CLIMATE

DANMARKS NATIONALBANK

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A gradual green transition supports financial stability

Climate change may impact financial stability

The financial sector faces both risks associated with the green transition (transition risks) and physical climate risks. Danmarks Nationalbank has performed a climate stress test to highlight transition risks in the banking sector.

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The analysis links unique data to highlight climate risks

The analysis links corporations' accounting data, industry-level emission data and credit register data to identify climate risks for corporate lending by the banks. Data for energy labels is included in the assessment of mortgage lending.

Read more

The banks are well equipped to handle transition risks

However, a drastic transition in which the banks need to make large impairment charges over a short time frame may result in a capital shortfall. The banks should take climate risks into account in their risk management and capital planning.

Read more

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Climate change

Climate change is impacting society already today and will have further consequences in the future. A successful green transition will require unprecedented efforts, both in Denmark and abroad.

As a case in point, climate change and the transition to a greener economy will impact corporate earnings and economic activity. This may compromise price and financial stability in Denmark, which it is Danmarks Nationalbank's objective to ensure. It is therefore essential that Danmarks Nationalbank increases its knowledge of how, and by how much, the climate challenges will impact various parts of the economy.

Against this backdrop, Danmarks Nationalbank will focus on climate challenges in a series of publications.

ABOUT THIS ANALYSIS

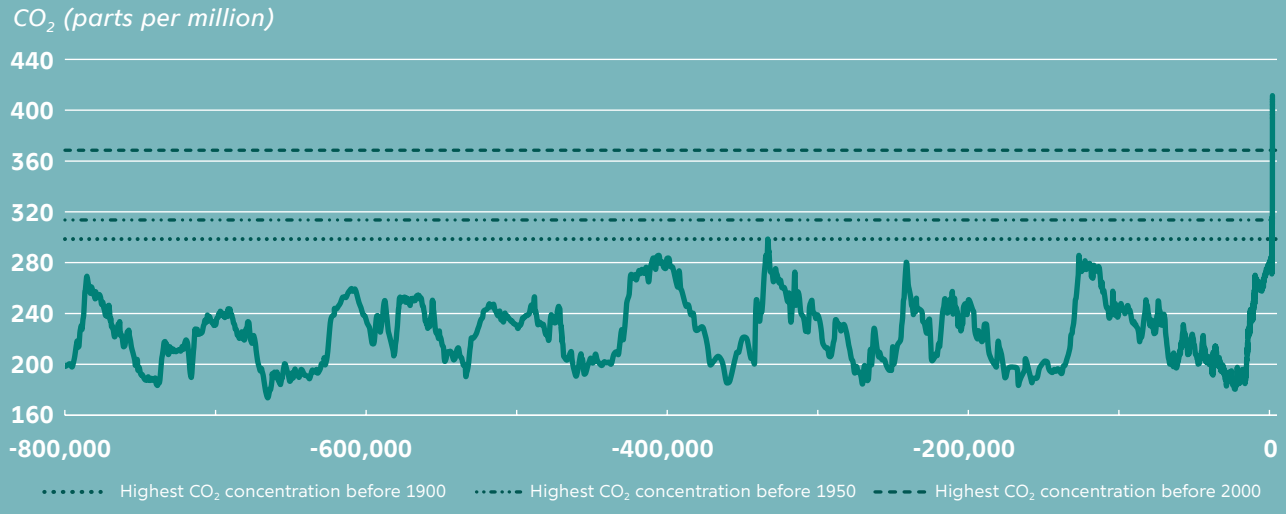
Climate stress test

In this climate stress test, we will examine how the banking sector may be impacted by 'transition risks', i.e. risks that may occur when moving towards a greener economy. A drastic transition involves particular risks, for instance where political decision-makers fail to take timely necessary measures and may therefore later have to resort to more drastic measures to achieve their climate targets.

CO_2 concentration in the atmosphere

800,000 BCE to 2019 ACE

The chart shows the number of carbon dioxide molecules per million molecules of dry air.



