M E M O R A N D U M

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Macro-based stress test of Swedish banks: results and methodology, autumn 2020

Summary
Finansinspektionen (FI) presents in this memorandum a stress test of the Swedish banks that we conducted in the autumn of 2020. The memorandum describes the methodology behind the stress test and its outcome. The test illustrates potential effects on the financial position of the major Swedish banks if the current economic crisis were to deepen as a result of an increase in the spread of the coronavirus.

The results indicate that the major banks have significant resilience to the credit losses that could arise and also a capacity to maintain the supply of credit. The average CET1 capital ratio decreases by 2.8 percentage points in the scenario, from 17.6 per cent in Q2 2020 to a low point of 14.8 per cent, if the banks pay out dividends from their profit from 2019–2022 in accordance with their dividend targets. The lowest margin to the current capital requirement is then approximately 1 percentage point. However, like all other similar analyses, there is considerable uncertainty associated with the results.

FI uses macro stress tests as a tool to assess individual banks' resilience as well as stability in the financial system. Over the past few years, we have developed a number of models and approaches for different components of the banks' earnings, balance sheets and risk-weighted assets. These enable us to assess how their capital ratios could be affected in severe macroeconomic scenarios.

So far, we have focused on developing a time-series model for credit losses and models for the banks' most important sources of earnings: net interest income and net fee and commission income. Our overall methodology and the various sub-models are based on aggregated portfolio data that the major banks report to FI as part of their legislated periodic reporting but also in other contexts.

In order to apply our methodology in the ongoing pandemic, we analyse how the banks can meet in the short term a conceivable increase in firms' need for liquidity support and replacement of their market financing with bank loans.

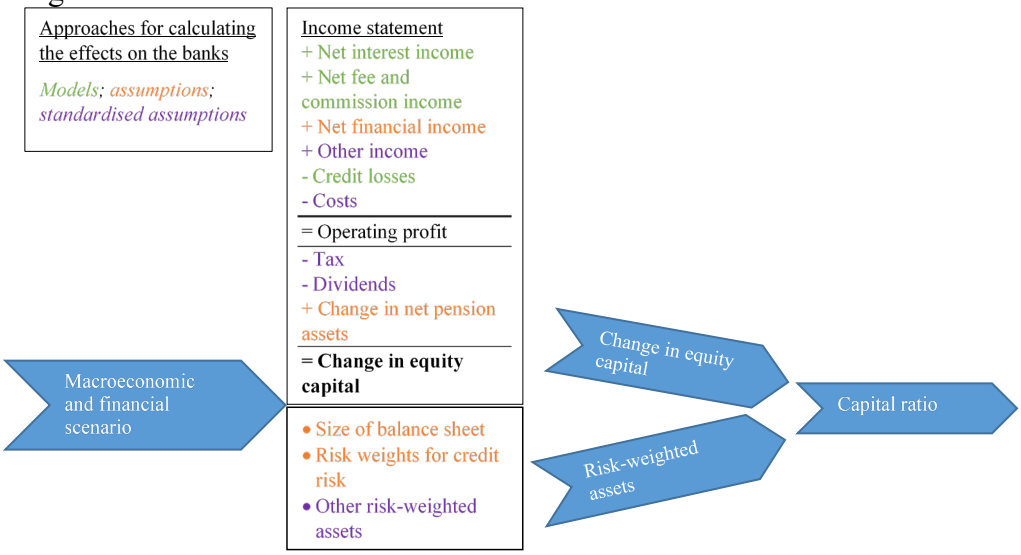
Contents

1. Background and purpose

This memorandum describes the methodology and outcome of a stress test of the major Swedish banks' capital situation that Finansinspektionen (FI) conducted in autumn 2020.[1]

Macroeconomic scenario-based stress tests analyse how severe hypothetical macroeconomic scenarios may affect the financial position of the banks and more specifically Common Equity Tier 1 (CET1) capital ratios and leverage ratios (see Diagram 1). Over the last few years, we have developed models for different components of banks' income statements and balance sheets together with a range of assumptions. The models are primarily based on historical relationships with macroeconomic variables. The methodology FI has used primarily pertains to the three major Swedish banks.[2] FI uses macro stress tests as a tool for assessing not only the resilience of individual banks, but also the solvency of the financial system.

