STAFF MEMO

Climate risk and banks' loans to firms

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Abstract

Based on information about emissions and exposure to physical risk from various official Norwegian sources, we determine the share of Norwegian banks' loans to firms that are exposed to transition risk – consequences of transitioning to a lower-carbon economy – and physical risk – consequences of higher global temperatures. We look at banks' relative exposures by an emission price increase from today's level to NOK 2000. We examine the use of energy labeling of commercial property and show how banks' property collateral can be affected by changes in storm surges and flooding. The mapping is a first step in obtaining a more detailed picture of how climate changes can impact risk in Norwegian banks in the years ahead. Important questions remain for further analysis, both linked to the effects of the transition to lower emissions and to the overview of the economic consequences of physical climate changes.

Key words: Climate risk, business and industry, credit risk, financial stability

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1 Introduction

It has long been known that anthropogenic emissions contribute to global warming. The current global temperature is already over 1 degree higher than it was 100 years ago (see IPCC (2021)). And if we are unable to cut greenhouse gas emissions, the temperature may rise substantially ahead. In many areas, the effects of climate change are beginning to come into evidence (see ECB (2021)).

The economic risks related to climate change – climate risk – is often divided into two categories.

- Current production methods must be replaced by lower-carbon alternatives. This entails transition risks. In Norway, since the beginning of the 1990s, we have had national taxes on greenhouse gas emissions. In the past 30 years, the level of Norwegian emissions has remained fairly stable. The target in the Climate Change Act is to reduce emissions by about 55 percent compared with 1990 by 2030 and to render Norway climate neutral, ie zero net emissions of greenhouse gases, by 2050. Achieving the target requires a significant shift in the pace of emission cuts.

- Higher global temperatures affect nature and weather systems. This entails physical risks. In all climate scenarios, including those that presuppose large emission cuts, temperatures are expected to continue to rise. Substantial investments in preventive measures will be required to limit the extent of damages.

Banks are well versed in managing risk. As long as climate risk can be analysed adequately, it should not differ from other types of risks facing banks (see for example Brunetti et al. (2021)) for a discussion. However, climate change represents a new factor, without historical precedence. We cannot analyse climate risk based on financial accounts, as we traditionally do when assessing risk at firm level.

Finding correct information can be demanding. Extensive work is underway to improve the understanding of how climate change and climate policy influence economic variables. Considerable international work is also in progress to improve reporting of climate-relevant information, especially at firm level. However, we cannot wait for this work to be completed before assessing the implications of climate risk for financial stability. To gain an understanding, it is particularly important to understand the effects of climate risk for banks – since banks play a central role in

both credit and payment intermediation.[1] In the following we will therefore focus on assessing climate risk at Norwegian banks based on information about climate exposure and risk from publicly available sources for climate exposure in Norway.

There is a growing body of literature that discusses exposures in the financial sector to climate-related shocks. Battiston et al. (2017) were among the first who defined the concept of climate stress testing. They demonstrated that financial institutions' overall exposure to climate-sensitive businesses was considerable. They then looked at both direct climate exposures – emission-intensive industries and indirect climate exposures – industries that were vulnerable because of modifications other businesses had to make. These past years tools have been developed to assess climate exposures in investment portfolios. One example is the "Paris Agreement Capital Transition Assessment" (PACTA) (2degree Investing Initiative (2021)).

In recent years, many central banks have analysed climate risk in the banking system.[2]. In 2018, the Netherlands Bank conducted an analysis of how restructuring the energy system could influence the financial sector, see Vermeulen et al. (2018). In 2020, Grippa and Mann (2020) from the IMF published a climate stress test of the Norwegian banking system. They found that a marked increase in emission prices can have a significant, albeit manageable, effect on Norwegian banks. The ECB published an extensive climate stress test in September 2021 (see ECB (2021)). It shows that most banks have moderate climate exposures, but that considerable regional variations exist and that individual institutions may be vulnerable. Large banks appear to be more exposed than small banks, among other reasons because large banks are more exposed to large companies operating within energy production and fossil fuel extraction. The ECB also underlines the importance of early efforts to reduce risk. The greatest stress occurs if no measures are taken to reduce emissions, which results in large physical climate changes.

Our contribution consists of providing a concrete, quantified assessment of various types of climate risk for Norwegian banks' loans to non-financial institutions, based on official data sources such as Statistics Norway and the Norwegian Environment Agency. Our analysis of transition risk builds on data for industry-specific emissions. In addition, substantial work is devoted to identifying the average emission price paid by the various industries. This is compared

[1] For a discussion of banks role in Norway (see Norges Bank (2021)).
[2] See eg Marques and Carvalho (2021) from Portugal and Battiston et al. (2020) from Austria. The Bank of England has produced a number of publications on various types of climate risk (see Bank of England (2021)).

with expected emission prices according to the projections in the 2021 Climate White Paper (see Ministry of Climate and Environment (2021)). We conflate this with data about the banks' industry-specific exposures from Finanstilsynet (Financial Supervisory Authority of Norway). The banks are ranked according to their loan-weighted exposures to industries ranked according to how vulnerable these are to an increase in the emission price, measured as an increase in the price paid by the industry for emissions as a share of production.

In addition, we assess climate risk facing commercial real estate – the main exposure for most Norwegian banks. Norges Bank has, in collaboration with Create Solutions (see Visma (2021)), gained access to granular data for Norwegian commercial real estate, which we use to look at exposures to indirect emissions by reviewing energy labelling of commercial real estate across banks.

Using data from the Norwegian Mapping Authority, we can compare localisation of commercial real estate where the banks have collateral in zones that are exposed to physical risk, as defined by the Norwegian Water Resources and Energy Directorate (NVE) and other national sources. We use the data to provide insight into banks' exposure to physical risk.

The analyses focus on risk in today's portfolios and are based on publicly known risk factors and a static bank balance sheet, where we assume that the current lending composition is held constant. Finally, we discuss some factors that can affect risk if we alter these assumptions. Important questions remain for further analysis. Transitioning to a lower-carbon economy may become more demanding than the challenge of reducing emissions in individual industries. There is also considerable uncertainty about the economic consequences of physical climate changes.

2 Banks' exposure to transition risk

If we are to meet the climate goals, greenhouse gas emissions must be substantially reduced. With increased focus on emission cuts, measures to reduce future emissions will become an increasingly important factor in assessing corporate profitability. The price on remaining emissions must be expected to rise. Firms that fail to transition will see their earnings reduced. This could, at least for a period, increase the risk of losses on existing loans. This will also require more extensive follow-up and analysis of new borrowers.

To determine firms' degree of exposure when the emission price rises, one must assess the level of emissions and possible increase in the emission price. Ideally, the emission level and emission price at firm level are known. In practice, such information is unavailable to most of the banks' customers. We therefore ascertain the emission level and emission prices at industry level. We then assess possible consequences of the rise in the emission price in line with the plans in the 2021 Climate White Paper and relate this to the breakdown of exposures by industry for the largest Norwegian banks.

2.1 Only large firms report in line with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations

So far, reporting of emissions and climate measures has not been subject to the same disclosure requirements as financial disclosures. In recent years, the Task Force on Climate-related Financial Disclosures (TCFD) has established recommendations for climate-related financial disclosures at firm level (see TCFD (2021a)). To date, primarily large, listed companies follow the TCFD disclosure recommendations. The International Financial Reporting Standards (IFRS) Foundation, which draws up international accounting standards, is also working on establishing sustainability reporting standards (IFRS (2021)). This summer, the European Commission put forward a proposal for a new directive on corporate sustainability reporting (CSRD) (see European Commission (2021b)). So far, Norway is not covered by this directive.

