STAFF MEMO

The commercial real estate market - no longer a “black box”

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The commercial real estate market - no longer a “black box” *

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Abstract

Norwegian banks’ exposure to commercial real estate (CRE) is substantial. Historically, banks in Norway and in other countries have incurred considerable losses on loans to this sector during financial crises. Publicly available information has been limited. This is partly because CRE is a highly heterogeneous product, and transactions involving commercial buildings are often not recorded in public registers. Norges Bank has recently obtained access to a large sample of data for commercial buildings. We have linked this data set to banks’ mortgages on buildings and estimated the market value of buildings. Our results show that the preponderance of banks’ exposure to CRE is to the office market in cities, particularly in Oslo. On the other hand, the most expensive office buildings are one of the segments banks are less exposed to. Furthermore, we find that banks are broadly exposed to the CRE market and that individual banks’ exposures to different building types are fairly similar.

Key words: Financial stability, commercial real estate, banks’ credit risk

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1 Introduction

Loans to firms engaged in the sale and management of property (commercial real estate (CRE) firms) account for around half of Norwegian banks' corporate exposures. Historically, CRE loans have proved to be an important source of losses in deep downturns and thus a possible source of systemic risk (see Hagen et al (2018) for a more thorough discussion). During the banking crisis in 1987-1992, Norwegian banks had to recognise substantial impairment losses on CRE loans. After the financial crisis in 2008-2010, US and European banks incurred large losses on such loans. Developments in the CRE market and banks' exposure to this sector therefore matter a great deal for financial stability in Norway.

The statistical basis for CRE has been limited. Norges Bank has previously recommended strengthening the data basis for CRE (see eg Norges Bank (2018)). There has not been an information source covering the entire sector that would make possible a comprehensive assessment of the sector. CRE is a highly heterogeneous product, and detailed information on this market has been difficult to obtain. The quality and use of the properties varies considerably. Leases and loan contracts are not public information. Moreover, ownership is established in a number of different ways. Sales have normally taken place through the sale of shares and have not been recorded in the register of real property. For that reason, public price statistics do not exist. Market analysts have usually followed the office market in cities, while other segments and regions have received less attention. The price statistics provided by market participants are primarily for office rents in cities and for rental and selling prices for the most attractive office space (prime office space).

In this *Staff Memo*, we explain how we assemble and use a large data set of commercial buildings in Norway and banks' exposure to them. We use information from different private providers and from public registers. Our most important information source is data from Create-Solutions (CS). CS gathers information about floor space, location, building type, tenants, etc, for most of the commercial buildings in Norway. We also use information obtained from the Norwegian Mapping Authority on registered mortgages on properties to obtain an overview of the buildings banks are exposed to. To estimate the size of banks' exposure in the form of mortgages on commercial buildings, we need estimates of the buildings' value. By putting together information about rents and yield from various market participants, we make an assessment of average price that differentiates between segments and regions.

More information about the CRE market and banks' exposure to the sector may improve assessments of the credit risk of banks' corporate loans. We are now able to estimate the degree of banks' exposure to different geographical areas and building types. The new data set can be used to assess the degree of banks' exposure to various shocks, such as an oil price fall, by being exposed to CRE.

In the following, we will first describe the data sources and how we make estimates of the value of the properties. We will then use the data basis to provide a description of the Norwegian CRE market. Finallly, we describe how banks are exposed to CRE.

2 Data basis

The data basis comprises a combination of data from the Cadastre and other public register documentation and information obtained from various private entities.

2.1 Cadastre and land register

The Cadastre, which is Norway's official property register, is the most important source of information about real estate in Norway. The Ministry of Climate and Environment owns the Cadastre, while the Norwegian Mapping Authority has technical and administrative responsibility. The register contains information on property boundaries, area, buildings, dwellings and addresses. A property is identified by a cadastral unit (cadastral number and property number). A property can be a lot or a sectioned part of a property (eg a freehold flat).

The Cadastre contains information on all buildings in Norway. As a main rule, free-standing building units are to have their own property number. In the Cadastre, all buildings are classified according to building type, which is determined according the function of the building. Multi-purpose buildings, for instance combination dwelling and commercial buildings and storage and production buildings, are grouped by the function that occupies the main part of the utility floor space. Here, commercial buildings are all buildings in the Cadastre not classified as a dwelling.

The land register is Norway's official register of registered rights to and encumbrances on real property. Legal title and mortgages are among the most important rights. A mortgage is registered on a mortgage document. On the mortgage document, one or more mortgagees (owners) pledges one or more items of collateral (cadastral number and property number). The secured amount is for all items of collateral collectively and may not be divided by item of collateral. The mortgage is transferred to a mortgagor, which is often, but not always, a bank.

We use information about banks' security interest in properties to obtain an overview of the buildings they are exposed to. Section 5.1 describes how we use mortgage documents to link banks to buildings.

2.2 Data on commercial buildings

CS provides additional information on commercial buildings in the Cadastre by using algorithms to obtain information from other public registers. Besides the figures we can obtain from the land register, CS provides information about eg floor space, location, building type and tenants.

Our building sample includes all commercial buildings CS provides additional information on. The buildings in the sample primarily belong to commercial building segments, and they are divided into the main categories office, retail, hotel and restaurant, warehouse/logistics and industrial. The retail segment is the most heterogeneous segment and includes shopping centres and grocery shops. The CS data cover few buildings primarily owned by the public sector, such as hospital and care buildings, schools and sports facilities. Since we are interested in banks' credit risk, such a sample is adequate for our purposes.

3 Estimates of market value

A commonly used method for estimating the value of an asset, including commercial property, is to sum the discounted free cash flow the asset gives rise to (see Hagen (2016)). The discount rate reflects the yield on the investment.

Based on this valuation principle, it is customary to use the following relationship between the rental price and selling price of a commercial property

$$Selling\,price = \frac{Rental\,price}{Yield} \tag{1}$$

The yield is an approximation of the required real rate of return on an investment. It is common to decompose the yield into a risk-free interest rate and a risk premium. In a transaction, the rental income from and selling price of a property are known. Based on this, the yield can be calculated. It is possible to use the yield from comparable transactions to estimate the selling prices for other buildings.

Based on (1) and estimates of rents and yield, we can estimate the market value of individual buildings. We obtain an estimated value of 99 percent of the buildings in our sample. Cross-checks indicate that our estimates are reasonably accurate at an aggregate level (see further discussion in Appendix A.2).