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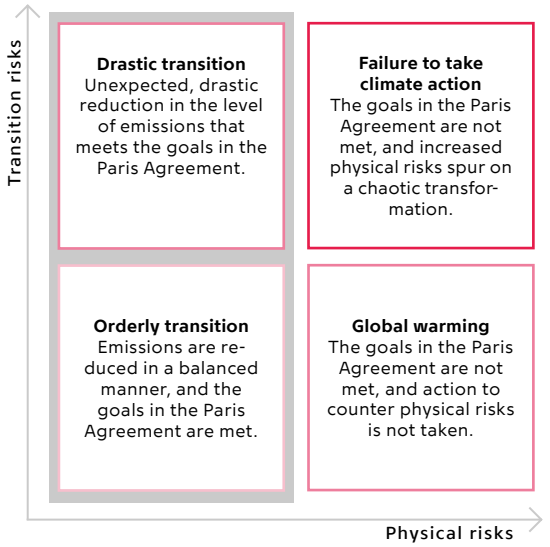
Source: National Oceanic and Atmospheric Administration (until 1957) and National Aeronautics and Space Administration (from 1958).

In the past few years, climate risks have become a key item on the agenda as a threat to financial stability. However, the coronavirus outbreak has meant that central banks and other financial institutions have had to focus on the consequences of the pandemic. The climate risks are still present though. There is still a marked gap between actual emission levels and the levels stipulated under the Paris Agreement with the aim of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C".[1]

A distinction is typically made between two types of climate risks: physical risks and transition risks. An example of a physical risk is flooding due to rising sea levels. Flooding may affect property values and thus a significant part of the mortgages used as collateral for the banks' lending. Transition risks are the risks connected with the green transition. These risks may manifest themselves in different ways, for example in the form of climate policy measures such as increased taxes and duties on emissions, or in the form of changed consumer behaviour where consumers actively steer clear of climate-damaging products. This may affect corporations through, for example, a drop in the value of energy-intensive assets, increased costs and poorer earnings. For the banks that have lent money to the affected corporations, this results in an increase in the risk on their loans to these corporations.

The analysis focuses on transition risks Chart 1



Note: NGFS (2019) describes various climate scenarios. If there is a green transition, this will reduce the physical risks. However, there may be transition risks associated with the green transition if it is drastic. The best-case scenario for a green transition is an orderly and predictable process that reduces emissions. In turn, the worst-case scenario is one in which no climate action is taken, and society fails to reduce the emission level in time, resulting in physical risks. See NGFS (2019) and Danmarks Nationalbank (2019) for a more detailed description.
Source: NGFS (2019).

Danmarks Nationalbank is a member of Network for Greening the Financial System (NGFS), the members of which consist of central banks and supervisory authorities. The NGFS has described different scenarios for the development in the two risk types, see Chart 1. We focus on transition risks in this analysis.[2]

The analysis shows that, in particular, there are risks associated with a drastic transition. If the banks must absorb significant losses over a limited number of years, they may need capital. An example of a drastic transition could be a scenario in which there is political failure to take the necessary steps to limit emissions in good time, with a subsequent need to take more drastic action to meet climate targets.

Ideally, Danmarks Nationalbank would like to perform a fully developed climate stress test of the banking sector. At present, however, very few central banks have published climate stress tests on their banking systems, and there is far from consensus on the structure of such climate stress tests. There are several reasons for this. It is, for example, difficult to translate climate scenarios, which inherently have a

1 Folketinget (the Danish Parliament) (2016). See also Rogelj et al. (2018) for emission developments compatible with temperature increases of 1.5-2°C.

2 Danmarks Nationalbank has previously highlighted how climate risks can have a spillover effect on financial stability. See Danmarks Nationalbank (2019).

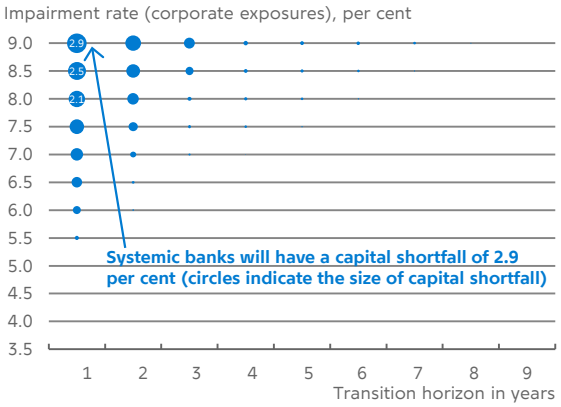
long time frame, into more short-term economic scenarios that can be included in a traditional stress test of the banking system. Moreover, both the macroeconomic consequences of a green transition and the consequences for the banks will depend on how the transition is managed in practice.

