same time, households spent a smaller share of their income on consumption and used income increases and lower interest rates to save and repay debt. As a result, credit growth has been limited during the economic recovery in the run-up to the outbreak of the corona pandemic.

5 See Hviid and Kuchler (2017).

Seen in isolation, the slightly negative and narrowing credit gap, as well as the general strengthening of households' propensity to save indicate that Danish households are generally more resilient to an economic downturn compared to their situation prior to the financial crisis. The resilience of households depends, among other things, also on the development of interest rates, both the actual and the natural. The natural interest rate is developing more slowly than the actual interest rate. According to the model, if the natural interest rate increases by one percentage point, the structural credit level will fall by five per cent. All else being equal, an increase in the natural rate of interest will mean that the credit gap would close.

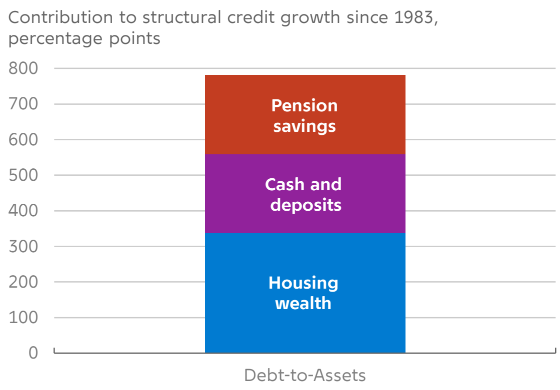
However, the credit gap is an aggregate measure which does not take into account the fact that there may be considerable variation in household income, debt levels and DTAs. In addition, there is considerable uncertainty about the length and depth of the economic downturn following from the corona outbreak. These factors also influence the resilience of households.

Increasing wealth enables debt accumulation

In order to understand how the various explanatory factors have supported the development of structural credit, a number of decompositions are made on the basis of the econometric model.

According to the DTA model, a large part of the increase in structural credit since 1983 has a close correlation with rising housing wealth, see Chart 4. Higher housing wealth might be linked to higher household debt levels for several reasons. Firstly, mortgage debt accounts for most of the debt, which means that a close direct correlation between the size of the housing wealth and the debt can be expected. Secondly, in the past, homeowners have tended to increase their mortgage debt following

Increasing wealth enables debt accumulation Chart 4



Note: Decomposition over the entire estimation period (1983-2019), showing the contribution of the structural factors to the growth of structural credit.
Source: Danmarks Nationalbank and own calculations.

unexpected house price increases, and increases in housing wealth.[6] Home equity extraction mainly takes place in connection with refinancing mortgage loans.[7]

While there is not an equally close direct correlation between pension wealth and credit, the model shows that increasing pension wealth has also contributed to the increase in structural credit.

Most families with members currently or formerly active on the labour market have an asset in the form of pension savings. The savings-based pension system has expanded considerably in recent decades and pension wealth has grown somewhat more than incomes. Households' pension wealth is generally less liquid than other assets, but the knowledge that money is put away for retirement is likely to be factored into households' consumption and savings decisions. Households of retirement age will increasingly be able to pay interest and amortisation on debt without having to suffer financially, which means that having a certain gross debt at retirement is not as worrisome as it used to

6 Andersen and Leth (2019).

7 See, for example, Danmarks Nationalbank (November 2017) and Andersen et al. (2019).

be.[8] This trend is also reflected in new loan products on the market particularly aimed at people close to retirement age.[9]

Andersen et al. (2020b) show a similar correlation between increased pensions and debt accumulation. According to the analysis, households with greater pension savings tend to have higher debt in the longer term and to use debt with deferred amortisation more than households with smaller pension savings.

In addition to increases in housing and pension wealth, household deposits and cash have also increased in the period since 1983. According to the model, this has contributed to a higher structural credit level. However, the model does not give an indication of the mechanism behind this correlation.

For example, higher deposits may be an expression of households accumulating a liquidity buffer or emergency savings for hard times. In a household with debt, this may result in inflating the balance sheet, as the deposit could have been spent on debt repayments instead. According to register data at household level, many households both have considerable deposits and considerable debt.[10] Part of the positive correlation between deposits and debt is also due to bank lending is contributing to increasing deposits overall in the economy.[11]

Deposits and cash are very liquid as opposed to, e.g., large parts of the pension wealth. A higher level of deposits and cash will make households generally better able to withstand economic downturns and a possible decline in disposable income.

Economic growth and lower debt servicing costs have contributed to higher debt levels

According to the DSB model, debt has in particular grown with increasing incomes in the form of higher potential GDP. A higher level of potential GDP reflects developments in productivity, structural employment and capital stock. At the same time, a higher potential GDP indicates a higher expected future income, enabling households to pay higher borrowing costs and thus higher debt.

However, structural credit has increased more than potential GDP over the period. In 1983, structural credit amounted to 60 per cent of potential GDP, while this ratio was 120 per cent in 2019, see Chart 5. According to the model, lower borrowing costs in the form of lower interest rates have contributed to higher debt levels.

In addition, a number of regulatory measures have had an impact on borrowing costs and thus also on the structural credit level.

Regulation affects structural debt

Over the whole period, changes in regulation have not had a particularly significant impact on structural debt levels in comparison with income and interest rates, see Chart 5. In order to gain a better understanding of how structural changes have contributed to the development of credit, it is necessary to look at the effect of each variable in sub-periods.