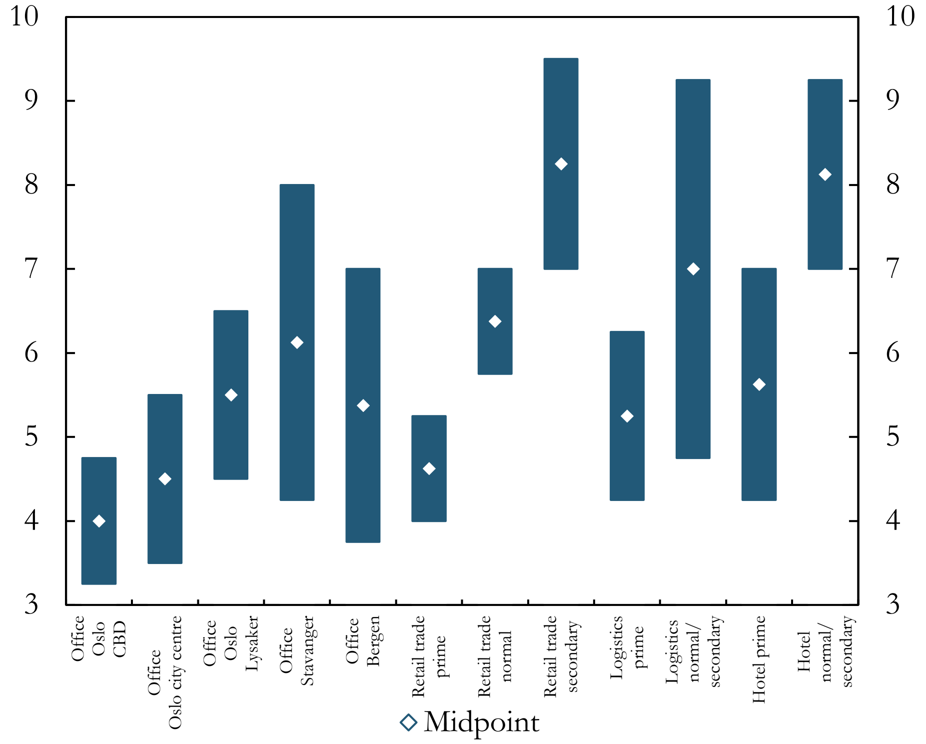
We primarily use a rental price index for commercial buildings in Norway calculated by Statistics Norway to estimate the market rent at building level (see Medby (2021)).[1] The rental price index covers all segments of our sample. The index takes into account location at municipal level, floor space and building type. For office buildings in Oslo, Bergen, Trondheim and Stavanger, we use average office rents from the company Arealstatistikk. The rents from Arealstatistikk are available at both a higher frequency and more granular level than Statisitics Norway's rental price index and therefore provide a better picture of the building's market rent.[2] Furthermore, we have based the market rent for logistics buildings on transaction volume and reported property values from CRE firms (see further discussion in Appendix A.2).

[1] The data set for this index is rental income from commercial buildings reported on business income statements. The sample covers commercial buildings in all of Norway in the period 2010-2020. There are more than 400 000 observations in the sample, of which office and retail buildings comprise around half.

[2] As mentioned above, price statistics for commercial property are limited, and unfortunately, we do not have access to similar rental price statistics for other segments and regions.

For estimates of the yield, we use ranges of the lowest and highest yield reported by the company Newsec (see Chart 1). The ranges are for different regions and segments, and they are based on the vast majority of transactions above NOK 50 million. Most of the information is on the office segments, which reflects the fact that around half of the transaction volume is in this segment.[3] The ranges are especially wide for other types of building. For example, the difference in the highest and lowest yield for retail buildings in 2021 Q4 is 5.5 percentage points. We use the mid-point between the lowest and highest yield in the range as the estimate of the yield for individual buildings.

Chart 1: A sample of ranges for observed yields for different segments. Based on actual transactions above NOK 50 million. Percent



"Prime" covers the most attractive buildings in a given segment. "Normal" contains more attractive buildings than "secondary" in a given segment.

Source: Newsec

[3]See Newsec (2022).

4 The CRE market

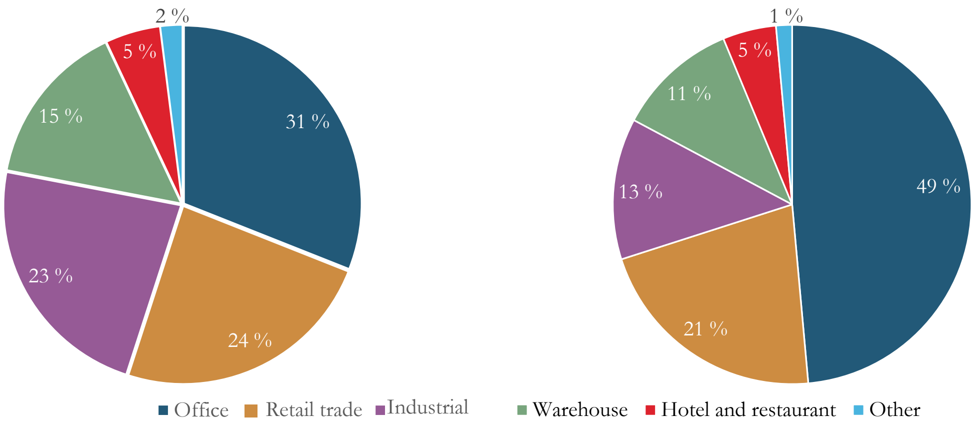
4.1 Buildings

The sample of commercial buildings totals 97.6 million square metres, divided into around 50 000 buildings. Office and retail are the largest segments with 30.5 million and 23.9 million square metres, respectively (Chart 2a). Office buildings almost always have the highest price per square metre, and in terms of estimated market value, this segment accounts for 49 percent of the entire sample (Chart 2b). Industrial and warehouse buildings constitute just over a third of building floor space, while their share based on value is a good deal lower. Hotels and restaurants are clearly the smallest segment.

Chart 2: Commercial buildings by segment. Percent

(a) Square metre

(b) Estimated market value in NOK

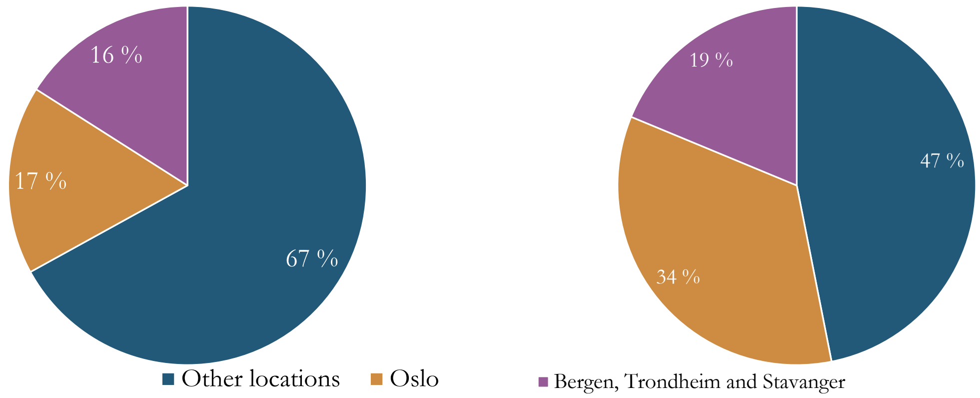


Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Around a third of building floor space is located in cities (Chart 3a). The buildings in cities typically have a higher price per square metre, and in terms of market value, this share is just above 50 percent (Chart 3b).