The TCFD recommends that firms report their greenhouse gas emissions at three levels, called "scope 1 to 3" (see TCFD (2021b)). Scope 1 emissions are direct emissions in production. Scope 2 emissions are indirect emissions from consumption of purchased electricity, heating or steam. Scope 3 emissions are all other indirect emissions in the value chain of the reporting firm. Moreover, firms should report plans for reducing emissions. The sum of emissions for each firm in scope 1, 2 and 3 counts the same emission several times. Scope 2 and especially scope 3 emissions are more difficult to quantify than scope 1 emissions.

At a national level, scope 1 greenhouse gas emissions define Norway's climate reduction commitments under the Climate Change Act and the Paris Agreement (see Lovdata (2017b)). Scope 1 emissions are emissions that firms must pay for themselves, while high emissions in scope 2 affect the firm through a possible increase in energy and heating prices. Energy intensive industries can have large emissions in scope 2. The same is true for heating for example. High emissions in

scope 3 will in the long run affect firms through reduced demand or expectations of product improvements. Sale of fossil fuels is an important source of emissions in scope 3 in Norway. The Norwegian oil and gas industry has very high emissions in scope 3. In 2020, emissions from combustion of annual production of oil and gas from the Norwegian shelf was about 10 times as high as total emissions from economic activity in Norway.

2.1.1 Low degree of reporting among Norwegian shipping companies

To determine the degree of reporting according to the TCFD standards, we have reviewed banks' exposures to Norwegian shipping firms. We chose that industry for several reasons. It is a relatively homogenous industry that accounts for approximately 10 percent of banks' corporate loans. In addition, it is faced with particular challenges from a climate perspective since it has considerable scope 1 emissions (fuel combustion). At the same time, international shipping has so far been shielded from carbon pricing.

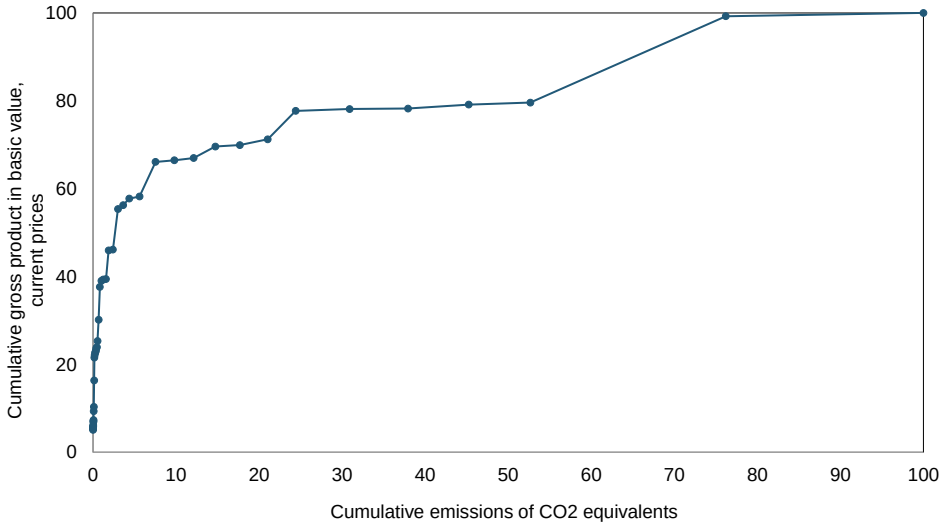
We find that climate reporting for approximately 25 percent of exposures is in line with the TCFD standards. The largest exposures normally have the best reporting, so these exposures account for slightly more than a third of total loans. Reporting firms have scope 2 emissions that are approximately 10 percent of scope 1 emissions. None of the firms reports scope 3 emissions.

Many of the firms report that their emission reduction ambitions are in line with the International Maritime Organization's (IMO) guidelines (see IMO (2021)). This highlights the importance of international cooperation and ambitious industry standards as normative for the firms. At the same time, little information exists about what firms will actually do.

2.2 A small number of industries dominate overall emissions

Most exposures in Norwegian banks are to small and medium-sized enterprises (SMEs). Most of these companies do not report in line with the TCFD standards, so their disclosures do not yet provide an adequate picture of emissions by these companies.

Chart 1: Emissions of CO2 equivalents and gross product in base value, at constant prices. 45 industries. Percent of total emissions and total gross product. 2019



Sources: Statistics Norway and Norges Bank

To obtain a picture of Norwegian banks' exposures to emission-intensive industries, we must use other sources. We choose to use industry-specific emissions from Statistics Norway's climate reporting (see Statistics Norway (2021)), which provides air emissions in CO2 equivalents, broken down on 45 different industries. We use figures from 2019.[3]

The industry distribution in the emission accounts can be adapted so it conforms with the industry reporting in the national accounts. When we conflate emission figures distributed by industry and data on total production from the national accounts, we find that approximately 80 percent of turnover is generated in industries that only account for approximately 25 percent of the emissions (Chart 1).

Four industries account for around 30 percent of the emissions, ie basic metals; air transport; refined petroleum products, chemicals and chemical products, pharmaceutical products; and agriculture and hunting. The highest emissions come from oil and gas extraction, including service activities and transport via pipelines, and from ocean transport. These two industries each account for approximately 25 percent of the emissions.

[3]Emission figures for 2020 were published on 4 November 2021 and are not included in our analysis.

2.3 There are important differences in price of emissions

Reducing greenhouse gas emissions is the objective. Emission prices must therefore rise. The most vulnerable exposures will typically be within industries that have both large emissions and expect a marked increase in emission prices. Norway introduced a tax on carbon emissions already in 1991 (see Ministry of Finance (2020b)). In 2021, for example, the tax on CO2 is NOK 1.37 per litre of petrol (see Ministry of Finance (2020a)) – this corresponds to paying approximately NOK 590 per tonne of CO2 equivalents from petrol combustion (see Norwegian Environment Agency (2019b)).[4]

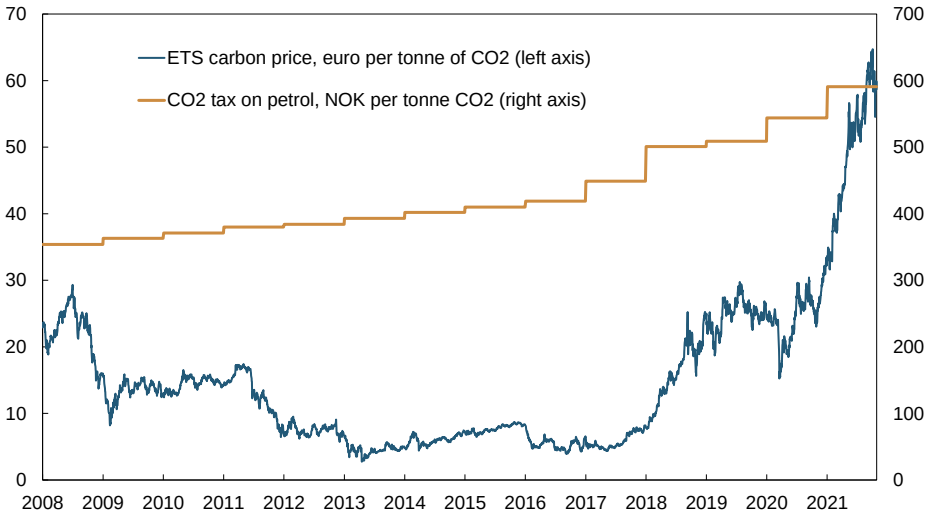
In addition to this, Norway takes part in the EU Emissions Trading System (ETS) (see Norwegian Environment Agency (2019a)). The ETS sets a cap on emissions from large firms within a selection of industries that are exposed to competition by allocating a limited amount of free emission allowances. Over time, the number of such allowances will be reduced. The allowances are allocated partly based on historical production and goals for best practice within the industry. In addition, some allowances are auctioned on an allowance market. Firms with a surplus of allowances may sell these on that market. Accordingly, firms that have higher emissions than the allowance allocation can purchase new allowances. ETS firms are accountable for all emissions with allowances that have been allocated to them or that they have purchased. Firms with emissions under ETS will be able to write off any Norwegian carbon tax against the use of ETS allowances. Domestic air transport and oil and gas extraction are subject to both emission allowances and Norwegian carbon taxes.