Regulation has had both positive and negative impacts on the development of structural credit in the individual sub-periods, see Chart 6. Changes in the variable reflect changes in regulation (such as the introduction of deferred amortisation, the possibility of extended loan maturities, changes in the maximum

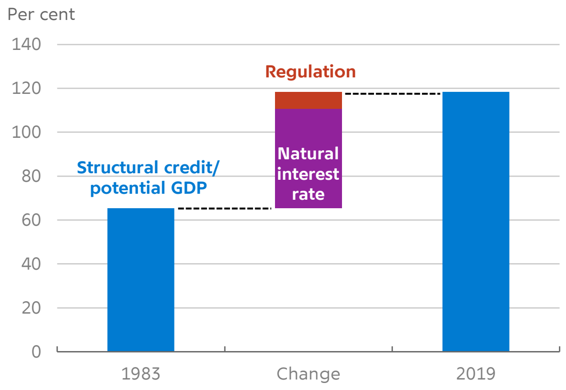
8 See Danmarks Nationalbank (2012).

9 One example is Danish mortgage lenders Realkredit Danmark, who offers a loan product called FlexLife®, where instalments will be reduced to a minimum once the outstanding debt reaches a certain percentage of the value of the home. To be approved for this product, the total home loan must not exceed 75 per cent of the value of the home.

10 See also Box 1 in Danmarks Nationalbank (2019a).

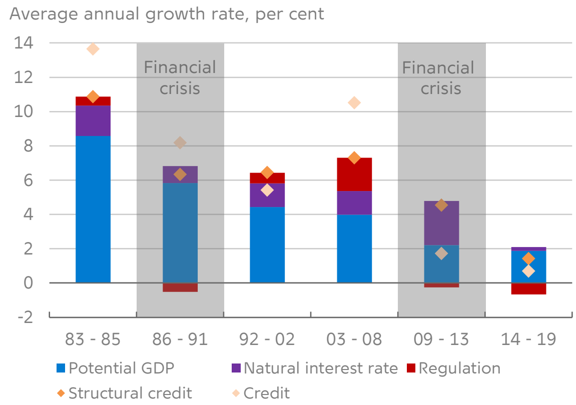
11 See McLeay et al. (2014).

Structural credit-to-GDP doubles as debt service costs decrease Chart 5



Note: The development of the structural credit to potential GDP ratio on the basis of a decomposition of the debt servicing burden over the entire estimation period. The contributions express the relative explanatory power of each variable in the model.
Source: Danmarks Nationalbank and own calculations.

Lower borrowing costs contribute to increase in structural credit Chart 6



Note: The sub-periods have been chosen based on the timing of changes in regulation, periods of financial crises and the evolution of the credit gap, see Chart 3. The credit gap generally increased throughout the period between the two crises. The grey areas indicate the two financial crises. The first crisis lasted from 1986 to 1993.
Source: Own calculations based on Danmarks Nationalbank and the Systemic Risk Council.

loan-to-value, down payment requirements) as well as changes in the interest deduction rate, see Box 2.

The period between 1983 and 1985 was characterised by decreases in interest rates, which gave rise to strong credit growth. During this period, the tax deduction rate of interest expenses increased, resulting in lower borrowing costs and thus a higher level of structural credit.

The subsequent period from 1986 to 1991 was characterised by low economic growth and rising unemployment. At the same time, regulation was tightened – mix loans were introduced and there was a gradual reduction of the interest deduction rate. In effect debt servicing costs increased, which led to a lower level of structural debt.

The period from 2003 to 2008 was characterised by strong credit growth and very accommodative credit standards. Regulatory changes contributed to a higher level of structural credit during this period, see Chart 6. This is because loans with deferred amortisation were introduced in 2003, which reduced the first-year debt servicing costs significantly and made it possible to borrow more relative to income than before. The loans with deferred amortisation were introduced at a time when actual credit was in line with the structural credit level, and there were no signs of risk build-up, according to the level of the credit gap. According to Rangvid (2013), the timing of the introduction of mortgage loans with deferred amortisation was inappropriate because there was no need for stimulus at that time.[12] These loans contributed to sharp increases in credit and house prices during the period. Regulatory changes can thus both affect the structural level and reinforce the cyclical credit fluctuations.

Risks may occur even when the aggregate credit level can be explained by structural factors
The post-2008 period is characterised by major changes in financial regulation to correct some of the imbalances that became apparent during the financial crisis. In addition, there was a greater focus

12 See Rangvid (2013), *Expert committee on the causes of the financial crisis.*

on monitoring the build-up of risks in the financial sector and the economy, so that authorities could take early action to counter risk-taking by both households and businesses.

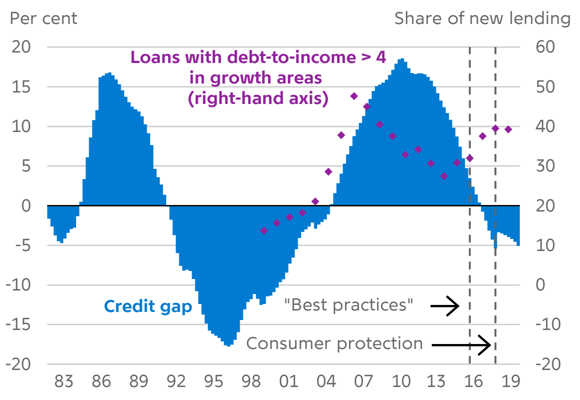
In recent years, the actual credit level has generally been slightly lower than the structural credit level, which is reflected in a slightly negative credit gap, see Chart 7. Although the credit gap has been slightly negative, there have been signs of a build-up of credit risks.