As an alternative to a fully-developed climate stress test, we are instead trying to highlight the following using a number of sensitivity analyses: Will the banking sector have a capital shortfall if it has to incur a loss of a certain size over a given time frame? In connection with a drastic transition, it is conceivable that banks will have to make substantial impairment charges over a short time frame.

The climate angle is that these impairment charges are not distributed evenly across the banks. On the banks' corporate loans, the impairment charges are distributed on the basis of emission intensity in the industries to which the banks make loans. On the banks' mortgage loans, the impairment charges are distributed on the basis of the energy labelling of the properties mortgaged as collateral for the loans. The stress test is thus based on the assumption that the loans that give rise to the largest impairment charges during a green transition are loans to customers engaged in particularly climate-damaging activities.

It will take a drastic transition for the systemic banks to experience a large capital shortfall

Chart 2



Note: The chart shows the systemic banks' capital shortfall in relation to the total capital requirement in different combinations of impairment charge ratios and impairment charge time frames. The capital shortfall is the amount the banks need to meet their capital requirements, and the circles indicate the size of the capital shortfall as a percentage of the risk-weighted exposures. The impairment charge ratios are for corporate lending. The impairment charge ratios in the other sectors are assumed to be proportional to corporate impairment charges.
Source: Own calculations.

The analysis uses relatively unique microdata in an international context. By linking accounting data for corporations and industry-level emission data with credit register data for bank lending, we can calculate corporate default probabilities under a given climate stress, thereby highlighting the distribution of climate risks across banks. On the banks' mortgage loans, it is possible to link lending to data for energy labels.

The banks are generally well equipped

The systemic banks can withstand even very significant impairment charges connected with a green transition. However, this presupposes that the resulting impairment charges are distributed over several years. This is illustrated in Chart 2, which shows the systemic banks' capital shortfall, illustrated by the size of the circles, for different combinations of impairment charge levels on corporate lending and time frames. The capital shortfall has here been defined as the amount, stated in percentage of the banks' risk-weighted exposures, which the banks need to meet their capital requirements, including buffer requirements. The largest circle in the top left-hand corner of the chart corresponds to the systemic banks having a capital shortfall of 2.9 per cent of their risk-weighted exposures relative to their total capital requirements.

The analysis assumes that the level of impairment charges in other sectors is proportional to the level of impairment charges in corporate lending, i.e. corporations' bank loans. For example, the impairment charge ratio for loans to households is assumed to be three fourths of the impairment charge ratio for corporate lending, while the impairment charge ratio for mortgage loans is assumed to be one fourth of the total bank impairment charges. These fractions correspond roughly to historical averages.

The time frame is an important element of the analysis because a longer period allows the banks to absorb losses through their current earnings. As long as the level of impairment charges is low, or the impairment charges are spread out over several years, the banks will have no or a minimal capital shortfall in relation to the total capital requirements.

To put the figures into perspective, Danish banks' corporate impairment charges for their banking activities amounted to just under 7 per cent in the period 2008-10. Chart 2 shows that the systemic banks must make larger impairment charges over a shorter time frame to acquire a significant capital shortfall. The green transition must thus result in a scenario that is worse than the financial crisis before the banks seriously risk being short of capital.

Non-systemic banks generally have a higher capital shortfall than systemic banks, see Chart 3. For the non-systemic banks, the largest circle at the top left-hand corner corresponds to a capital shortfall of 4.9 per cent of the risk-weighted exposures. However, the analysis shows that the non-systemic banks can also cope with significant losses in connection with a gradual transition.