The price of traded ETS allowances has increased markedly the past year and is now almost as high as the Norwegian carbon tax (Chart 2). This probably reflects an expectation of a reduction in the cap on the number of allowances – both free allowances and in the market as a whole.

Some emissions are not priced. The main examples are methane emissions from livestock farming in agriculture and use of fossil fuels in international shipping. International shipping is difficult to tax because fuel can be bunkered in zero-tax jurisdictions. So far, the Norwegian authorities have called for lowering emissions from livestock farming in agriculture by means other than the use of carbon taxes.

[4]Note that this is simply one of many petroleum taxes – the road pricing tax on petrol in 2021 is set at NOK 5.01 per litre. Here we only calculate the CO2 tax as a carbon tax.

Chart 2: The emission price of one tonne of CO2 equivalents. European allowance price in EUR (European Trading System, ETS) and Norwegian NOK taxes 2 January 2008 – 15 October 2021



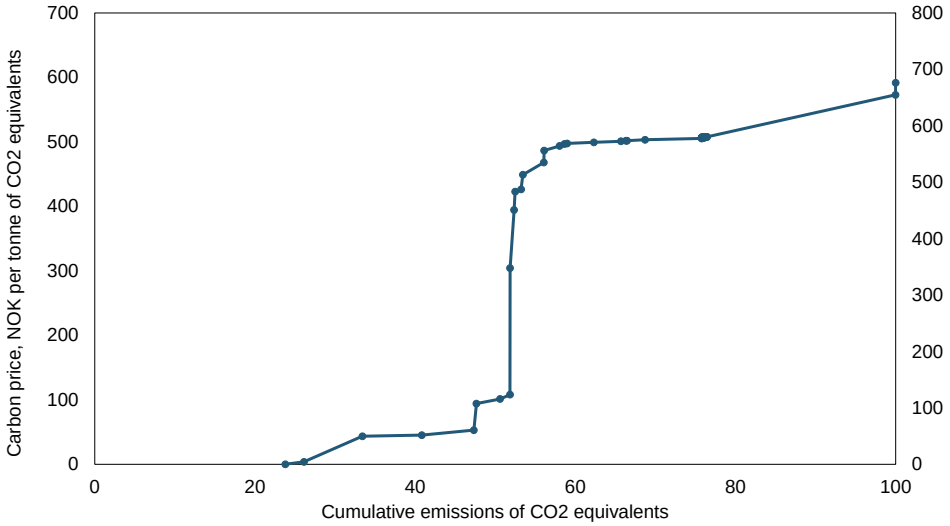
Sources: Energi og Klima (2021), Ministry of Finance and Norges Bank

Because many emissions are either exempt from taxes or have been allocated free climate allowances, the Norwegian carbon tax and allowance price under the ETS do not provide little indication about the amount Norwegian companies currently pay for their emissions. By combining Statistics Norway's reporting of various types of emissions at industry level with the overview of public indirect taxes, we have calculated the price on diverse types of emissions in the Norwegian system. Note that here we only apply explicit CO2 taxes, and do not look at all taxes on fossil fuels.[5]

For industries in the ETS, we have used figures from the Norwegian Environment Agency to identify the share of emissions in the ETS industry and the share of this that is covered through free allowance allocation (see Norwegian Environment Agency (2021)). ETS emissions in excess of allocated allowances are priced at the traded allowance price by the end of the calendar year. When we know the amount paid for various types of emission, we can calculate an average price each industry has paid for emissions. We have included emissions that fall outside the scope of the allowance and tax regime by setting the emission price at zero.

[5]In practice there are two ways to calculate climate taxes. The OECD uses all taxes on fossil fuel and will therefore also include for example the Norwegian tax on road pricing when they look at the total carbon price. The World Bank, however, only looks at the explicit CO2 tax and the effect of emission allowances (see The World Bank (2021)). In November 2021, Statistics Norway published the average emission price (see Randen et al. (2021)). This publication is built on the OECD's method. We use the World Bank's method as a guideline for our calculations. Note that the two methods are complementary. The goal of emission prices is linked to the CO2 tax, but this must be seen in connection with developments in the overall fossil fuel tax.

Chart 3: Emission prices after cumulative emission shares in 45 industries. Volume-weighted average by industry. NOK per tonne of CO2 equivalents. 2018 and 2019*.



*Prices for 2019. The volume weights are based on production figures from 2018.
Sources: Energi og Klima, Ministry of Finance, Norwegian Environment Agency, Statistics Norway and Norges Bank

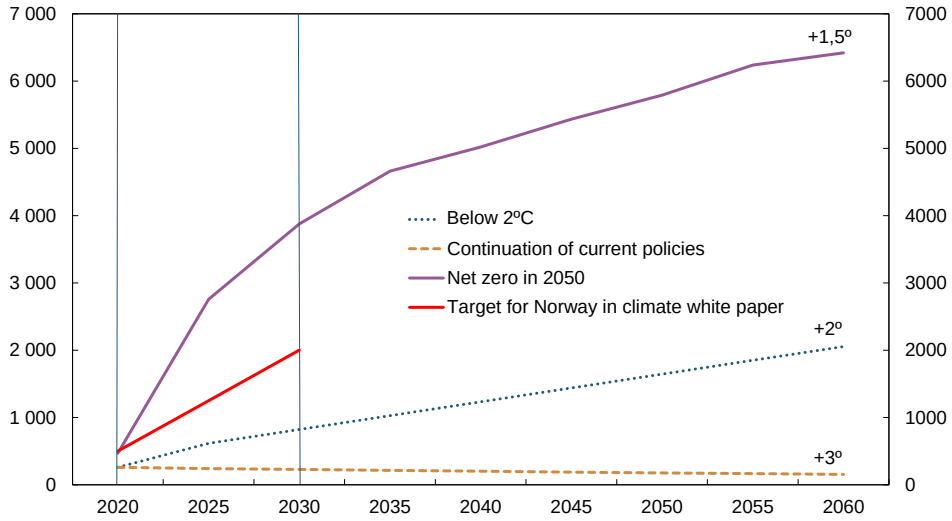
A review of the average price per tonne of carbon shows that there are large differences between industries. Roughly half of the emissions from Norwegian economic activity have an emission price that is below half of the Norwegian carbon tax (Chart 3). Parts of industries exposed to competition, such as the process industry, had in 2019 an average emission price of approximately NOK 100, against over NOK 500 for industries subject to Norwegian tax. Emissions in international shipping stand out in particular as they are not subject to any tax.

2.4 Transport, process industry and primary industries are most vulnerable to increased emission prices

What assumptions should we apply concerning future emission prices? This is a complicated question. Already in the 1990s, William Nordhaus and his research community began to develop a so-called Integrated Assessment Models (IAM models), integrating models that indicate how emissions affect the climate with models indicating how taxes on emissions can impact emission levels (see Nordhaus and Boyer (2020)). Based on such models, climate scenarios have been developed that shed light on how climate taxes must be increased to reach a climate target, and which consequences this may have for different variables, such as the composition of energy production. To provide a standardised basis for central banks and supervisors when using such models, the Network for Greening the Financial System (NGFS) has published a set of detailed scenarios for different climate targets (see NGFS (2021)).