Chart 3: Commercial buildings by area. Percent

(a) Square metre (b) Estimated market value in NOK

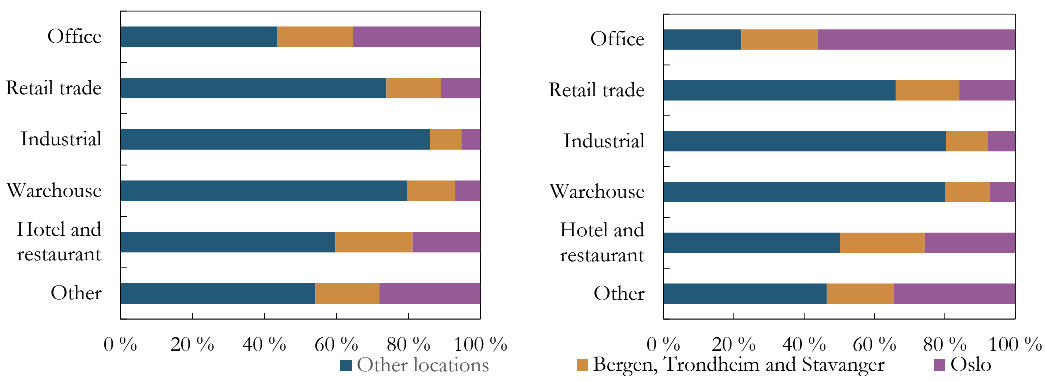


Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

More than half of office floor space is in Oslo, Bergen, Stavanger and Trondheim (Chart 4a). The market value of office buildings in Oslo accounts for more than half of the office segment's market value (Chart 4b). Around 40 percent of the floor space and value in the hotel and restaurant segment are in the four largest cities. The buildings in the other segments are more spread out across Norway.

Chart 4: Commercial buildings in different segments by area. Percent

(a) Square metre (b) Estimated market value in NOK



Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

4.2 Tenants

A total of 1.95 million employees work in the commercial buildings in the sample. When a commercial building is owned by the entity that uses the building, all or parts of the building are used for its own activities rather than for letting. The owner's debt service capacity is then less dependent on rental income. Nearly half of the employees working in industrial and logistics buildings are employed by companies that own the building they use (Table 1). This suggests that the loss risk for banks' exposure to industrial and warehouse buildings is less dependent on developments in market rents and vacancy rates. For office and retail buildings, this share is around 30 percent, while for the hotel and restaurant segment, the share is just above 20 percent.

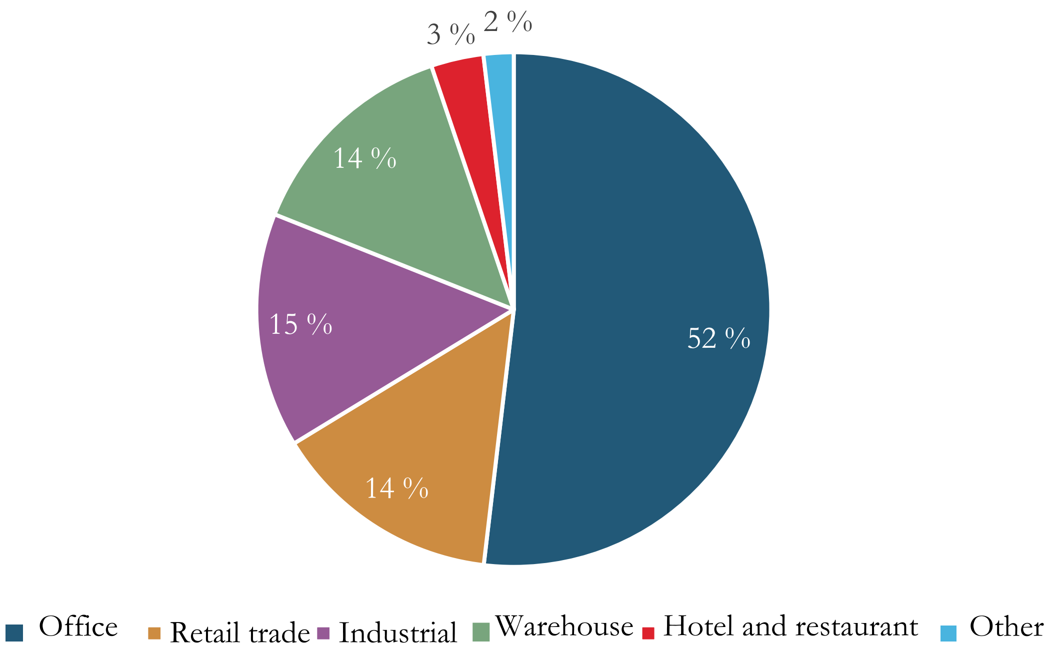
Table 1: Employees in different types of building

	Share of employees working for companies that own the building they use
Retail	31%
Hotel and restaurant	21%
Industrial	49%
Office	29%
Warehouse	44%
Other	31%

Source: Create-Solutions

Demand for leasing commercial space depends on economic developments, especially developments in employment. Analyses conducted by Norges Bank indicate that a 1.0 percent fall in employment in Oslo leads to a fall in office rents of between 4.0 percent and 4.5 percent (see Bjørland and Hagen (2019)). Around half of the employees work in office buildings (Chart 5).

Chart 5: Employees by type of building they work in. Percent



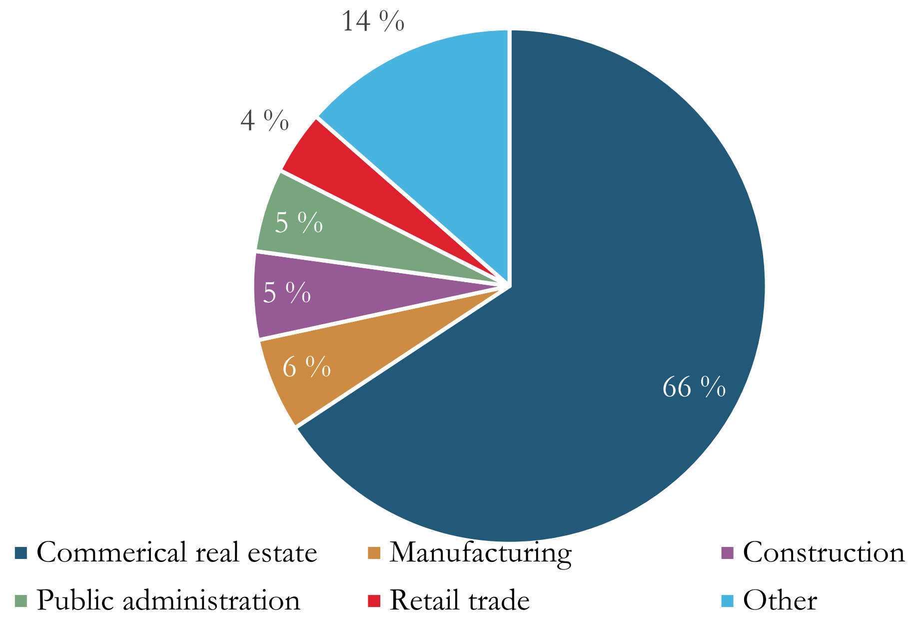
Source: Create-Solutions

4.3 Owners

CRE firms own around two-thirds of the building floor space in our building sample (Chart 6). Firms in construction, manufacturing, public administration and retail and wholesale trade own around 20 percent of building floor space.[4]