This is because the indicator reflects only the aggregate development of both credit and macroeconomic variables, but not a number of other factors that are essential to take into account. For example, the proportion of new lending to households with high debt relative to income began to increase in 2014, see Chart 7. About 85 per cent of these homeowners tended to choose the riskiest loan types.[13] At the same time, interest rates were very low. The combination of the possibility of deferred amortisation and low interest rates generally allowed homeowners to incur more debt relative to the household's income than in the past.

In the post-2014 period, both the Danish Systemic Risk Council, the European Systemic Risk Board, and the International Monetary Fund, have pointed at the first signs of risk build-up and the need to reduce risks in lending to households.[14] The Danish authorities introduced a number of new measures to limit risks in the housing market and strengthen the resilience of households. In 2015, the Danish Financial Supervisory Authority published guidelines on prudent credit assessment when granting housing loans in growth areas. In 2018, the Danish Government launched a number of new initiatives in response to a recommendation from the Systemic Risk Council.[15] Together, these measures have contributed to ensuring that homeowners with a high debt-to-income and high loan-to-value are increasingly opting mortgage loans with a fixed interest rate and/or loans with amortisation. The measures thus help strengthen the resilience of home buyers, while limiting the build-up of risks from new loans.

Signs of risk build up despite negative credit gap

Chart 7



Note: The proportion of new lending to households where debt is more than four times that of the disposable income in areas with particularly high house price growth (growth areas).
Source: Danmarks Nationalbank and own calculations.

13 Loans with deferred amortisation and/or at variable rate are considered risky. See also the Systemic Risk Council's recommendation (*link*).

14 See the Systemic Risk Council (2015), IMF (2016) and ESRB (2016).

15 The consumer protection initiatives, introduced in 2018, aim to limit partic¬ularly risky loan types among households with a DTA above 60 per cent and a Debt-to-Income ratio (DTI) above 400 per cent.

Impact of regulation on first-year debt servicing costs

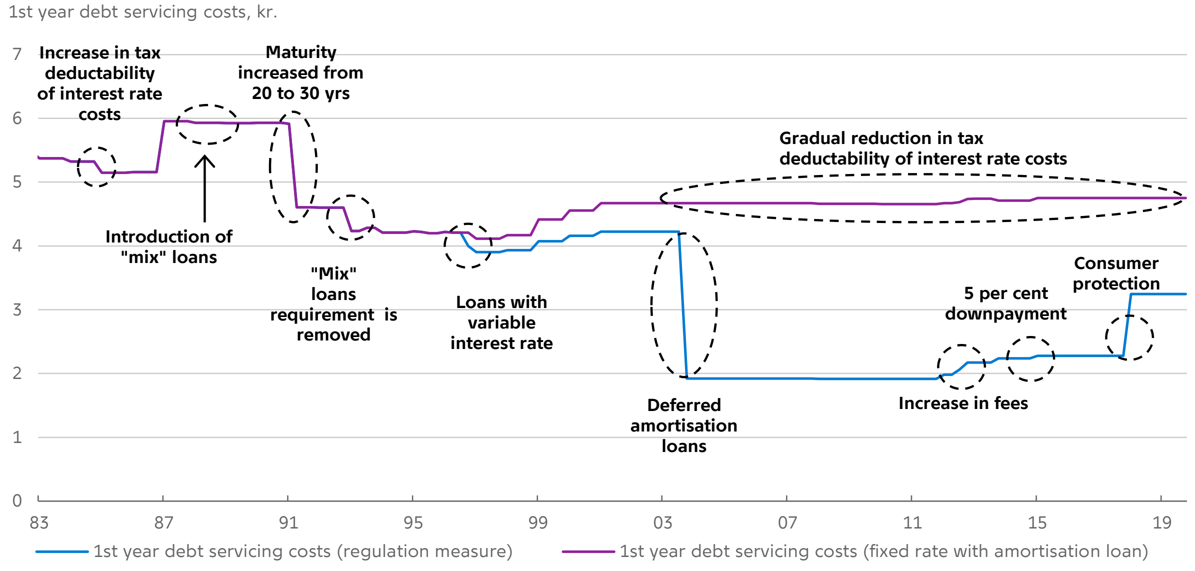
Box 2

The analysis introduces a measure of the first-year debt servicing costs that only takes into account regulatory changes and not interest rate changes. Regulatory changes may for example result in the introduction of new loan types, which could have an impact on the first-year payment.

The variable is based on a stylised first-year debt servicing cost after tax for a first-time buyer with a fully loan-financed home purchase. The debt servicing costs are calculated for four types of loans: fixed rate with amortisation, fixed rate with deferred amortisation, variable rate with amortisation, variable rate with deferred amortisation. The payments are calculated at a constant interest rate for the entire period to isolate changes due to, e.g., regulation, changes in the tax deductibility of interest expenses or introduction of new loan types. Based on the four types of loans, the regulation measure variable is created as the minimum possible first-year payment for each period.