The models used in the NGFS's climate projections show that to reach a goal of limiting the rise in temperature to below 1.5 degrees, the global emission price may have to rise to almost NOK 4000 per tonne of CO2 equivalents by 2030, and to almost NOK 6000 by 2050 (Chart 4). Other reports come to similar conclusions. For example, Fæhn et al. (2020) shows that the Norwegian carbon tax must rise to NOK 3000 by 2030 to reach the current Norwegian climate targets. Today the average global price on carbon emissions is approximately NOK 25 per tonne of CO2 equivalents (see Gaspar and Parry (2021)). With a goal of keeping the rise in temperature to about 2 degrees, however, the necessary increase is estimated at under NOK 1500 as far ahead in time as 2050.

Chart 4: Emission prices in various model projections. EU-28. NOK per ton CO2 equivalents. 2020-2060



Sources: Network For Greening the Financial System (NGFS) and Norges Bank

The 2021 Climate White Paper affirms that if Norway is to meet the requirements set out in the Climate Change Act, the Norwegian carbon tax must increase to around NOK 2000 by 2030. This comes in addition to an expected tightening of the ETS. Emissions in some industries, among others agriculture, will be subject to measures other than carbon pricing.

So far, international shipping has not been included in any climate agreement. This may change in the course of the coming years. The EU has announced plans to introduce carbon pricing in shipping (see European Commission (2021c)). During autumn 2021, Norway has also put forward new proposals for measures within shipping.

Table 1: Increased cost as a consequence of increased emission price. Percent of turnover in 2018

Paper and paper products	2.5
Electricity, gas, steam and air conditioning supply	2.6
Oil and gas extraction, including service activities and transport via pipelines	2.9
Land transport, except transport via pipelines	3.4
Mining and quarrying	3.5
Refined petroleum products, chemicals and chemical products, pharmaceutical products	6.1
Sewerage and waste management	6.3
Inland water and costal transport	6.3
Fishing	7.1
Other non-metallic mineral products	10.0
Basic metals	10.7
Air transport	15.4
Agriculture and hunting	25.1
Ocean transport	25.4
Average of all industries	3.0
Average of all industries, weighted by turnover in 2018	2.0

Sources: Energy and Environment (online newspaper), Ministry of Finance, Norwegian Environment Agency, Statistics Norway and Norges Bank

In the following, we assume that the emission price rises to NOK 2000 for *all industries*. For industries such as agriculture and shipping this is probably more than can be expected. For other industries it may be too low. We note that NOK 2000 is somewhat lower than some climate scenarios indicate is necessary to reach a target of 1.5 degrees, but at the same time it is higher than expected to be necessary to reach a target of 2 degrees. The projection in the 2021 Climate White Paper therefore appears to be a reasonable expectation for the emission price in the medium term if the goals in the Paris Agreement are to be met.

The 2021 Climate White Paper assumes that an increased tax falls in step with a reduction in emissions. The goal is to reduce emissions from Norwegian activity by around 40 percent in the period to 2030. Several large Norwegian companies have published emission targets that are slightly less ambitious. For example, Hydro intends to reduce emissions by about 30 percent by 2030 (see Hydro (2021)).

We assume that emissions of CO2 equivalents per industry remain unchanged even if the emission price increases to NOK 2000. For the great majority of industries this sets an upper limit on how vulnerable the industry will be to increased taxes. It should be noted, however, that some industries, such as shipping and extraction of oil and gas, have exhibited growing emission intensity in the period from 2010 to 2019.

We measure vulnerability as increased payment for emissions as a share of the value of total production. Increased payment for emissions is the difference between NOK 2000 and the current average emission price for the industry, multiplied by the industry's emissions. In 14 industries, the increase in the emission price will account for more than 1 percent of turnover in 2020 (see Table 1). The table is dominated by three types of activity: transport, process industry and primary industries. Some industries, such as agriculture and ocean transport, incur a considerable estimated increase in costs because the current emission price is low. Oil and gas extraction produce large emissions, but the emission price is already relatively high.

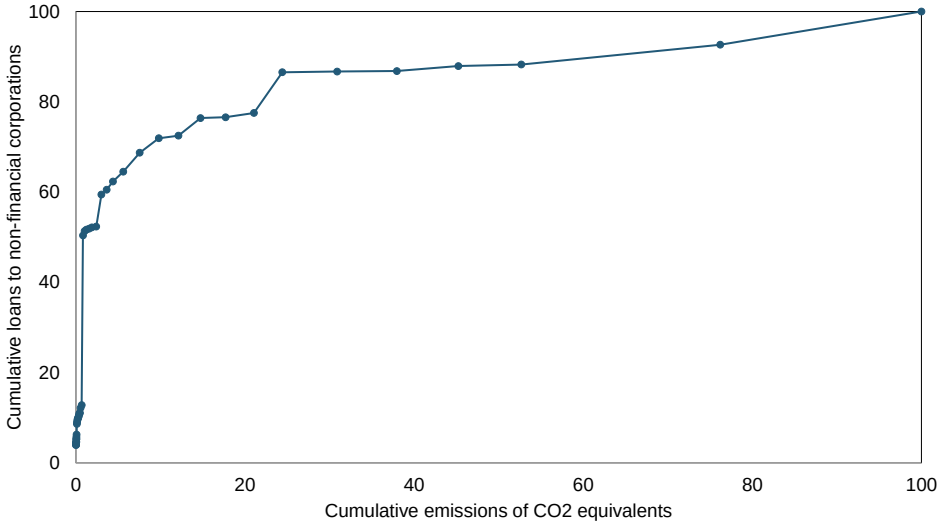
2.5 Banks are moderately exposed against industries which are particularly vulnerable

Finanstilsynet's loan exposure reporting provides a breakdown by industry of banks' loans to firms. The report is at 5-digit NACE level. The entire exposure is classified within the borrower's primary industry affiliation – even if the borrower operates in different industries. We can thus conflate total loans in the industries with emission information (Chart 5).

The chart shows that most of the banks' loans to firms are to industries with a moderate share of total emissions. Roughly 85 percent of loans are to industries that account for approximately 20 percent of emissions – and 15 percent of the loans are to industries that account for 80 percent of emissions. Many of the industries with large emissions – such as parts of the process industry – only account for a marginal share of banks' loans to firms.

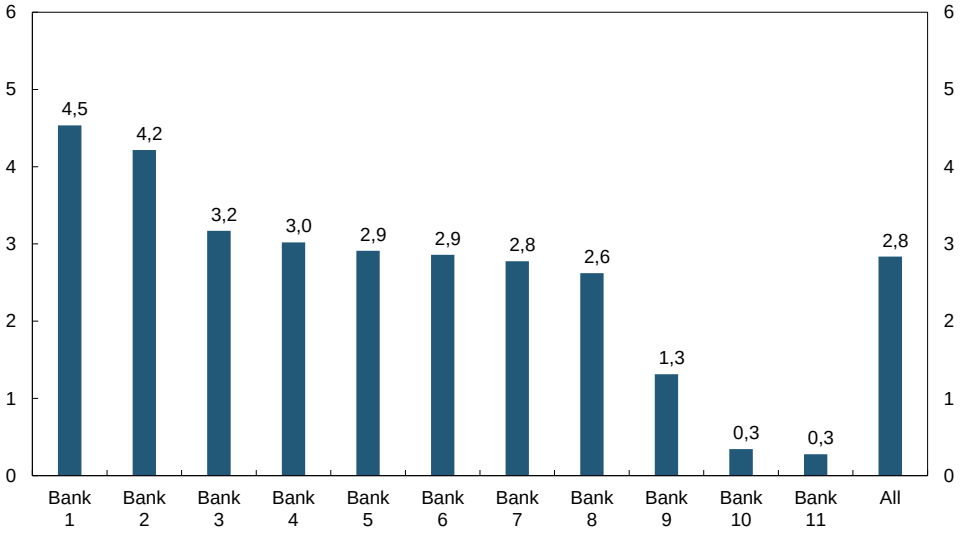
We calculate loan-weighted exposures against the effect of increased emission price for the 11 largest banks in Norway – nine Norwegian banks and three branches of foreign banks (Chart 6). The process industry and agriculture have relatively small loans in banks. On the contrary, ocean transport represents a large industry for Norwegian banks. The same is true for companies operating within oil and gas extraction, especially within oil services. Approximately 20 percent of the large Norwegian banks' loans are to industries that are vulnerable in the event of a marked increase in the emission price. About half of these loans are related to ocean transport or inland water and coastal transport. Banks with substantial exposure to such transport are therefore the ones that are most vulnerable to transition risk. Some of the foreign banks that operate in Norway have placed the majority of their ocean transport loans in the Norwegian branch, making the branches appear more climate-exposed than the group as whole.