[4]The sector classification in this *Staff Memo* largely follows Statistics Norway's Standard Industrial Classification. We classify firms in the category "sale and management of real property" as CRE firms.

Chart 6: Square metres of commercial buildings by sector of entity that owns the building. Prosent

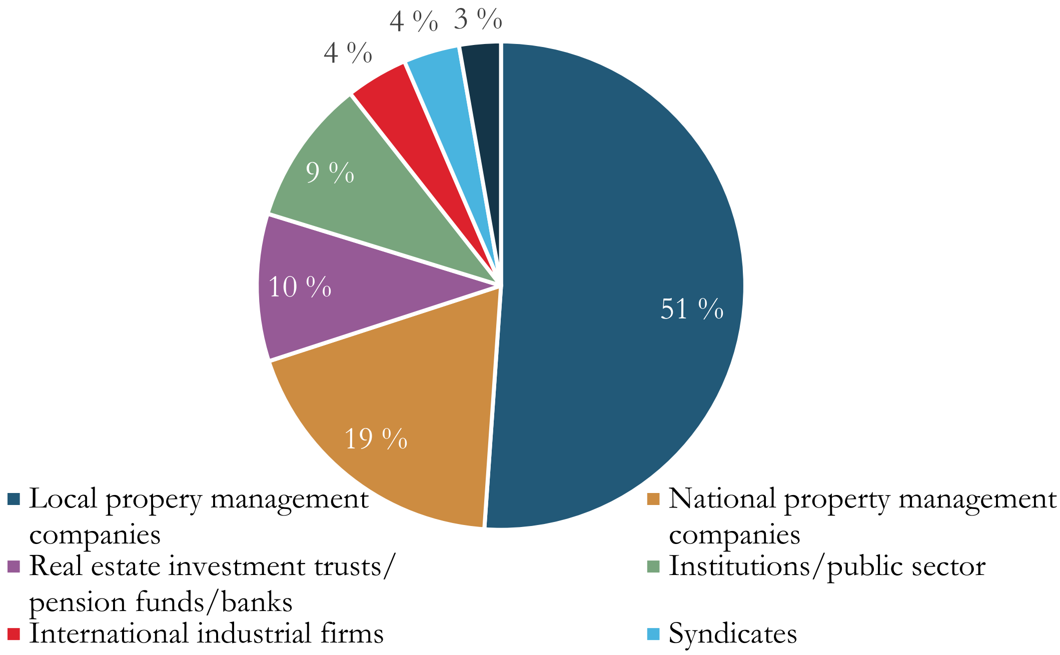


Source: Create-Solutions

Local property management companies are the clearly largest owner category[5] with an ownership share of 51 percent of the estimated market value of the entire sample (Chart 7). National property management companies own 19 percent. The largest CRE firms, such as Olav Thon Eiendomsselskap ASA and Entra ASA, are included in this group.

[5]We use CS's categorisation of owner types.

Chart 7: Estimated market value of commercial buildings by owner category. Percent



Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

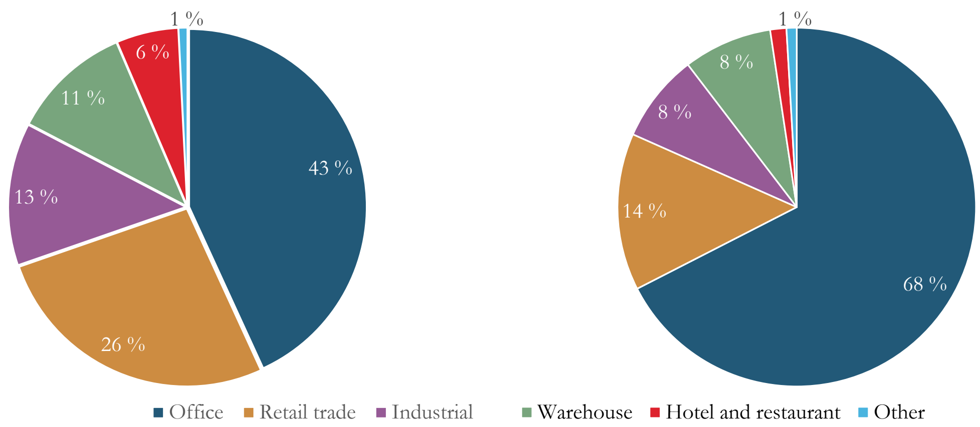
Local and national property management companies have substantial holdings in all commercial building segments, but they are more exposed to the retail segment (Chart 8a). Syndicates[6] are the smallest owner group, with an ownership share of 3.7 percent. However, their share[7] has risen by nearly 50 percent over the past three years. Syndicates and real estate investment trusts are dominated by financial investors who mostly do not manage properties and they are particularly exposed to the office segment (Chart 8b).

[6] Syndicates are a form of ownership where a company is set up for one or more properties where a small number of investors contribute capital. The company is normally set up by a financial sector entity.

[7] In terms of building floor space.

Chart 8: Estimated market value of commercial buildings by building type for different owner categories. Percent

(a) National and local property management companies (b) Real estate investment trusts and syndicates



Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Ownership concentration in many of the segments is high. The five largest entities own 15 percent, 18 percent and 19 percent, respectively, in the retail, office and hotel and restaurant segments (Table 2). Olav Thon Eiendomsselskap ASA is by far the largest owner in the retail, hotel and restaurant segments, while Entral ASA is the decidedly largest owner in the office segment. Ownership concentration is more moderate for warehouse and industrial buildings.

Table 2: Ownership concentration

	Total ownership share for the five largest owners in different segments
Retail	14.7 %
Hotel and restaurant	19.3 %
Office	17.7 %
Warehouse	6.4 %
Industrial	4.6 %

Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

5 The banking sector's exposure to buildings and owners in different sectors

We combine information on buildings from the Cadastre with information on banks' security interest in properties from the mortgage documents in the land register. The combination makes it possible to estimate banks' CRE exposure to different regions and segments.