Diagram 1. Process for macroeconomic stress tests



Source: FI.

The banks' CET1 capital ratios are affected by changes in their earnings, but also by how their risk-weighted assets develop:

$$CET\ 1\ capital\ ratio = \frac{Share\ capital + Reported\ earnings}{Risk\ weighted\ assets}$$

1 It is possible to give a general indication of banks' resilience in terms of their solvency and liquidity. In this memorandum, we focus on solvency (capital situation).

2 The three major Swedish banks are SEB, Handelsbanken (SHB) and Swedbank. We use data at a consolidated level. Some models included Nordea as this bank was Swedish during the taxation period and it still is a systemically important bank for the Swedish financial system. Aggregate data is used in some models and bank-specific data in others.

If the banks have negative earnings after tax and pay any dividends, this reduces their CET1 capital. If the CET1 capital decreases through a scenario or if the risk-weighted assets increase, the capital ratio will fall. The starting point for the calculations is the banks' balance sheets and income statements at the end of the quarter prior to the start of the scenario in question.

Higher credit risk and consequential credit losses is the single most important risk in terms of impairing the capital situation of the major Swedish banks. Consequently, we have mainly focused on developing models to show how these banks' credit losses may develop in a stressed situation.[3] We have also developed models for net interest income and for net fee and commission income as the banks' earnings also may be negatively affected due to, for example, increased borrowing costs and reduced demand for the banks' services. In addition to these econometric models, we make assumptions primarily about development of the banks' balance sheets and risk-weighted assets for credit risk.

The analysis is based on a top-down approach, which means that FI has performed all the calculations that are based on less detailed data than what the banks themselves use in their own stress tests. We largely use data from FINREP (financial reporting framework) and COREP (Common Reporting Framework), but also data that the banks have reported to FI in other contexts.

2. Methodology and outcome of stress test autumn 2020

Both Sweden and the rest of the world find themselves in a serious financial crisis as a result of the spread of coronavirus and the steps that have been taken to manage the pandemic. The stress test FI conducted in autumn 2020 is based on a macroeconomic scenario that entails increasing spread of contagion that further deepens the prevailing crisis. The scenario is not a forecast of forthcoming economic developments but should instead be regarded as a hypothetical scenario, and is more negative than the latest forecasts.

In this section we explain the calculations and the overarching methodology we have chosen. More details about our models and assumptions can be found in Appendix 1 and more about the outcome can be found in Appendix 2. The outcome of the stress test is also summarised in FI's stability report from November.[4]

3See Axelsson, P., David, Å, Kamath, K., Lönnbark, C. and Thell, V. (2020), Macro-based credit loss model for major Swedish banks, F Analysis 26, Finansinspektionen.

4FI (2020b). The first application of our stress test methodology was presented in a scenario analysis in FI's stability report in June 2020, FI (2020a). We then used a macroeconomic scenario for Sweden that is consistent with the National Institute of Economic Research's basic macroeconomic forecast of 29 April 2020.

Given that crises rarely occur and vary in nature, there is limited data on which to determine how the banks will be affected by a new crisis. It is therefore necessary to make assumptions, the validity of which is difficult to assess. The uncertainty regarding the models is always significant as every crisis is more or less unique. Consequently, the calculations should be regarded as illustrations of possible courses of events, not as forecasts.

We are using data from the banks' reporting for the first and second quarters of 2020 as a starting point, and our estimates for each quarter in the scenario begin in the third quarter of 2020 and run to the fourth quarter of 2020. We perform calculations for each major Swedish bank individually. We report all scenario variables and results as annual figures for 2020–2022 and as averages for the three major banks.