Chart 5: Emissions in CO2 equivalents and banks' loans to non-financial institutions. 45 industries. Percent of total emissions and total loans to non-financial institutions. 2019



Sources: Finanstilsynet, Statistics Norway and Norges Bank

Chart 6: Increased cost* as a result of increased emission prices, as share of production and weighted by the banks' share of loans. Percent. 2019



*The emission price increases from the 2019 level to NOK 2000 tonne of CO2 equivalents. No emission cuts. Bank customers measured at industry level.
Sources: Energy and Environment, The Ministry of Finance, The Financial Supervisory Authority of Norway's, Norwegian Environment Agency, Statistics Norway and Norges Bank

The need for ocean transport will not cease even if the emission price should rise. One can expect that ocean transport will to a large extent be able to pass on parts of the increase in costs to higher freight rates. Furthermore, there is potential over time for reducing direct emissions from oceangoing vessels. However, great uncertainty still remains regarding which technological solutions will be the best. Since ships are capital-intensive and have a long expected service life, it is important that this transition starts as fast as possible. Besides, we know that roughly half of the Norwegian banks' exposures to ocean transport are related to either freight of oil and gas or to ships that are used in the oil service industry. These activities may be in need of more restructuring than emission cuts and price adjustments.

3 Banks' exposure to property according to energy labelling

In the previous section, we discussed exposures to scope 1 emissions. As mentioned, scope 2 emissions are linked to the purchase of electricity and heating. Norwegian dwellings and commercial real estate (CRE) cover most of their need in energy through electricity. They therefore have relatively small direct scope 1 emissions, but potentially large scope 2 emissions.

Property, in the form of dwellings and CRE, is the largest individual exposure for Norwegian banks. Approximately 80 percent of loans in Norwegian banks are either mortgages or loans to companies operating in CRE or building and construction. Because of the sizeable exposures, it is important to understand the risk associated with this type of loan.

The use of electricity for among other things heating makes it easier to make use of clean forms of energy. Electrification is still not sufficient to ensure that energy consumption is sustainable. There is reason to believe that higher requirements for zero-emission electricity may lead to electricity becoming a scarce resource in the years to come. Hence, efficient energy consumption is important. High electricity consumption can lead to increased vulnerability if electricity prices should rise markedly. An additional element is the possibility that renters who are concerned about their own climate footprint may want to reduce the energy consumption in their premises. For many service companies emissions from office premises will account for a substantial share of the company's total emissions and will therefore be given considerable weight in their climate adaptation.

CRE companies already report that low energy consumption and energy certification have become an important competitive parameter in the search for renters. This will also be reflected in the pricing of commercial buildings. Commercial buildings that have a small climate footprint can expect a better price. On the other hand, buildings that are not upgraded may fall in value.

3.1 Requirement for energy labelling of commercial property is not sanctioned

The authorities are attempting to help buyers and renters evaluate the energy consumption in buildings by setting requirements for energy labelling. In Norway, all vocational buildings over 1000 square metres, including all buildings that are to be rented out, must have an energy label (see Lovdata (2017a)). Energy labelling – or the absence of energy labelling – can therefore be an important indicator of commercial property valuation.

Nevertheless, there seems to have been little awareness concerning the requirement for energy labelling. According to the inspections conducted in 2017 and 2018 by the Norwegian Water Resources and Energy Directorate (NVE), only around half of the buildings had such an energy label (see NVE (2021a)). The regulatory sanction for the absence of energy labelling is relatively mild. If energy labelling did not exist at the time of sale, the buyer can within one year perform energy labelling to be paid by the seller.[6]

The energy certificate mainly provides information about the building body, insulation, windows, etc., and technical installations, but less about how energy efficiently the building is managed and used. A building often has several energy labels. Energy labelling can be performed by accredited assessors (see ENOVA (2021)). They may be employed by those who own or manage the building, or external energy advisor can perform the task. It is the owner's duty to provide energy labelling and the owner is also responsible for the data used. By the end of 2020, about 30 000 energy labels were registered according to ENOVA. The figures from Create Solutions show that they are distributed across 7 600 commercial buildings.

[6]Section 5 of the Energy Labelling Regulation: «If the owner has not presented an energy certificate, and the owner after written request from the buyer has not presented the energy certificate before the sales contract is entered into, the buyer can have an energy certificate produced with the aid of an expert to be paid for by the seller within one year after the sales contract is entered into.»

3.2 Banks should follow up exposure to ineffective energy consumption

Thanks to the Norwegian Mapping Authority and Create Solutions, Norges Bank has access to detailed information about Norwegian commercial buildings. We can also conflate commercial buildings with banks through registered collateral. In this data set information on energy labelled buildings is also included.

In the 11 largest banks' loan portfolios only between 20 and 30 percent of the commercial buildings have registered an energy label (Chart 7). The share varies a good deal among the banks. A couple of the foreign branches, which have a somewhat greater share of high-quality buildings in central areas in their loan portfolio, have the highest share of buildings with a registered energy label. Among the buildings that have an energy label, most have an average energy grade (Chart 8). This is the case irrespective of the bank or building type.

Banks have a vested interest in making sure that the property they hold as collateral has energy labelling and that owners have a plan for ensuring energy efficiency. Moreover, by imposing requirements, banks can contribute to developing and furthering the scheme, which can be of benefit to all users.

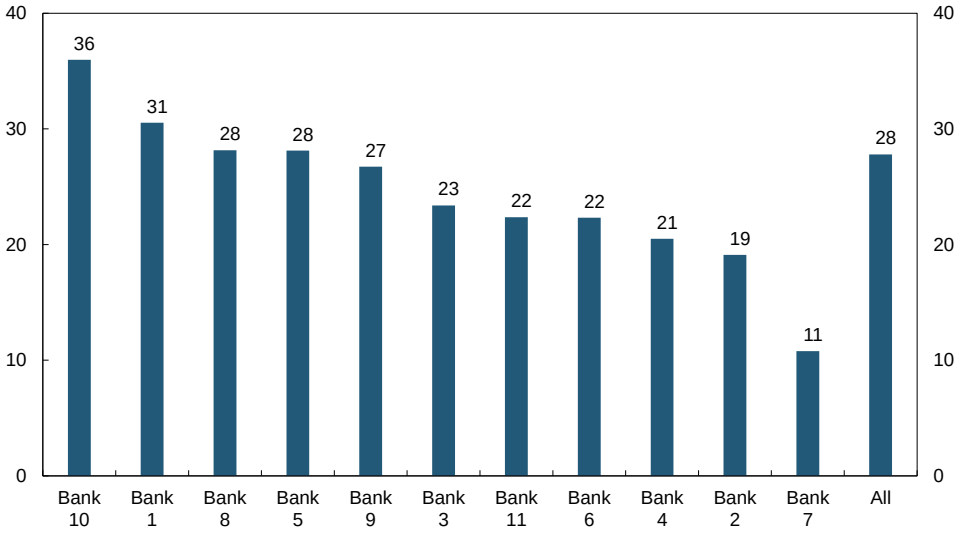
4 Banks' exposure to physical climate risk

Physical climate risk arises a result of more extreme weather, rising sea levels or just generally higher temperatures. Such changes can have both direct consequences, such as increased risk of flooding or forest fires, and indirect effects, such as changes in biological systems. The consequences of physical climate risk can, in many cases, be mitigated through preventive measures.