5.1 Linking building and bank data

In the Cadastre, all buildings are assigned to a property. There is often more than one building on a property, and a building can extend over several properties. The mortgage documents in the land register provide an overview of the buildings mortgaged to banks. Often the same property can be mortgaged to more than one lender.

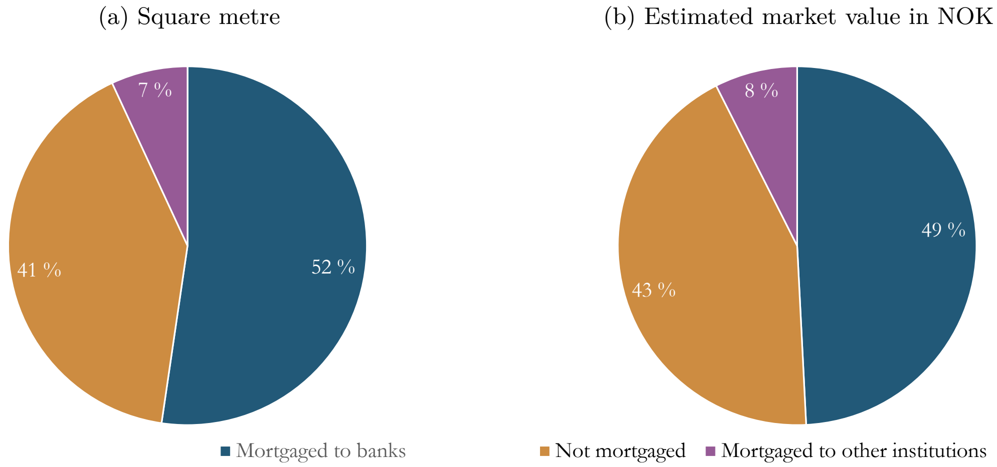
We first link banks to properties. If a property is mortgaged to more than one bank, we assign the property to the bank with the largest security interest. Then we link properties to buildings. If a building extends over several properties, the building is assigned to the property with the highest mortgage. This method entails that a building is assigned only to one bank. Cross-checks against other data sources[8] for banks' exposures indicate that this method provides an accurate picture of banks' exposures at an aggregate level (see Appendix A.1 for a further discussion).

5.2 Banks' exposure to owners, segments and regions

Based on mortgage documents, we estimate that 60 percent of the building floor space in the sample is mortgaged (Chart 9a). Fifty-three percent of the building floor space in the sample is mortgaged to banks in Norway. In terms of estimated market value, this share is 49 percent (Chart 9b).

[8]We have information from banks' and insurance companies' financial reporting to the Norwegian authorities (ORBOF), which provides aggregate lending to CRE firms, and Finanstilsynet's (Financial Supervisory Authority of Norway) exposure database (ENGA) provides this information at engagement level.

Chart 9: Commercial buildings by type of lender. Percent

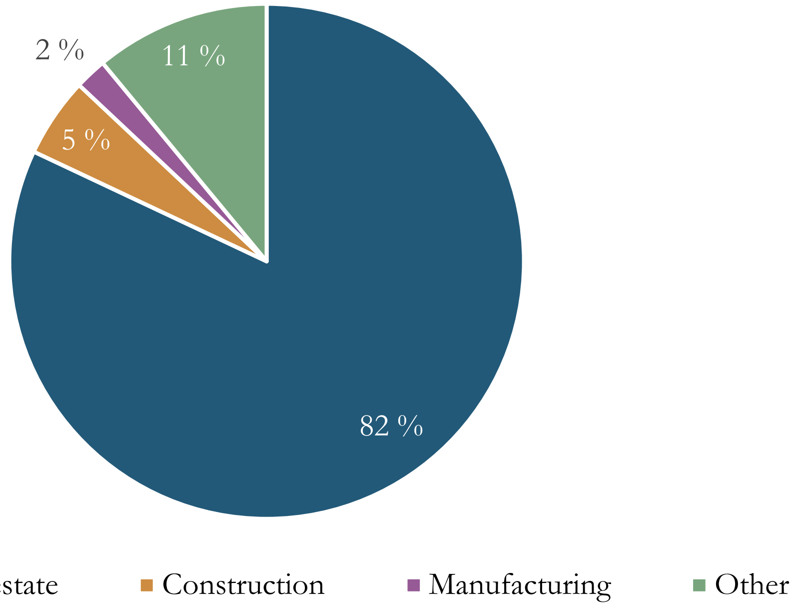


Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Eighty-two percent of the estimated market value of the buildings mortgaged to banks has been pledged by a CRE firm (Chart 10). Indirect exposure to CRE, defined as a security interest in a commercial building owned by firms in sectors other than CRE, therefore appears to be fairly modest.[9] The remainder of the buildings mortgaged to banks have been largely pledged by property development and manufacturing firms. It is normal for the owner of an industrial building to use the building for own activities (Table 1). This means that the risk of losses is linked more to developments in the sector they operate in than to developments in the CRE market.

[9] A corporate group whose primary business is in a sector other than commercial property management may have separate CRE subsidiaries that own and manage properties. In cases where a CRE firm has mortgaged properties in such a corporate group, we overestimate the lender's direct exposure to CRE activities.

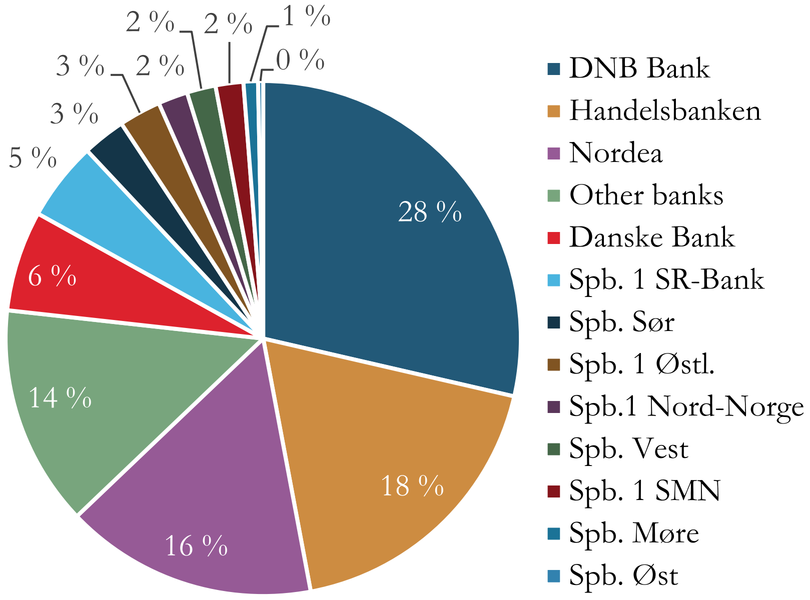
Chart 10: Estimated market value of buildings mortgaged to banks. By borrower sector. Percent



Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

A large share of the exposure to commercial banks is concentrated among a few large institutions. DNB, Handelsbanken, Nordea and Danske Bank are the largest in this market and all together account for around three-fourths of the estimated market value of the buildings mortgaged to banks (Chart 11). DNB's market share is clearly the largest, close to 30 percent. In this *Staff Memo*, we focus on the 12 largest market participants, which are hereinafter referred to collectively as the "macro bank". The macro bank accounts for 86 percent of the total estimated market value mortgaged to banks (Chart 11).