In practice, this means that fixed rate loans with amortisation are the maximum first-year debt servicing cost. With the introduction of variable rate loans in 1997, it became possible to take out a loan with lower first-year debt servicing costs, see the chart. The introduction of loans with deferred amortisation in 2003 allowed homeowners to take a loan with a significantly lower first-year payment, which meant that they could incur higher debt relative to their income than before. The introduction of loans with deferred amortisation is reflected in the fall in the first-year debt servicing costs in 2003, see the chart. For comparison, the chart also shows the first-year debt servicing costs for a fixed interest loan with amortisation, which were unchanged during this period.

Overview of regulatory changes and impact on debt servicing costs



Note: First-year debt servicing costs for a loan of kr. 100 for a first-time buyer. Interest rates are kept constant throughout the period to isolate regulatory changes such as the introduction of new loan products. The calculation is based on calculations for the housing burden, which is calculated as the sum of housing taxes and the financing costs of a fully loan-financed home purchase relative to the average disposable household income, see also the Danmarks Nationalbank (2011) and Grinderslev et al. (2017).
Source: Danmarks Nationalbank and own calculations.

As the variable aims to reflect credit conditions at any given time, the full impact of the measures may be observed and is evident from the first-year debt servicing costs. How the individual household's access to loan financing is affected by the different measures will depend on household income, choice of loan and existing assets. Accordingly, not all households will be affected equally by the measures. The analysis leaves this out of account, as it is beyond the scope of the current analysis to estimate a first-year debt servicing costs reflecting all these factors in practice.

By applying the regulation measure, it is possible to distinguish between the effect of lower interest rates and regulatory changes. Typically, a simple index is used to show regulatory changes. Such an index reflects only a tightening or easing of credit conditions, but not the impact of the measures. The measure introduced in this analysis thus gives a more faceted picture of regulatory changes, as it reflects the impact on the first-year debt servicing costs on a housing loan.

Literature

Andersen, Henrik Yde, Stine Ludvig Bech, Alexander Meldgaard Otte and Ida Rommedahl Julin (2019), Mortgage refinancing supports private consumption, *Danmarks Nationalbank Analysis,* No. 17, September.

Andersen, Henrik Yde, Søren Leth (2019), Housing Wealth Effects and Mortgage Borrowing, *Danmarks Nationalbank Working Paper*, No. 133, January.

Andersen, Henrik Yde, Stine Ludvig Bech and Alessia De Stefani (2020a), Mortgage Choice and Expenditure over the Lifecycle: Evidence from Expiring Interest-Only Loans, *Danmarks Nationalbank Working Paper*, No. 150, January.

Andersen, Henrik Yde, Niels Lynggard Hansen and Andreas Kuchler (2020b), Large Savings Go Hand in Hand with Large Debt, *Danmarks Nationalbank Working Paper, No. 5,* June.

Barker, Kate (2009), *Monetary Policy and Debt Sustainability*, Bank of England.

BCBS (2010), *Guidance for national authorities operating the countercyclical capital buffer*, Basel Committee on Banking Supervision, December.

Danielsen, Troels Kromand, Casper Winther Nguyen Jørgensen and Rasmus Mose Jensen (2017), Revisiting Potential Output in Denmark, *Danmarks Nationalbank Working Paper*, nr. 111, February.

Danmarks Nationalbank (2011), Developments in the market for owner-occupied housing in recent years – Can house prices be explained?, *Monetary review,* 1st quarter.

Danmarks Nationalbank (2012), The wealth and debt of Danish families, *Monetary review*, 2nd quarter.

Danmarks Nationalbank (2013), Consumption, income, wealth, *Monetary review*, 2nd quarter.

Danmarks Nationalbank (2014), A multi-speed housing market, *Monetary review*, 3rd quarter.

Danmarks Nationalbank (2017), Risks are building up in the financial sector*, Financial Stability*, 2nd half, No. 23, November.

Danmarks Nationalbank (2019a), Lower excess capital adequacy for the banks, *Danmarks Nationalbank Analysis (Financial Stability)*, No. 25, November.

Danmarks Nationalbank (2019b), Monetary and financial trends (Decline in interest rates and refinancing boom) 2019, *Danmarks Nationalbank Analysis*, No. 19, September.

The Systemic Risk Council (2015), *Recommendation on limiting risky loan types at high levels of indebtedness*.

Drehmann, Borio, Gambacorta, Jimenez and Trucharte (2010), Countercyclical capital buffers: exploring options, *BIS Working Paper*, No. 317.

Expert committee on the causes of the financial crisis (2013), *The financial crisis in Denmark – causes, consequences and learning*.

European Commission (2017), *Benchmarks for the assessment of private debt*, Note for the Economic Policy Committee.

European Systemic Risk Board (2016), *Warning on medium-term vulnerabilities in the residential real estate sector of Denmark*, ESRB/2016/07, 22, September.

Grinderslev, Kramp, Kronborg and Pedersen (2017), Financial Cycles: What are they and what do they look like in Denmark? *Danmarks Nationalbank Working Paper*, No. 115, June.

Hviid, Simon Juul and Andreas Kuchler (2017), Consumption and savings in a low interest-rate environment, *Danmarks Nationalbank Working Paper*, No. 116, June.

Ingholt, Marcus Mølbak (2019), Multiple credit constraints and time-varying macroeconomic dynamics, *Danmarks Nationalbank Working Paper*, No. 137, May.

International Monetary Fund (2016), Denmark: *2016 Article IV Consultation*, 27 June.

Juselius, Michael and Mathias Drehmann (2015), Leverage dynamics and the real burden of debt*, BIS Working Paper,* No. 501, May.