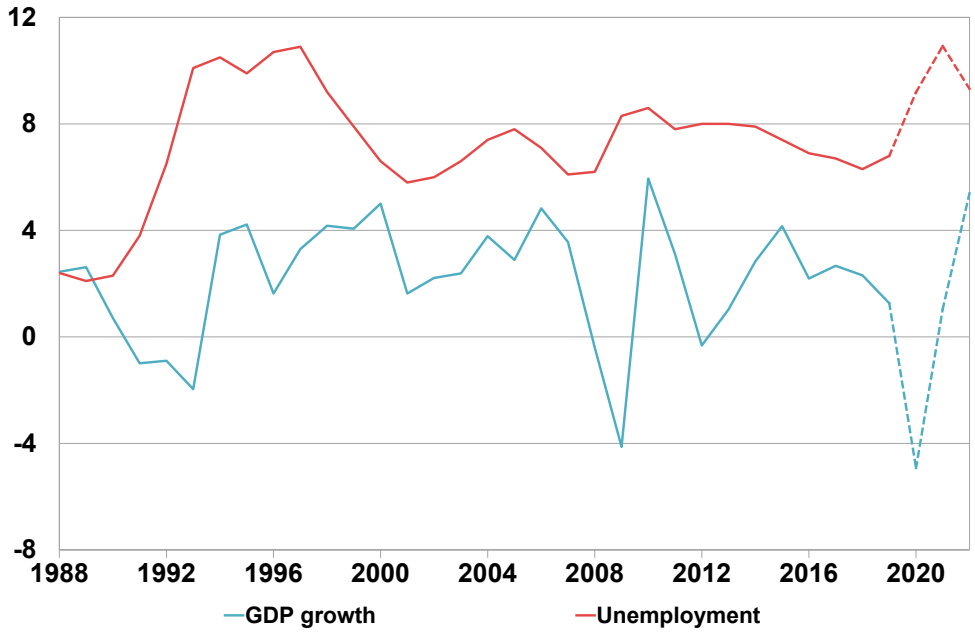
2.1 Macroeconomic scenario

The macroeconomic scenario embodies a deepening of the economic downturn that began in spring 2020 due to an increasing spread of infection and further restrictions and lockdowns in various countries. It is based on the Riksbank's scenario in which there is a second wave of infection that was published by the Riksbank in its monetary policy report in September.[5] In this scenario, GDP in Sweden falls by 4.9 per cent for the whole of 2020, with a recovery taking place only in 2021 and 2022 (see Diagram 2 and Table 1). Unemployment increases from 6.8 per cent in 2019 to 9.2 per cent for the whole of 2020, and increases further to 10.9 per cent in 2021. As the major Swedish banks also have relatively large exposures to the other Nordic countries and the Baltic states, the OECD scenarios are used for economic growth and unemployment in these areas.

In addition to the scenarios from KI and the OECD, FI makes assumptions about the trend for a number of financial variables in Sweden (see Table 1). House prices, commercial real estate prices, share prices and the ten-year treasury rates are expected to fall in the near future and then recover.

5 The Riksbank's scenario from 22 September 2020 and the OECD scenario from 10 June 2020 in which there is a second wave of infection. The Riksbank's scenario is more severe than many forecasters' basic forecasts from September, but is milder than the National Institute of Economic Research's basic forecast from April, which was used in our scenario analysis from spring. The scenarios cover 2020 and 2021. 2022 is based on assumptions. The scenario for Germany and the UK is not shown in Table 1. For more information about these, please refer to: http://www.oecd.org/economy/outlook/statistical-annex/

Diagram 2. Annual GDP growth and unemployment in Sweden, including in the scenario
Per cent



Source: FI and the Riksbank.
Note: GDP is expressed as annual change in per cent. Unemployment is expressed as annual average in per cent.