Banks are exposed to both physical climate risk in that losses on CRE-loans may occur as a result of damages and because physical climate risk can affect the value of collateral that is used as security for loans. Collateral risk will be reduced if the collateral object can be insured against damages. In Norway, buildings that sustain natural damage will be covered by the Norwegian National Scheme for Natural Damage Assistance, which is a collective insurance scheme with public contributions.[7]

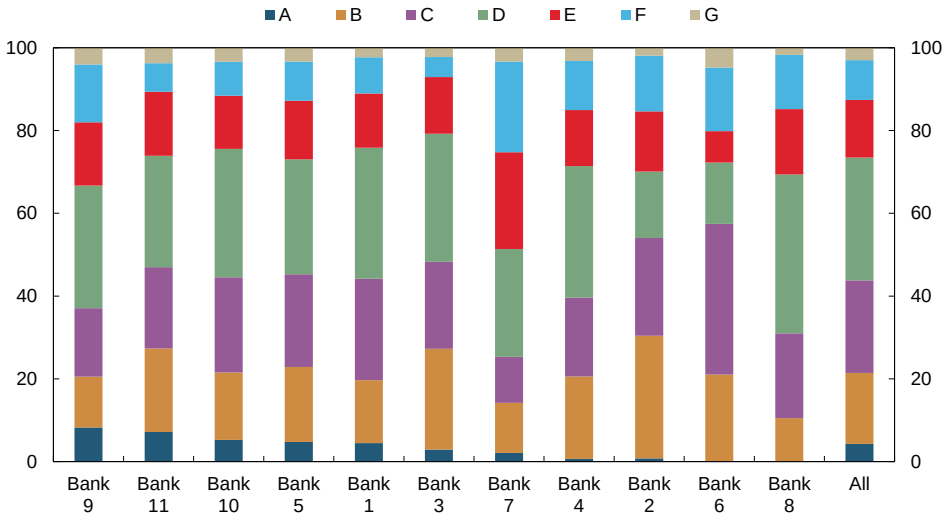
[7] All buildings that are insured against fire will also have coverage for natural perils. Companies that provide insurance against fire make contributions to this insurance scheme. In addition, the government has a scheme to cover natural damage to buildings that cannot be insured through private schemes. jf. Landsbruksdirektoratet (2021). Insurance only covers the replacement of the existing building.

Chart 7: Commercial buildings with energy grade in the banks' loan portfolio. The 11 largest banks. Percent of industry surface area in each bank's portfolio. 2021



Sources: Create Solutions and Norges Bank

Chart 8: Commercial buildings with energy grade* in banks' loan portfolio. 11 largest banks. Percent of industry surface area with energy grade in each bank's portfolio.2021



*The energy grade ranges from A to G, where A is most energy efficient. Sources: Create Solutions and Norges Bank

If the probability of repeated damage is considerable, it could nonetheless influence the value of the building. Studies, for example from Denmark, show that pricing of housing to some extent reflects exposure to natural disasters (see Mirone and Poeschl (2021)). If the consequence of climate changes should become more severe than currently expected, vulnerable CRE could fall in value compared with today's price.

4.1 Physical risk for property is well mapped

Areas that are exposed to direct physical climate risk, and especially risk of damages as a result of precipitation, are in some measure predictable. Storm surges affect buildings located near the sea. The area that can be afflicted by storm surge events becomes larger when the general sea level rises. The effect of climate changes on the sea level in Norway is complex. The report "Sea level change for Norway" from 2015, Simpson et al. (2015) indicates that the sea level can increase by between 15 and 55 cm by the end of the century if the level of emissions evolves in pace with the representative concentration pathway RCP8.5.[8] With RCP4.5 the sea level rises between 0 and 35 cm, while RCP2.6 results in a sea level rise between -10 and 30 cm.

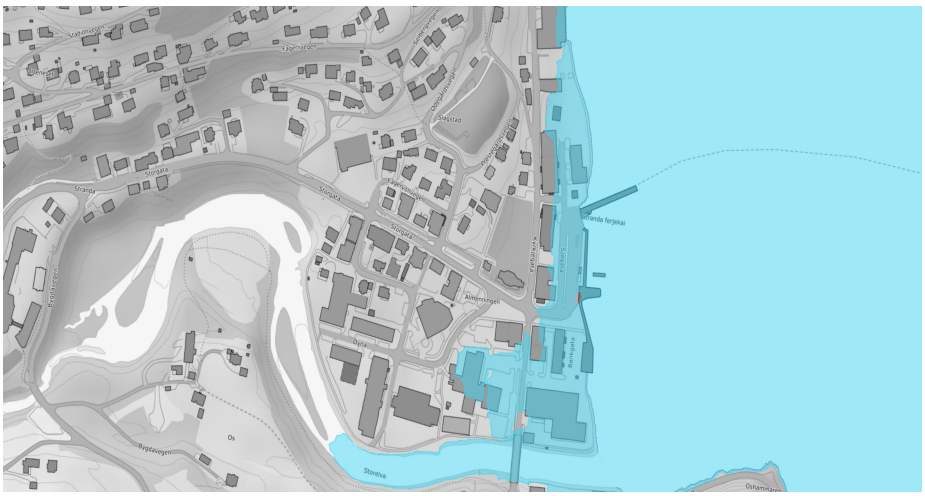
Climate changes are expected to lead to increased precipitation. This can augment the risk of flooding, landslides and avalanches. High levels of precipitation can lead to damages also in areas that are not exposed to flooding. On the other hand, a change in the composition of precipitation can also affect risk. For example, less snow and more rain can reduce the biggest spring floods, which have traditionally accounted for a considerable natural peril risk in Norway.[9] Norwegian authorities have mapped out the most exposed areas. Maps over vulnerable areas are available from the Norwegian Water Resources and Energy Directorate (NVE) (see for example NVE (2021b)). NVE and the Norwegian Mapping Authority provide detailed information about individual buildings located in the danger zone (Chart 9).

For flooding, NVE has defined a vigilance area. NVE writes that even though flood vigilance maps can never be entirely accurate, the map including a usage description is sufficient to determine where the potential flooding risk is and where the flooding risk must be more closely investigated, if new construction measures are planned» (see NVE (2020)).

[8]The metric indicates the accumulated concentration of climate gasses. RCP8.5 builds on an assumption that emissions will continue to rise throughout the 21st century. This is not considered as particularly realistic any longer. With RCP4.5 emissions peak around the year 2040, and with RCP2.6 emissions are cut already from 2020 up to 2100, but remain somewhat higher than assumed in the Paris Agreement (which applies RCP1.9) (see for example Wikipedia (2021)).

[9]Climate Analytics estimate that the median risk of flooding in Norway is little affected by the rise in global temperatures. However, the uncertainty may increase (see Climateanalytics (2021)).

Chart 9: Sea level along the built-up area Stranda in Møre and Romsdal according to estimated 200-year* storm surge in 2090.