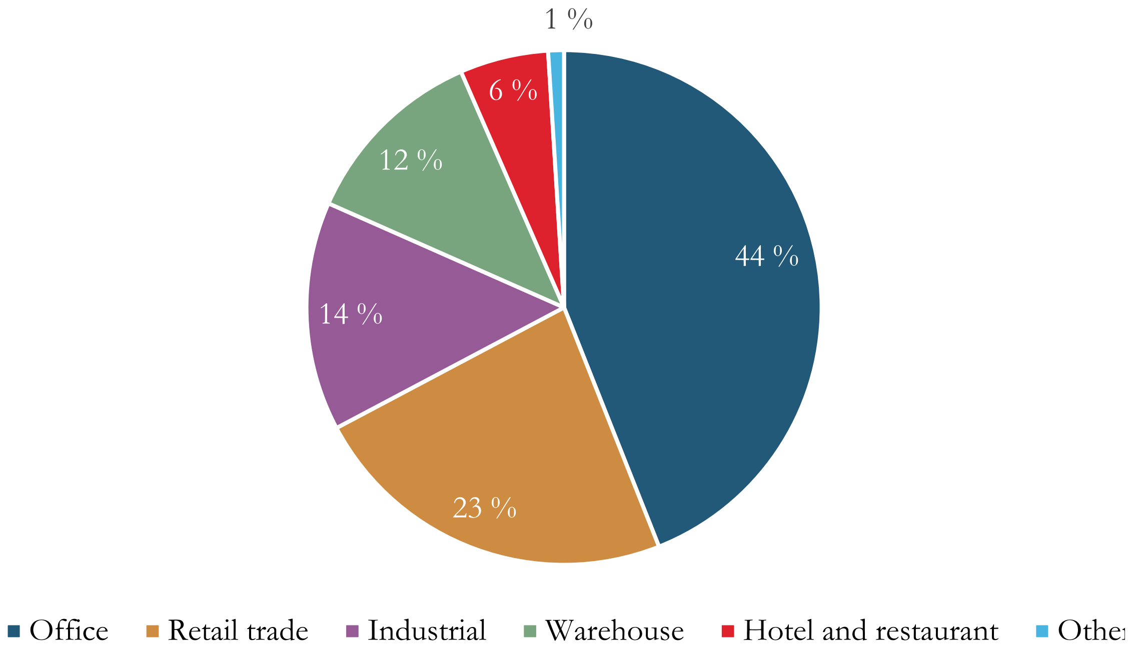
Chart 11: Estimated market value of commercial buildings mortgaged to banks. Banks' share in percent



Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Chart 12 shows the market value of the buildings mortgage to banks by building type. We see that the breakdown is approximately the same as all the buildings in the entire data set as shown in Chart 2b. This implies that banks' security interest in the office, retail, industrial and warehouse segments is substantial, but their exposure to hotels and restaurants is markedly less. They are clearly most exposed to the office segment. The exposures of DNB and the branches of foreign banks to different types of commercial building are fairly similar. However, DNB's exposure to office buildings is somewhat less than that of the branches of foreign banks. Sparebank 1 Østlandet and the branches of foreign banks are more exposed to office buildings than the other banks.

Chart 12: Estimated market value of commercial buildings mortgaged to banks. By building type. Percent



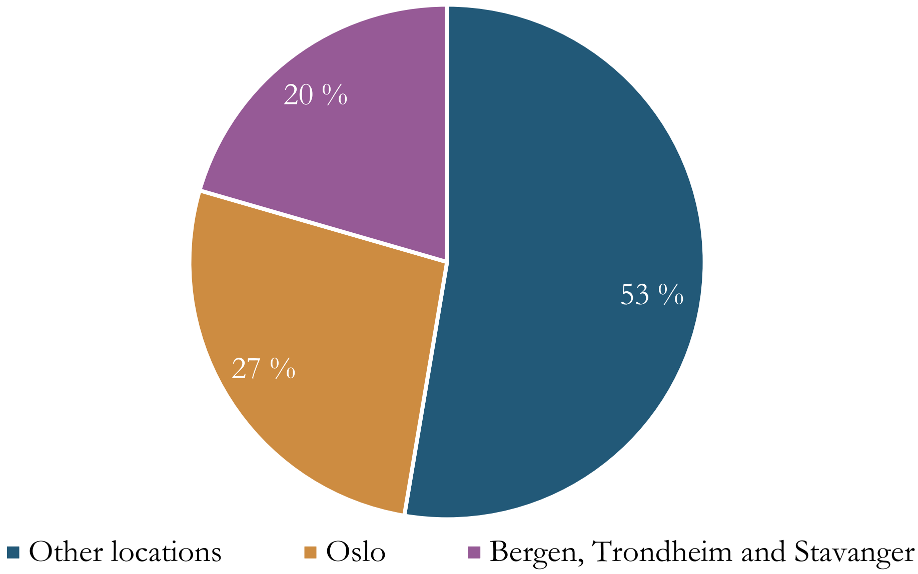
Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Chart 13: Estimated market value of commercial buildings mortgaged to individual banks. By building type. Percent

Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Buildings located in the largest cities account for around half of the market value of the buildings mortgaged to banks (Chart 14). Commercial buildings in Oslo, including office buildings, are somewhat underweighted in banks' mortgage portfolios (Chart 14, Chart 3 and Table 3b). Nevertheless, banks' exposure to office buildings in Oslo account for 21 percent of their total exposure to commercial buildings, which is largely because of the substantial number of office buildings in Oslo with a high price per square metre.