Risks are unevenly distributed across industries

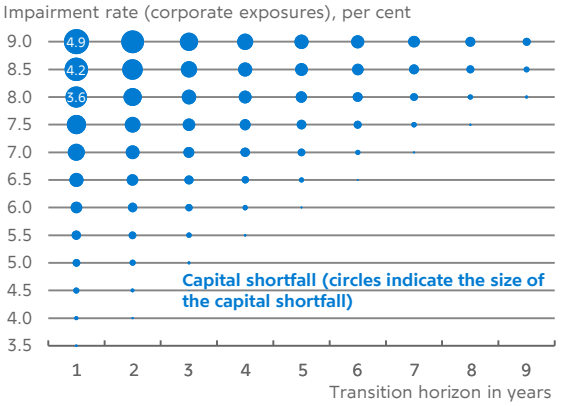
The distribution of the banks' impairment charges on industries is based on, among other data, industry-specific emission data from Statistics Denmark.[3] The analysis combines emission data with credit register data for bank lending. Chart 4 shows how the size of the lending is connected with emission intensities in various industries.

Most industries are characterised by low emissions, and the vast majority of the banks' corporate lending has, in fact, been to industries with limited emissions. The agricultural sector is an exception, where both lending and emission intensity are of a certain size.

In the analysis, banks' exposure to transition risks is directly connected with the industries to which they make loans. However, the data basis is not as granular for all industries as one might wish. For example, there is only one average emission level for all

Chart 3

Non-systemic banks are at greater risk of being short of capital

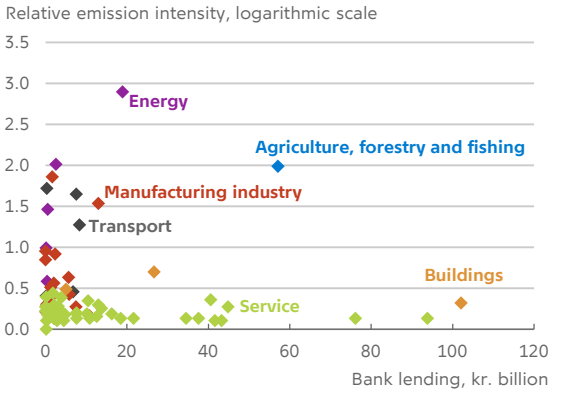


Note: The chart shows the non-systemic banks' capital shortfall in relation to the total capital requirement in different combinations of impairment charge ratios and impairment charge time frames. The capital shortfall is the amount the banks need to meet their capital requirements, and the circles indicate the size of the capital shortfall as a percentage of the risk-weighted exposures. The impairment charge ratios are for corporate lending by the banks in connection with their banking activities. The impairment charge ratios in the other sectors are assumed to be proportional to corporate impairment charges.

Source: Own calculations.

Chart 4

Lending to the most emission-intensive sectors is concentrated in certain industries



Note: The relative emissions of the different industries have been calculated so that the average level is 1 and are shown on a logarithmic scale (with the natural logarithm as the base). The various items indicate sub-industries. Lending data indicates the value of bank lending (outstanding nominal amount) to the industries concerned and does not include lending by mortgage credit institutions or lending to foreign corporations.

Source: Statistics Denmark and own calculations.

3 The relative emission intensities are calculated based on Statistics Denmark's statement of direct and indirect air emissions broken down by Danish sector codes. Indirect emissions of industries include parts of their subcontractors' emissions. The emissions have been scaled in the analysis, so that the average industry has a relative emission level of 1. It is not possible to distinguish between high-emission and low-emission corporations in a single industry, but a new report from the European Systemic Risk Board (ESRB) (2020) shows that there are significant variations between industries. Nor has demand effects been taken into account, for example that corporations in low-emission industries may experience weaker demand from corporations in high-emission industries, or that corporations which sell, but do not themselves produce, emission-heavy products may be hit by low demand.

corporations in the 'agriculture, forestry and fishing' sector. However, there may be considerable variation in corporations' emissions in a given industry, and the analysis does not take this into account. We cannot distinguish between the cow farmer and the potato grower. Banks with significant exposures to a high-emission industry may therefore have less exposure to transition risks if their loans are made to the most energy-efficient corporations in the industry in question.

Lending to the most emission-heavy industries is relatively limited, and it therefore seems less likely that Danish banks would experience a capital shortage simply as a result of the incurrence of losses in these industries. It seems more obvious that this will require a scenario in which the transition occurs concurrently with or triggers a more widely based economic downturn.

The systemic banks appear to have the safest corporate customers

The calculations that form the basis of Charts 2 and 3 are based on a modified version of Danmarks Nationalbank's stress test model. In the model, the corporate impairment charges are distributed across the banks based on 'climate-stressed' default probabilities. There are three steps involved in the construction of this distribution scale.