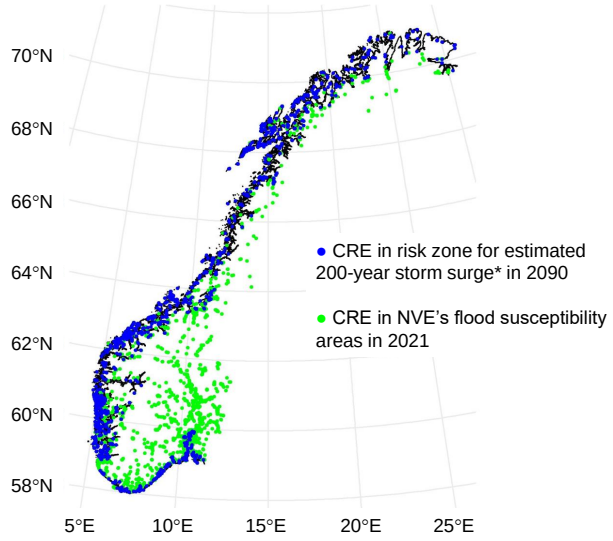
* If the 200-year storm surge hits the town Stranda in Møre and Romsdal in 2090, the retailer Europris, for example, which is situated on the headland where the river Storelva flows into the fjord, will be vulnerable.
Source: Norwegian Mapping Authority

Physical climate risk will make it more important for banks to monitor whether or not commercial buildings are located in exposed areas. The value of commercial buildings in such areas may increasingly depend on the implementation of preventive measures. Over time, some commercial buildings will be made vacant, and businesses moved to different locations.

4.2 Banks are moderately exposed to physical climate risk

Loans backed by collateral in commercial buildings are registered in the Norwegian Mapping Authority's land registry. We can therefore identify which banks have collateral in buildings on a property. By using information about the building's location, we can identify buildings that are situated in a risk zone. Even if a building is situated in a risk zone, this may not constitute a risk if necessary precautionary measures have been taken. Chart 10 shows the location of commercial buildings situated in storm surge and flooding risk zones.

Chart 10: Map of Norwegian commercial property in risk zones*



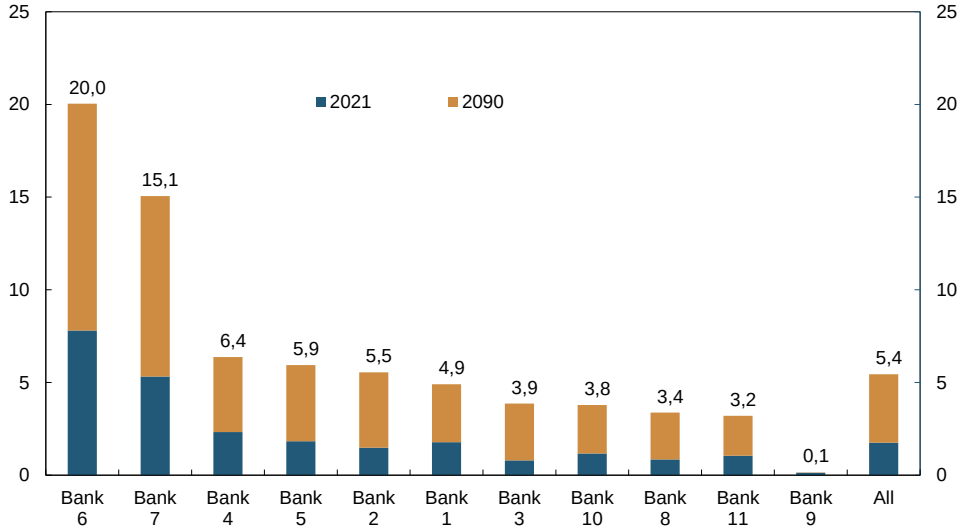
*In the climate-adapted flood zones, assumptions about increased flow of water as a result of climate changes are incorporated.
Source: Create Solutions, Geonorge and Norges Bank

Storm surges follow the coast, and the danger of floods follows the large valleys in Østlandet.

Currently a reliable valuation of the commercial buildings is lacking, but we have precise information about the number of square metres of the various buildings. We can now calculate the share of the different banks' property that is situated in the different storm surge risk zones (Chart 11). We see that today just about 1.8 percent of property in which the 11 largest banks have collateral is situated within a "200-year risk zone" for storm surge (0.5 percent probability of being hit during a given year). With the rise in the sea level rise expected in the period to 2090, the share that is situated in the "200-year zone" will increase to approximately 5.5 percent. There are wide differences among the banks. Banks with the majority of their loans inland naturally have little exposure to the 200-year storm surge. On the contrary, banks with loans to commercial property in city centres located near coastal areas may have considerable collateral in property exposed to such risk.

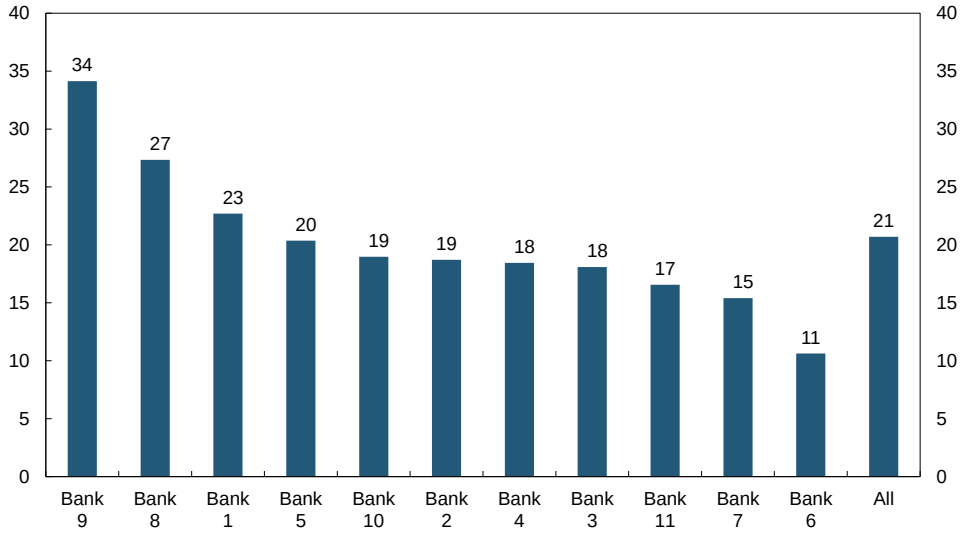
Similar analyses can be conducted for risk factors such as flooding, landslides and avalanches. The vigilance areas for flooding is fairly extensive. Over 5 percent of collateral in the 11 largest banks is situated within such areas (Chart 12). Some banks that had low exposure to surge, have higher than average exposure to flooding, which reflects wide regional differences between the banks.

Chart 11: Commercial buildings in risk zones for estimated 200-year storm surge*. Percent of commercial areal in every bank's loan portfolio. The 11 largest banks. 2021 and 2090



*200-year storm surge will statistically occur once every 200 years, ie with a 0.5 percent probability every year.
Sources: Create Solutions, Geonorge and Norges Bank

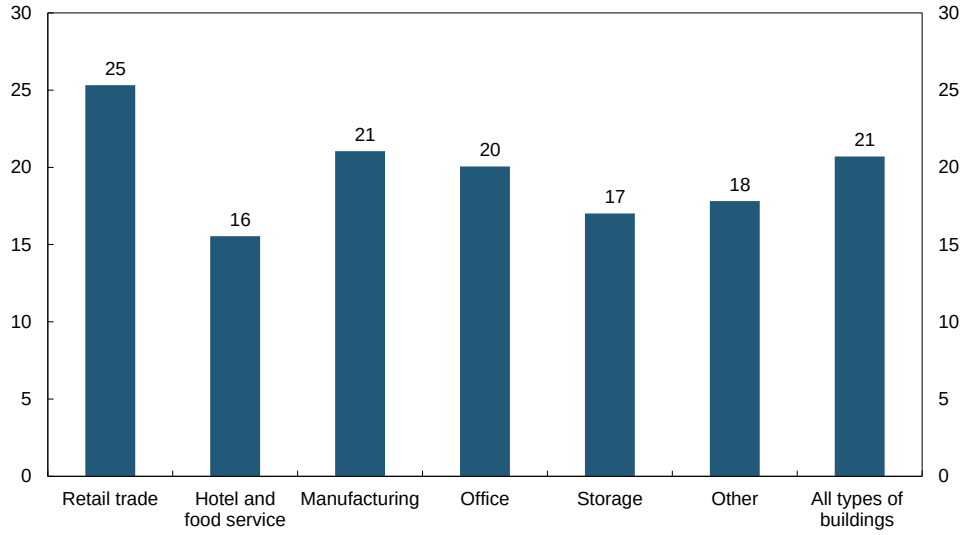
Chart 12: Commercial buildings within NVE's flood vigilance area. 11 largest banks. Percent of surface area in each ban's' loan portfolio. 2021