Chart 14: Estimated market value of commercial buildings mortgaged to banks. By area. Percent



Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Table 3: Office buildings in Oslo

Share of the market value of the office segment in Oslo	56 %
Estimated market value of office buildings in Oslo mortgaged to banks as a share of the estimated market value of all office buildings mortgaged to banks	48 %

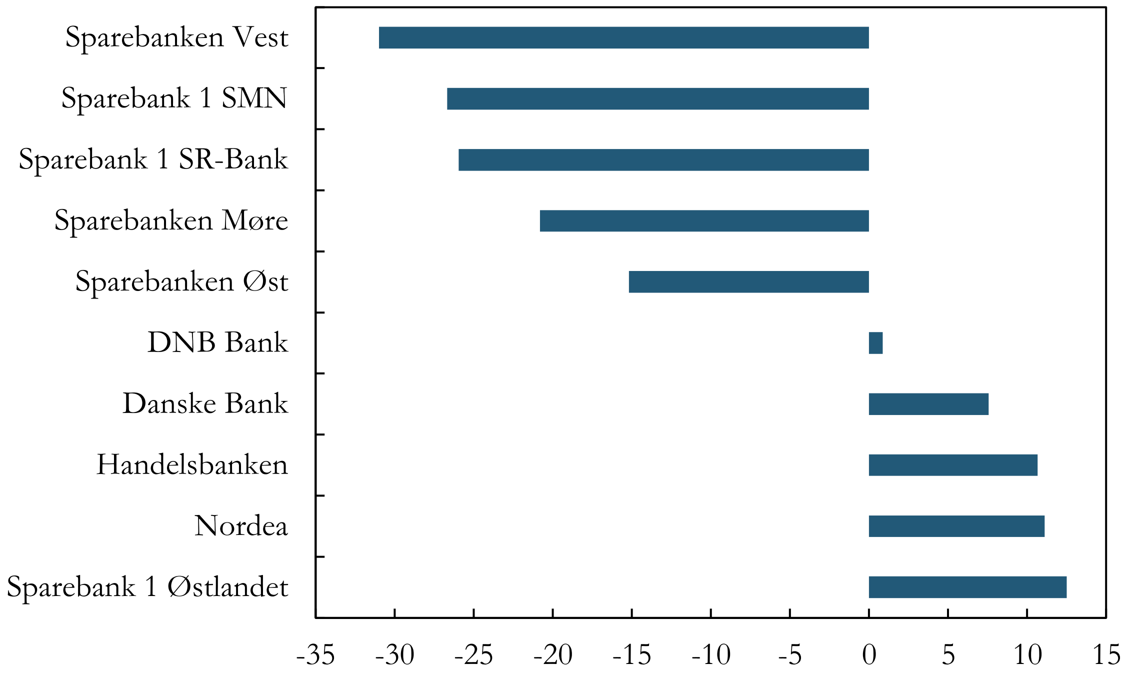
Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Branches of foreign banks and Sparebank 1 Østlandet are more exposed to the Oslo region,[10] (Chart 15). We generally find that, as expected, savings banks are more exposed to buildings in

[10]Oslo, Asker, Bærum and Drammen municipalities constitute the Oslo region.

their regions.

Chart 15: Difference between individual banks' exposure to commercial buildings in the Oslo region and other banks' exposure to office buildings in the Oslo region. Percentage points

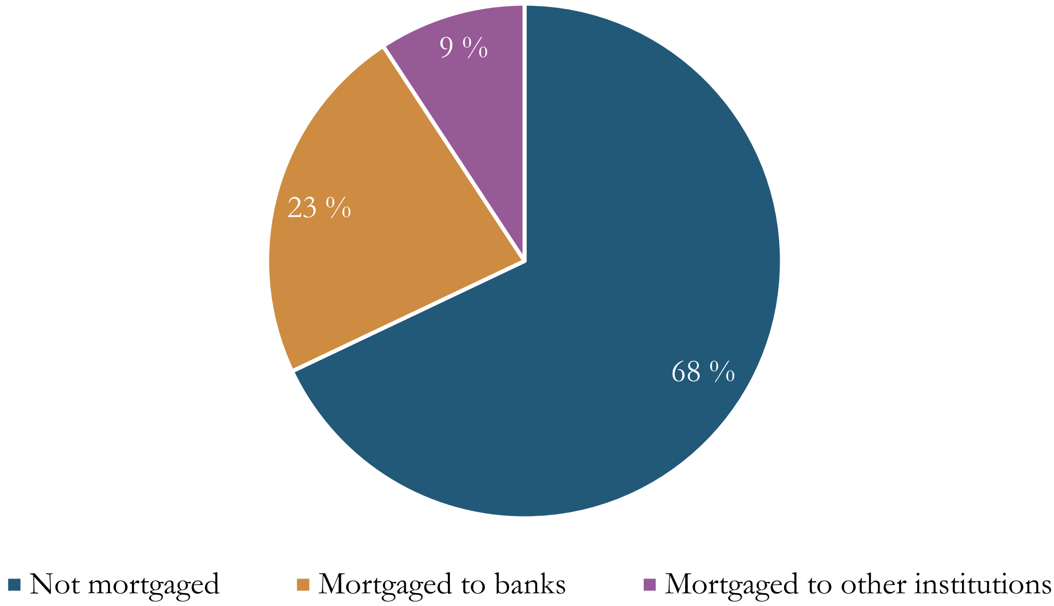


Here, exposure is calculated as the estimated market value of commercial buildings in the Oslo region mortgaged to a bank or banks relative to the estimated market value of all commercial buildings mortgaged to a bank or banks.

Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

Norges Bank has long used price developments for the most attractive office space in Oslo (prime office space) as a vulnerability indicator for CRE. This is partly due to the lack of a statistical basis for making a more comprehensive sector assessment. Prime office space refers to high-quality office buildings located in Vika and at Aker Brygge. The office buildings in this area account for 12 percent of the estimated market value of office buildings in Oslo. Twenty-three percent of this segment is mortgaged to banks (Chart 16), and the branches of foreign banks are the largest market participants. Banks' exposure to this segment (23 percent) is considerably lower than their exposure to other commercial buildings in the sample (49 percent). One possible reason for banks' relatively low exposure to prime office space is that the companies that own buildings in this area depend less on bank loans for financing. Among the large owners at Aker Brygge we find, for example, B Storebrand, Norwegian Property and KLP.

Chart 16: Estimated market value of office space in the geographical area for prime office space, which is Aker Brygge and Vika. By type of lender. Percent



Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

6 Summary

Banks' exposure to CRE is considerable, and historically, banks in Norway and other countries have incurred substantial losses on loans to this sector in deep downturns. In this *Staff Memo* we provide an overview of most commercial buildings in Norway that are relevant for banks' credit risk by using register data supplemented by information on commercial buildings.

We have linked information on buildings to banks' security interests in real properties. The provides us with such information as banks' regional exposure, exposure to different segments and a measure of the concentration of mortgaged commercial buildings. We also obtain information about banks' exposure to owners of commercial buildings. Furthermore, we estimate average prices for properties based on information on rents and yield by region and segment. This enables us to estimate the size of banks' exposures in the form of estimated market value of buildings mortgaged to them.

In our sample of commercial buildings, we find that retail and office are the largest segments, and hotels and restaurants clearly the smallest segment. Furthermore, the office segment accounts for around half of the estimated market value of the buildings in the sample. Around half of the estimated value of the buildings in the sample is mortgaged to banks. A large part of this exposure is concentrated among a few banks. CRE firms own a substantial share of the buildings mortgaged to banks. This suggests shining a spotlight on buildings owned by CRE firms in assessments of vulnerabilities in the CRE market.