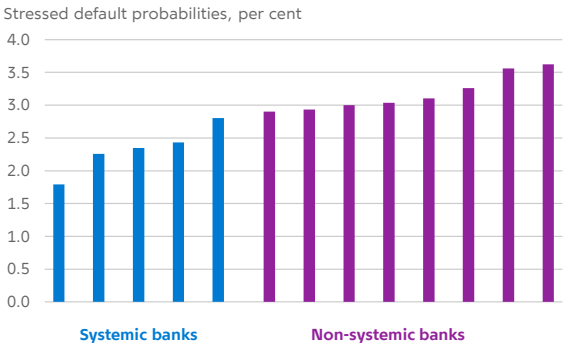
The first step is to estimate a model of default probabilities for Danish corporations based on their latest financial statements. The corporations' leverage, i.e. the ratio between their debt and assets, constitutes an important explanatory variable in the model.

As the second step, the estimated default probabilities are stressed. In specific terms, this is done by assuming a decrease in the value of the corporations' assets which is proportional to the emission intensity in the industries to which the corporations belong. The decrease in the value of the assets increases the leverage and results in higher default probabilities in the most emission-intensive industries.

The final step is to link the 'climate-stressed' default probabilities with credit register data for bank lending. For each bank, it is therefore possible to calculate an exposure-weighted default probability. These probabilities are then used as a distribution scale to distribute impairment charges across banks in the calculations.

The systemic banks' corporate customers are assessed as having lower default probabilities

Chart 5



Note: The pillars show exposure-weighted default probabilities, climate stress-adjusted, for corporate lending in the banking activities of the banks which form part of the analysis (see Appendix 1). The probabilities are also contingent on an unfavourable macroeconomic situation.
Source: Bisnode and own calculations.

The consequence of the calculation method is that the risk is assessed as being highest in corporations which are either indebted, belong to high-emission industries or (in particular) both. The method is thus an attempt to capture a realistic correlation between emissions and credit risks for banks. It is hardly possible to know the true relationship, as, in practice, it will depend on how a green transition is implemented and the possibility for the corporations to pass on increased costs to consumers etc.

The exposure-weighted default probabilities for different banks are shown in Chart 5. The chart shows that the estimated default probabilities are generally lower in systemic banks than in non-systemic banks. The reason is not that systemic banks' lending is connected with lower emission intensities than non-systemic banks' lending; the average emission intensities are at about the same level in both groups. The reason for the difference is instead that the systemic banks generally have the safest customers according to the default probability model.

In general, we also do not see a picture of the transition risks being especially concentrated in individual banks. However, some credit institutions with a high proportion of lending to the agricultural sector may be more exposed to transition risks. The conclusion must also be taken with the above caveat that it is

not possible to distinguish between how 'green' the banks' lending is within the different industries.

Increased energy costs may affect property prices

Mortgage credit institutions are, for example, exposed to transition risks through the mortgage value of homes. Homes have different levels of energy efficiency, as measured by their energy labels. Some homes have a large part of their value attached to the building rather than the plot, and the value of their mortgage can therefore fall sharply if the current costs increase significantly as a result of, for example, climate policy measures.

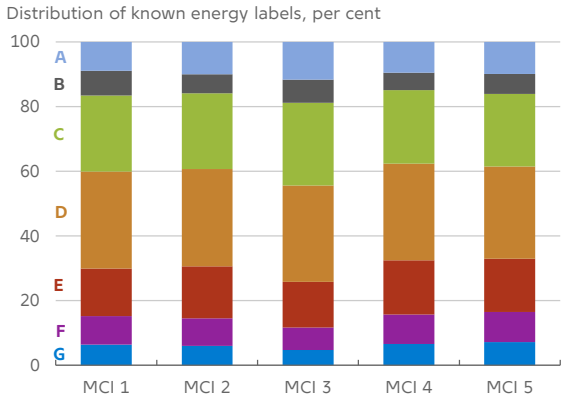
In the analysis, mortgage credit institutions' impairment charges are distributed in accordance with the distribution of energy labels on the properties on which they have a mortgage. For example, a mortgage credit institution with a higher proportion of mortgages on properties with energy label E will experience higher impairment charges than a mortgage credit institution with a higher proportion of mortgages on properties with energy label B in the sensitivity analysis. Here the implicit assumption is that increased future energy costs are not already reflected in property prices.[4] The losses on non-performing loans may consequently end up being higher for loans secured by a mortgage in properties with high energy costs.