Kiyotaki, Nobuhiro and John Moore (1997), *Credit Cycles*, *Journal of Political Economy,* Vol. 105, No. 2, pp. 211-248.

Lang, Jan Hannes and Peter Welz (2018), Semi-Structural Credit Gap Estimation, *ECB Working Paper Series*, No. 2194, November.

Lindquist, Kjersti-Gro (2012), Sustainable household debt: Towards an operational view and framework, *Norges Bank Staff Memo*, No. 33.

McLeay, Michael, Amar Radia and Ryland Thomas (2014), Money Creation in the Modern Economy, *Bank of England, Quarterly Bulletin Q1*.

Pedersen, Jesper (2015), The Danish Natural Rate of Interest and Secular Stagnation, *Danmarks Nationalbank Working Paper*, No. 94, March.

Appendix 1

Estimation of the structural debt level of households

There are different approaches to estimating the structural debt level such as using statistical filtering (Drehmann et al., 2010; BCBS, 2010) or econometric models (Juselius and Drehmann, 2015; Lang and Welz, 2018). We combine the intuitive approach of Juselius and Drehmann (2015) with the estimation method of Lang and Welz (2018). We use an unobserved component model to estimate the structural debt level, making it possible to break down credit development into a trend component (cr_t^*) and a cyclical component $(\widehat{cr}_t)$, see line (1) in the table below. Lower-case letters indicate logarithms of the variables.

Unobserved component models for structural credit

Table 1

	Debt service burden (DSB)	Debt-to-Assets ratio (DTA)
(1)	$cr_t = cr_t^* + \widehat{cr}_t$	$cr_t = cr_t^* + \widehat{cr}_t$
(2)	$cr_t^* = \alpha_1 + y_t^* - \gamma(R_t^* + R_t^{Regulation}) + \varepsilon_t$	$cr_t^* = \alpha_2 + \beta_1 housing_t^* + \beta_2 pensions_t^* + \beta_3 deposits_t^* + \varepsilon_t$
(3)	$\widehat{cr}_t = \mu_1 \widehat{cr}_{t-1} + \mu_2 \widehat{cr}_{t-2} + \varepsilon_t^{\widehat{cr}t}$	$\widehat{cr}_t = \mu_1 \widehat{cr}_{t-1} + \mu_2 \widehat{cr}_{t-2} + \varepsilon_t^{\widehat{cr}t}$

Note: Variables and coefficients in the two models are different, so the models may provide different results for structural credit and the associated credit gaps. The deposit variable also covers cash.

The cyclical component corresponds to the credit gap and follows an AR(2) process, see line (3). The trend component reflects the results provided by the model for a structural debt level and is a log-linear function of income (y_t^*) and financing costs (R_t elements) respectively, in the model on the left and of wealth in the model on the right, see line (2). The model is put into state space form and is estimated by maximum likelihood based on a Kalman filter.

We estimate two independent unobserved component models for DSB and DTA, respectively, for the period from the 1st quarter of 1983 to the 3rd quarter of 2019. The debt ratios are structural, as the structural debt level is a function of other structural factors. In line (2), it is denoted by (*) reflecting measures of structural variables. The calculation of these structural measures for the explanatory variables is described in Table 3. The relationships are derived from formulas for calculating DSB and DTA ratios.

The debt service burden (DSB) expresses the total cost of borrowing relative to total income. The DSB ratio is based on the notion that the economy fluctuates around a constant DSB. In the case of an annuity loan with a remaining maturity of m years, the following is derived:

$$\frac{Annuity\ Payment}{Income} = \frac{R_t}{1-(1+R_t)^{-m}} \frac{CR_t}{Y_t} = \tilde{\alpha}_1 \rightarrow cr_t = \alpha_1 + y_t - \gamma R_t$$

, where $\alpha_1 \equiv \ln(\tilde{\alpha}_1)$.

where R_t is the nominal interest rate, Y_t is the income (measured by potential GDP), and $\ln\left(\frac{R_t}{1-(1+R_t)^{-m}}\right)$ is linearly approximated by γR_t. The transition to small variables reflects that the equation is transformed into logarithms. A higher income will make it possible to take on more debt. However, higher interest rates, and thus higher borrowing costs, will in turn result in the household only being able to have a lower debt level. That being said, changes in borrowing costs could also be due to the introduction of new loan types. To account for this, we are extending the borrowing cost component to include changes due to regulation, see Box 2. This is shown in line (2) in Table 1. Both variables express borrowing costs as a percentage and have in our baseline model a common coefficient to ensure that a change in borrowing costs for whatever reason has a uniform impact on the structural debt level. A separate estimation of the two variables does not give rise to significantly different coefficients, see Table 2. The asterisks (*) next to the variables in line (2) are omitted from the derivations for the sake of overview.

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The Debt-to-Assets (DTA) ratio expresses the relationship between household debt and assets. The DTA ratio must have two desirable properties: Firstly, a doubling of assets must lead to a doubling of structural credit (homogeneity), leaving the DTA ratio unchanged. Secondly, different assets must be able to have a different impact on the structural debt level. The derivation below therefore uses an index for the assets based on a Cobb-Douglas function:

$$\frac{Debt}{Assets} = \frac{CR_t}{HOUSING_t^{\beta_1} PENSIONS_t^{\beta_2} DEPOSITS_t^{\beta_3}} = \tilde{\alpha}_2 \rightarrow cr_t$$

$$= \alpha_2 + \beta_1 housing_t + \beta_2 pensions_t + \beta_3 deposits_t \text{ , where } \alpha_2 \equiv \ln(\tilde{\alpha}_2).$$

To obtain the first property, the restriction $\beta_1 + \beta_2 + \beta_3 = 1$ is introduced into the model. The restriction is in accordance with the data, as the homogeneity test is not rejected, see Table 2. Households' own securities holdings have been taken into account and excluded from the model, as they did not appear significantly along with the other assets.