Banks' exposures resemble the composition of the market, which means that banks' security interest in the office, retail, industrial and warehouse segments is substantial, but their exposure to hotels and restaurants is markedly less. Individual banks' building portfolios are fairly similar. As expected, banks' exposure to office buildings is considerable, especially in Oslo. However, banks' exposure to the most expensive office buildings is relatively low. Banks' broad-based exposure to CRE in Norway underscores the potential importance of our comprehensive data set as an information basis for future assessments of vulnerabilities in this sector and its importance for financial stability.

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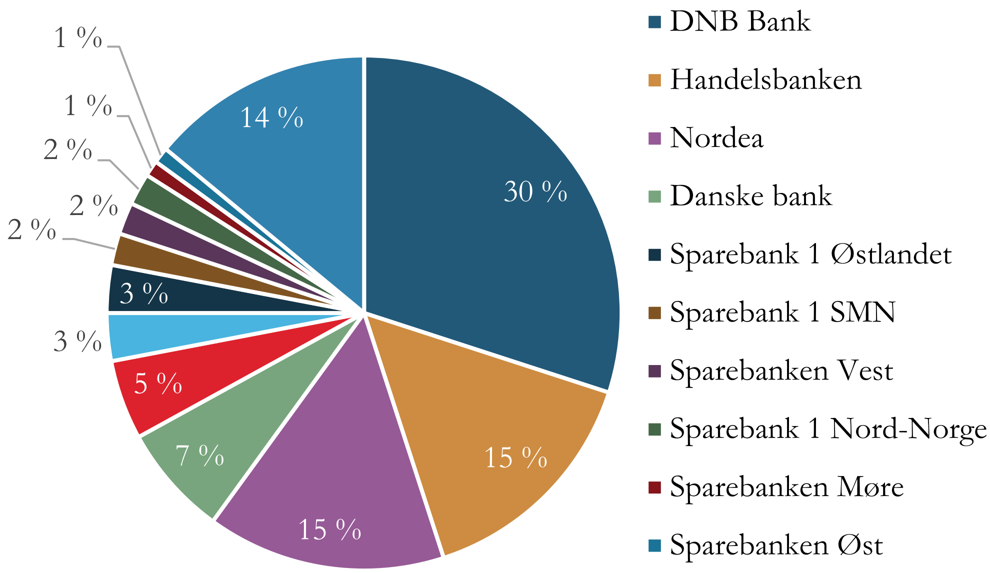
A Appendix

A.1 Cross-check of the link to banks' mortgage documents

We have performed a cross-check of the link between CS data and mortgage documents with statistics from banks and financial institutions' financial reporting to Norwegian authorities (ORBOF). Individual banks' share of total lending to CRE in ORBOF data closely coincides with individual banks' share of estimated market value of buildings mortgaged to banks. For DNB, these values ore 30 percent and 29 percent, respectively (Charts 17 and 11).

Chart 17: Individual banks' share of loans to CRE secured on a commercial building. Percent



Sources: Statistics Norway and Norges Bank

DNB's own reported exposures closely coincide with our data. DNB reports that lending to the office segment accounts for 38 percent of their CRE exposures (see DNB Group (2022)). By comparison, office buildings account for 41 percent ot the estimated market value of the buildings mortgaged to DNB.

A.2 Valuations and cross-checks of estimated market value

Estimating value requires us to apply some heroic assumptions. We assume a rental price of NOK 1000 per square metre for logistics buildings, which is a good deal higher than the average price per square metre provided by the hedonic index. This quantification is based on actual transactions and property values reported by CRE firms, which indicates that the hedonic index underestimates the rental prices for logistics buildings. Large logistics buildings along the motorways outside Oslo account much of logistics floor space, and many of these buildings are regarded as being among the more attractive premises in the segment. The hedonic index results in a rental price that is too low because the buildings are large and located outside cities. This reflects the considerable heterogeneity between the segments of CRE, and the effect of location and size on rents may vary across segments.

As mentioned above, we use the mid-point between the lowest and highest yield in the ranges as an estimate of the yield for an individual building. If the yields are evenly distributed around the mid-points, this method will result in a good estimate of the average yield in the different segments.[11]

Newsec does not report the yield for industrial buildings. We assume that logistics buildings have the same yield as industrial buildings. The buildings in this segment have common features that mean that the prices are probably comparable. Industrial and logistics building are typically located outside of urban centres, and the owner tends not to be an CRE firm.

As a cross-check of the results, we compare our estimates with data for estimates of transaction volume in different markets. CS has compiled a list of buildings that are sold, where they assume that a building has been sold in connection with major changes in the board of the building's owner. We use this list to compare the market value of buildings sold with Newsec's transaction volume estimates. We have reason to believe that market participants' transaction volume estimates are fairly representative.[12]

[11] We have no reason to use a value other the mid-point as the estimate. Furthermore, the cross-checks indicate that our estimated market values are reasonably accurate at an aggregate level.

[12] Their estimates closely coincide with estimates from other market participants, such as eg Akershus Eiendom.

For the retail segment, our estimate closely coincides with Newsec's estimate (Table 4). For office buildings, hotels and restaurants, our transaction volume estimates are somewhat lower. Even though we have adjusted upward the rents for logistics buildings a good deal compared with Statistics Norway's hedonic rental price index, our estimated transaction volume for logistics and industrial buildings is around 30 percent lower than Newsec's estimates.

Table 4: Transaction volume in billions of NOK

	Estimated transaction volume	Newsec's transaction volume estimates
Office	57.0	64.0
Retail	30.5	30.3
Logistics and industrial	27.1	38.5

Sources: Arealstatistikk, Create-Solutions, Newsec, Statistics Norway and Norges Bank

There are a number of possible reasons for these divergences. First, our data do not capture all transactions. It is also possible that buildings that are more frequently bought and sold are of higher quality.

We have also performed a cross-check of our price estimates against property values reported by Entra ASA and Olav Thon Eiendomsselskap ASA, which are the largest property management firms in the office and retail segments, respectively. We estimate that the market value of Entra ASA's building portfolio is NOK 63.3 billion, which is 6 percent lower than what they report (Table 5). Furthermore, we overestimate their rental income by 12 percent. This indicates that the yields we use in our estimates are higher than the average yield for Entra ASA's building portfolio. For Olav Thon Eiendomsselskap ASA's building portfolio, we overestimate market value and rental income by 16.5 percent and 10.3 percent, respectively. Overall, these cross-checks indicate that our price estimate are reasonably accurate at an aggregate level.

Table 5: Rental income and market value in billions of NOK

	Reported rental income	Estimated rental income	Estimated market value of building portfolio	Reported market value of building portfolio
Entra ASA	2.5	2.8	63.6	67.5
Olav Thon Eiendomsselskap ASA	3.5	3.6	63.5	54.5

Sources: Arealstatistikk, Create-Solutions, Entra ASA and Olav Thon Eiendomsselskap ASA annual reports for 2021, Newsec, Statistics Norway and Norges Bank