We specifically assume in the analysis that impairment charges are increased by 5 per cent for each step down the energy scale. There should be limits to how large the home price effect of increased energy costs can be, as homeowners may energy renovate their homes.

In practice, there is in any case limited variation in the distribution of energy labels across mortgage credit institutions, see Chart 6. The majority of the properties used as collateral for the exposures are energy labelled D or better.

Other supply and demand effects, such as the location of the building, are not taken into account. Nor

The distribution of energy labels appears to be even across mortgage credit institutions Chart 6



Note: The distribution is based on number of loans. A covers all A labels, i.e. from A to A2020. Only energy-labelled loans have been included.
Source: Tingbogen (Land Register) and Energistyrelsen (Danish Energy Agency).

are expectations of physical climate risks, such as increased likelihood of storm surges, taken into account. Energy labels have been obtained from publicly available energy label reports and have been compiled with the Land Register. Not all properties have energy labels.[5]

Banks can show due diligence themselves

The drastic transition is not a favourable scenario for financial stability. The reason is twofold: Firstly, the banks risk having to absorb impairment charges over a short time frame, and secondly a shorter time frame may result in larger overall impairment charges. A gradual transition, and thus a longer time frame, will presumably reduce the actual need for impairment charges because a longer time frame also gives the corporations a better opportunity to adjust their business models.

However, the banks can show due diligence in several ways themselves. For example, they can already

4 Copenhagen Economics analysed the correlation between energy labels and house prices in 2015. They found a significant price effect of around kr. 40,000-50,000 per step up the energy scale for an average house. However, the effect was lower than what could be expected from the calculated cost reduction of having a better energy label. See Copenhagen Economics (2015).

5 The analysis is based on the distribution of the energy labels that can be compiled with the Land Register. It may consequently affect the analysis results if this distribution is not representative of the actual distribution of housing energy efficiency across mortgage credit institutions.

today begin to identify the extent to which they are exposed to climate risks and take these risks into account in their internal risk management and in the pricing of their loans. In addition, the banks should consider whether they have taken climate risks into account in their capital planning. For example, banks calculate their risk weights based on default probabilities estimated on the basis of historical data.[6] The calculations thus do not take into account future risks such as climate risks in the regulatory capital requirements. It is therefore conceivable that the current capital requirements are too low for banks exposed to climate risks.

6 Where banks use internal models in the calculation of their risk-weighted exposures.

Literature

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Appendix 1

Analysis population Table 1

Systemic banks (credit institutions)
Danske Bank
Nykredit Realkredit
Jyske Bank
Nordea Kredit
Sydbank
DLR Kredit
Spar Nord

Non-systemic banks (credit institutions)
Arbejdernes Landsbank
Ringkjøbing Landbobank
Sparekassen Kronjylland
Vestjysk Bank
Lån & Spar Bank
Jutlander Bank
Sparekassen Sjælland-Fyn
Den Jyske Sparekasse
Sparekassen Vendsyssel
Alm. Brand Bank

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News offers a quick and accessible insight into an Analysis, an Economic Memo, a Working Paper or a Report from Danmarks Nationalbank. News is published continuously.

ANALYSIS

Analysis from Danmarks Nationalbank focuses on economic and financial matter. Some of the analyses are published with a regular frequency e.g. *Outlook for the Danish economy and Financial stability*. Other analyses are published continuously.

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Report comprises recurring reports and reviews of the functioning of Danmarks Nationalbank. For instance Report includes the *Annual report* and the annual publication *Danish government borrowing and debt*.

ECONOMIC MEMO

Economic Memo is a cross between Analysis and Working Paper and it often shows the ongoing study of the authors. The publication series is primarily targeted at professionals. Economic Memo is published continuously.

WORKING PAPER

Working Paper presents research projects by economists in Danmarks Nationalbank and their associates. The series is primarily targeted at professionals and people with an interest for academia. Working Paper is published continuously.

The analysis consists of a Danish and an English version. In case of doubt regarding the correctness of the translation the Danish version is considered to be binding.

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