The final (composite) indicator of household structural debt is calculated as a minimum of the structural debt level that the DSB and the DTA ratios would imply. Using the minimum of the trends corresponds to the credit gap reflecting the highest of the two ratios. However using the minimum means that over time, the composite credit gap will be overestimated. In order to avoid this overestimation, the final composite credit gap is corrected for the increase in its average over the estimation period. The correction is made by correcting for the difference between the mean of the maximum credit gap and a mean of the average of the two separate credit gaps. The correction adjustment is low.

Estimation results

Table 2

	Debt service burden (DSB)	Debt-to-Assets ratio (DTA)
1. GDP	1 (res)	-
2. Nominal interest rate	-4.80***	-
3. Regulation	-4.80***	-
4. Housing wealth	-	0.41**
5. Pension wealth	-	0.22***
6. Deposits and cash	-	0.37**
Restrictions:	1. = 1; 2. = 3.	4. + 5. + 6. = 1
Aggregate test compared to unrestricted model (p-value):	0.96	0.77

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Note: Estimated coefficients in the structural equation. Both models are with a constant. Explanatory variables reflect suggested structural measures of the variables. * significance level of 10 per cent, ** significance level of 5 per cent and *** significance level of 1 per cent.

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Table 3

Construction of measures for structural explanatory variables

Measure	Method	Description
GDP	Primarily model-based	The model includes a measure of nominal potential GDP. The measure of real potential GDP is based on Danielsen et al. (2017). Conversion to nominal values is made using a smoothened GDP deflator using an HP filter.
Nominal interest rate	Primarily model-based	The measure is based on Pedersen (2015) and reflects a short interest rate. The expected inflation from the same study has been added to the real interest rate to find a measure of the nominal interest rate. The resulting series for the natural nominal interest rate is smoothened for estimation purposes by using an HP filter to remove very short-term fluctuations.
Regulation	Calculated	The measure is based on Grinderslev et al. (2017), but has been expanded to account for macroprudential measures.
Housing wealth	Primarily model-based	The model includes a measure of structural housing wealth, based, among other things, on the fundamental house price calculated in Danmarks Nationalbank (2014) and the housing stock. The fundamental house price takes into account cyclical developments. Therefore, an HP filter is used to reduce cyclicality. Finally, the conversion from house price to wealth is made by scaling with the housing stock under the simplistic assumption that the housing stock is at its structural level. This is supported by the fact that the housing stock is a slow-moving variable.
Pension wealth	Statistical filter	The measure has been calculated by extracting the trend component of the pre-tax pension wealth using an HP filter. Consequently, short-term changes in value do not affect structural debt.
Deposits and cash	Statistical filter	The measure corresponds to the HP-filtered trend of the original data series. Accordingly, short-term changes do not affect structural debt.

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Note: In almost all HP filters, λ = 1,600 is used. For housing wealth, λ = 300 is used, as the data series has already been smoothened using a model.

Appendix 2

Robustness of the estimated structural debt level

The purpose of this appendix is to examine the robustness of the introduced credit gap (corresponding to the robustness of the estimated structural debt level) and compare it with other related methods. The estimation is subject to uncertainty. This is firstly because estimates from an econometric model are associated with uncertainty. In addition, different methods may often give rise to different estimates. In order to make up for this uncertainty, central banks typically work with several indicators to have a better basis for assessing credit development. The main conclusions of the robustness study are described below:

How uncertain are the estimates in the model?
The uncertainty of the estimates in the model itself is low, see Chart A (left). Overall, however, the results obtained with the model are expected to be subject to considerably greater uncertainty. This is because the explanatory variables in the model reflect measures of structural factors that are also uncertain and which in some cases are also estimated. An uncertainty band for the interest rate is shown as an example in Chart A (right). The credit gap is not sensitive to using the lower or upper limit of the interest rate instead of the point estimate (blue curve). As the interest rate only changes by a parallel shift, it only affects the estimated value of the constant in the structural credit equation (α_1). On the other hand, a different development in interest rates may affect the credit gap, see the penultimate paragraph. The calculation of the overall uncertainty of the model, which takes into account both the uncertainty of the model itself and the generation of its explanatory variables, is beyond the scope of this analysis. Rather, estimating the structural measures for all variables simultaneously requires a comprehensive unified model.

Does the model have an endpoint problem?
The current credit gap calculated using the model appears robust to estimation with a forecast, see Chart B (left). This indicates that the estimation of the model only has a slight endpoint problem.

What does the model look like in real time?
For the credit gap based on the DSB ratio, real-time estimation, where the estimation period is limited to the period up to and including the current period, results in a higher credit gap in the '90s and early 2000s. However, from 2005, the real-time estimate is close to the estimate based on the full sample and thus gives roughly the same warning signal of a future crisis in the years up to the most recent financial crisis, see Chart B (right). The two versions of the model have roughly coincided since then. The model for the DTA ratio cannot be estimated meaningfully on shorter samples.