Sources: Create Solutions, Geonorge and Norges Bank

We can also see the breakdown of risk-exposed commercial properties on various types of buildings. Shops and retail premises are relatively more vulnerable than other types of premises (Chart 13). The hotel and restaurant segment is somewhat more exposed to storm surge, while the office segment is more vulnerable in the event of flooding.

Chart 13: Commercial buildings within NVEs vigilance areas for surge and flooding. 11 largest banks. Percent of surface area in various types of commercial buildings. 2021



Sources: Create Solutions, Geonorge and Norges Bank

5 Limitations in the analysis and further work

In this Staff Memo, we have attempted to quantify the risk associated with banks' loans to firms linked to transition risk and physical risk. It is important to note that we are still early on in the process of understanding the potential implications of climate change for financial stability. We want to draw attention to three factors we believe are important to emphasise in further work: improved understanding of how Norwegian transition risk is impacted by indirect scope 2 and 3 emissions, better understanding of physical risk linked to temperature rise, and focus on how the transition to new technology could influence banks' risk-taking.

5.1 Transition risk facing banks is affected by more than scope 1 emissions

For banks, the total effect of climate change on the profitability of firms is the key element. In this analysis, we have focused on exposure to scope 1 emissions. Moreover, we discuss potential scope 1 emissions for commercial property by examining energy efficiency and energy labelling.

Scope 2 emissions are linked to the purchase of electricity and heat. The transition to green energy

sources can be demanding. Even though Norway has substantial production of hydropower, the Norwegian electricity market will be influenced by developments in the rest of Europe. Increased electricity prices can lead to many firms facing periods of low profitability. This can raise the probability of default in some industries.

One reason Norwegian banks are moderately exposed to scope 1 emissions is that Norway imports many industrial goods with large emissions (see Sørheim (2021)). Increased global carbon prices can impact price and access to such goods. This can expose Norwegian firms to cost pressures. In order to understand banks' exposure, it is important to understand how increased carbon prices and periodical bottlenecks due to production restructuring and reduced global emissions can influence Norwegian activity.

For Norway as a whole, it is the oil and gas industry and scope 3 emissions that represent the greatest uncertainty. Stricter climate policy will, according to our current knowledge, lead to lower demand for oil and gas over time. Some oil and gas resources will probably have to remain unexploited. Stricter climate policy may mean that investments in Norwegian oil and gas industries will become less profitable than expected.[10]

How the transition will play out is a complex question. Oil and gas has during roughly the 50 years of production in Norway been an industry featuring wide fluctuations in both earnings and investments. Rapid structural changes may entail sizeable consequences for the real economy. Norges Bank's often includes a fall in oil prices and oil investments in its stress tests and crisis exercises. In their plans, the banks should make provision for the fact that, regardless of any other factors, uncertainty about the future of the oil and gas industry contributes in isolation to higher uncertainty about the growth prospects for Norwegian economy.

[10] But the relationship is not straightforward. In the short term, oil and gas can be a substitute for coal and an alternative in periods of unstable energy production from green energy sources. New technological solutions, such as carbon capture and storage (CCS) may, in theory, contribute to oil and gas becoming part of the climate solution, also in the long term. In any event, Norway has probably exploited most of its oil reserves, and production of oil has long been expected to decrease in the years after 2030 – even though gas reserves are still considerable. The industry is characterised by a highly educated workforce that should have good opportunities to use their skills in other industries.

5.2 Many forms of physical risk are poorly mapped

Mapped physical risk is only one part of the possible consequences of climate changes. Climate changes can also influence factors that are more difficult to measure. There are several dimensions that put us at risk of underestimating the effects:

- First of all, many of the changes are very local. Climate analyses are being made at a fairly at a rather fine-meshed geographic level, but it is challenging to assess the economic consequences of this at macro level.

- It is also possible that climate changes could trigger greater changes in climate systems, such as global ocean currents. If the Gulf Stream should weaken, see eg Specktor (2021), the consequences could be colder weather in Norway – not warmer. Such "tipping points" are difficult to foresee.

- Climate changes will affect biological systems. So far, reliable analyses of the economic consequences of such changes are lacking, and they are therefore not included in the type of analyses we present here. We knnow that Arctic fauna is strongly affected by the rise in temperature (see eg MMC (2021)). Norwegian fishing and fish farming can be vulnerable in the long term. Both new species, as well as species loss, may have significant negative consequences.

Going forward, it is crucial that we broaden the perspective of possible consequences of changes in the environment. Further analyses of economic consequences of physical climate changes in Norway is necessary to identify potential risk factors. It can also alter our perception of how exposed Norwegian banks are to physical risk.

5.3 Climate changes require a change in banks adaptation over time

In this analysis, we have focused on exposures we believe have the highest probability of write-offs as a result of transition risk and physical risk given a static bank balance sheet. But even though we already see the consequences of climate changes now, the biggest changes still lie ahead. Much of the risk for banks is therefore not linked to their current balance sheets but to their future balance sheets.

The transition to a low-carbon society is a considerable economic challenge. At the same time, it is most likely a problem that can be solved – through targeted investments and development work, it is possible to replace today's polluting methods by other alternatives. Meanwhile, the return on this investment will be uncertain – some will have the opportunity to make immense profits, but many will fail. This is not an unknown phenomenon. Technology cycles entail vast changes in industry structure. Substantial capital must be reallocated. In a report from September 2021, the European Commission estimates that the EU needs EUR 470 billion in annual investments to counteract the effects of climate change (see European Commission (2021a)), which comes to about 4 percent of total GDP in the EU in 2020, or just about 15 percent of investments during the same year. In comparison, Norwegian oil investments, for example, have since the early 1980s accounted for between 8-10 percent of total investment in Norway.

Banks will play a role in this transition. Historical experience shows that such shifts can contribute to amplifying credit cycles. Even though banks' loans often have a less speculative character than many other financial investments, historical experience shows that periods of substantial investment waves also affect banks' credit risk, partly by increasing fluctuations in property prices.[11]

6 Conclusion

We have examined some important sources of direct climate exposure for loans from Norwegian banks. Overall, the banks have moderate loans to emission-intensive industries, but are exposed to some industries with high emissions – especially shipping. The banks have sizeable loan exposures to commercial property. It would appear that there is a need to reduce energy consumption for these properties. For certain banks, a portion of current collateral values in commercial property could lie in the risk zones in the event of a rise in sea level or flooding.

Forward-looking banks that actively take into account climate change risk assessments should have ample scope to reduce current balance sheet risks. However, we must bear in mind that we still lack a full overview of the consequences of climate changes. The banks must take into consideration that new investment opportunities arising from climate-related changes may involve risk. Considerable climate investments alone can generate investment cycles that heighten the risk of financial crises.

[11] This is, for example, the mechanism in the well-known Kiyotaki-Moore model (see Kiyotaki and Moore (1997)).

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