How robust are the DSB results to the use of obvious alternative explanatory variables?
The model largely exhibits the same characteristics when the ratio is estimated using alternative measures of interest and income in the form of a long after-tax bond rate and the total disposable income of households. The use of other variables in some cases gives rise to a higher credit gap before the 2008 financial crisis and a lower credit gap here and now, see Chart C.

What does the total credit gap look like compared to other methods?
In general, there are clear similarities between the development of the credit gap introduced and the credit gap calculated using other methods, see Charts D and E. Currently, the introduced credit gap is lower than the credit gap in a previous study by Danmarks Nationalbank (Grinderslev et al., 2017) and higher than the Basel gap and virtually all other calculation methods in the comparison. Filtering techniques are often vulnerable to the fact that the calculated trend can rise sharply after periods of high growth and then remain high. This may give rise to bias in the calculation of the credit gap, which subsequently will appear too low. The model in this analysis appears less vulnerable to this problem, which is why the credit gap is higher here and now compared to most alternative methods. This should be seen in the context of the fact that the trend in this analysis is modelled as a function of structural variables and is therefore anchored in that relationship rather than being affected with some delay by the actual credit development.

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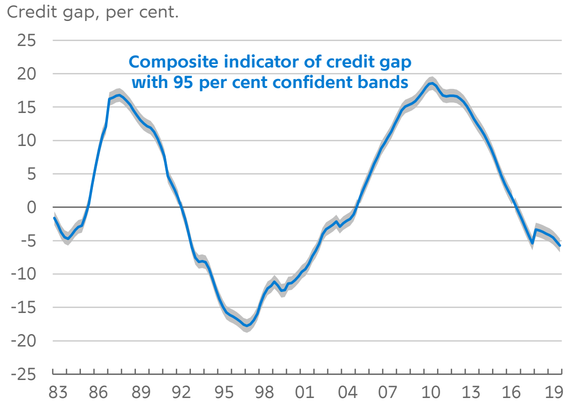
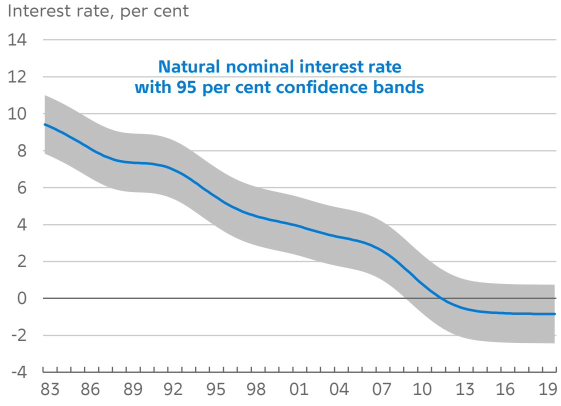
Chart A
Low uncertainty in estimation



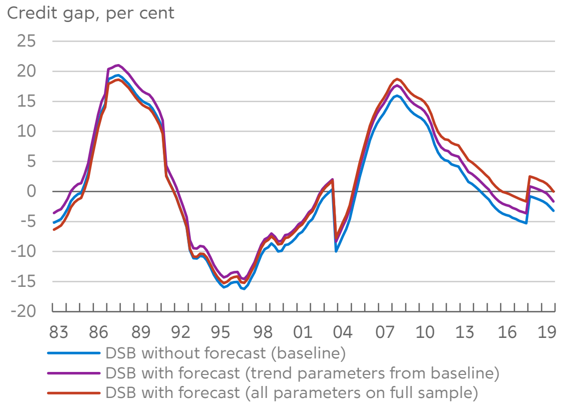
Uncertainty in explanatory variables (the interest rate as an example)



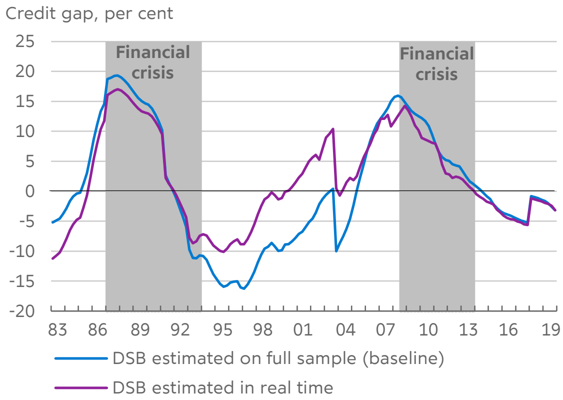
Note: The chart on the left shows confidence bands of 95 per cent calculated as the point estimate plus/minus 1.96*rmse (root mean squared error). It is inspired by Lang and Welz (2018). The explanatory variables in the model are assumed exogenous in the calculation. The chart on the right shows confidence bands of 95 per cent on the calculated natural nominal interest rate. The confidence bands are taken from Pedersen (2015) and are based on the natural real interest rate. Any uncertainty linked to expected inflation has not been included.

Source: Own calculations based on, e.g., Danmarks Nationalbank and Pedersen (2015).

Chart B
The model appears less vulnerable to endpoint issues



Estimation in real time gives roughly the same warning signal in the run-up to the 2008 crisis



Note: Estimations based on the debt service burden (DSB) ratio. On the left are estimations of the credit gap on the historical sample (baseline) and two versions, respectively, with a forecast up to 2024 added to the historical sample. In the purple series, parameters in the structural equation are only estimated on the historical sample. In the red series, all parameters in the model are estimated on the full sample. The same exercise has been carried out with similar results for the DTA ratio. The forecast is based on the following assumptions: 1) Growth rates in housing wealth, pension wealth and potential GDP are based on Danmarks Nationalbank's forecasts. 2) Deposits are assumed to follow potential GDP. 3) The natural nominal interest rate decreases linearly by a total of 0.5 percentage points over the period. 4) Unchanged regulation (unchanged minimum payment) is assumed. 5) Credit growth is assumed to continue at the average level for 2019 (1.9 per cent p.a.). The chart on the right shows a real-time estimate where all parameters in the model can vary over time. The real-time estimation is not complete, since the calculation of the explanatory variables (GDP, interest rate and regulation) at any point in time is based on the entire historical sample rather than being backward-looking only.

Source: Danmarks Nationalbank and own calculations.

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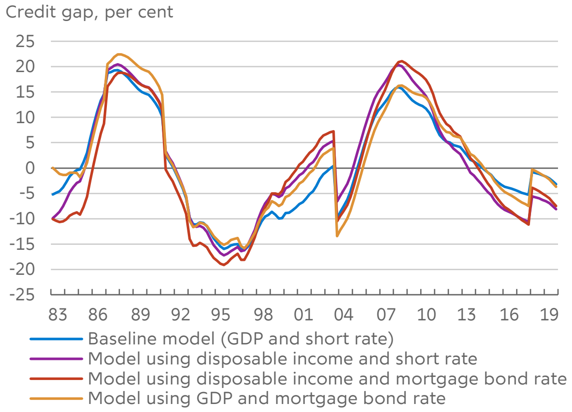
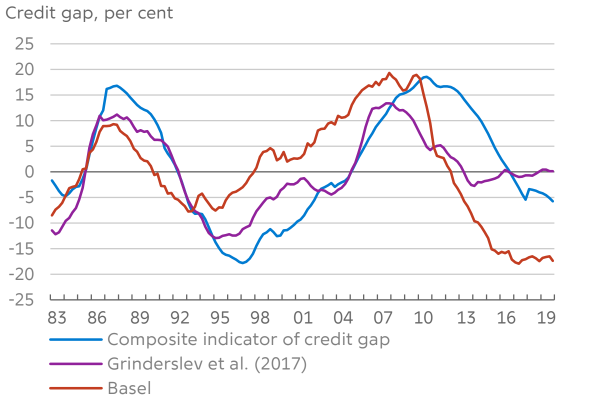
Chart C
Alternative variables in the DSB ratio



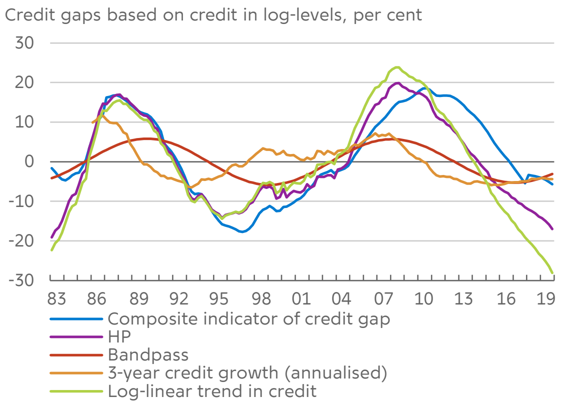
Note: Like the baseline model, the aggregate test of all restrictions in the models (same test as in the bottom row of Table 3) cannot be rejected. This means that the restrictions do not conflict with the data-generating process. The chart shows all four possible combinations of measures of interest and income. Structural measures for the alternative variables have been calculated with an HP filter inspired by Lang and Welz (2018).
Source: Danmarks Nationalbank and own calculations.

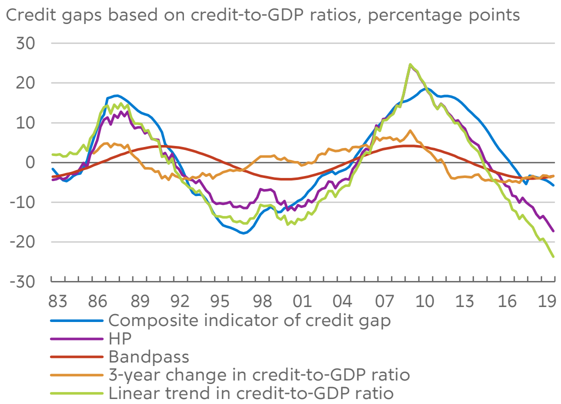
Chart D
Comparison with previous study of Danmarks Nationalbank and the Basel gap



Note: Grinderslev et al. (2017) is also based on an unobserved component model without a specification of the structural debt level. This credit gap applies in contrast to the other two to both households and non-financial enterprises. The Basel gap is based on BCBS (2010). The gap is constructed as a one-sided (backward-looking) HP filtering of household debt relative to GDP with a smoothening parameter λ = 400,000.
Source: Grinderslev et al. (2017), the Systemic Risk Council and own calculations.

Chart E
Comparison with other methods based on log-level credit (left) and credit relative to GDP (right), respectively





Note: Calculations using the bandpass filter require a specification of the cycle length, which is assumed to be between 16 and 20 years. In the calculation based on an HP filter, a double-sided filter with a smoothing parameter λ = 400,000 is used.
Source: Danmarks Nationalbank and own calculations.

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