Table 1. Important macroeconomic and financial variables in the scenario
Annual percentage changes and per cent

	Sweden						Other Nordic countries	The Baltic region
	GDP	Unemployment	House prices	CRE prices	Equity prices	10-year government bond rates	GDP	GDP
Q4 2020	-8.1	11.8	1.8	-27.2	-6.9	-0.2	-8.3	-9.9
2020	-4.9	9.2	5.2	-11.6	0.4	-0.1	-4.9	-5.3
2021	1.0	10.9	-3.0	-9.5	-2.0	-0.4	1.5	2.4
2022	5.4	9.3	4.4	9.3	3.4	0.1	3.6	4.0

Source: FI, the Riksbank and OECD.
Note: GDP, house prices, commercial real estate prices (CRE prices) and share prices are expressed as annual percentage changes. The figures for the fourth quarter of 2020 are annual changes compared to the fourth quarter of 2019 and the other figures refer to the full year. Unemployment and ten-year treasury rates whole year figures are expressed as an annual average in per cent.

2.2 Credit losses

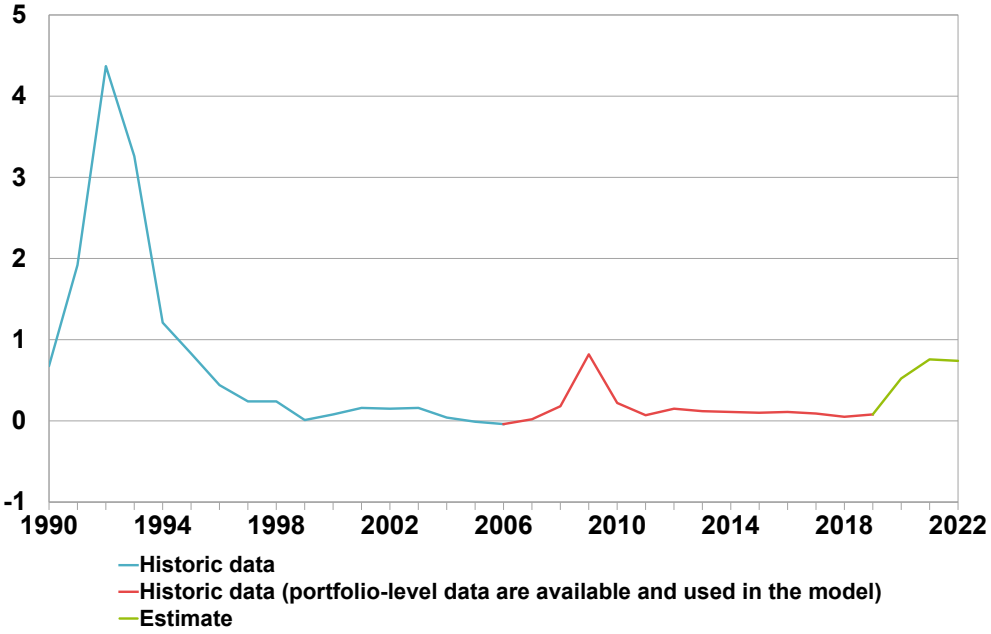
If the provisions for credit losses increase sharply, an otherwise profitable bank could make a loss. We estimate the banks' credit losses under the scenario with econometric models which are estimated on the basis of the relationship between the major banks' credit losses and macroeconomic variables during the period between 2007 and 2017. The most important variables that are included in the models are GDP growth, unemployment and real estate prices.

The estimates are divided into different categories for lending to the public and for different regions.[6]

Total credit losses for major banks in the period 2020–2022 are estimated in these models to be approximately SEK 130 billion.[7] Expressed as a proportion of banks' total lending to the public, this is equivalent to a credit loss ratio of 2.2 per cent. We assume that the credit losses in this scenario are evenly distributed between the third quarter of 2020 and the end of 2022.[8] The losses amount to 0.5 per cent of lending in 2020, 0.8 per cent in 2021 and 0.7 per cent in 2022 (see Diagram 3). The total credit loss ratio in this scenario is higher than during the financial crisis of 2008–2010, but lower than during the crisis of the 1990s.

Diagram 3. Credit losses as a proportion of lending, and outcome in the scenario

Percentage of exposures



Source: FI and the Riksbank

Note: Annual figures. Historical data shows an average for SEB, SHB, Swedbank and Nordea. The information from prior to 2006 is based on data collected by the Riksbank. The estimate shows the average for the three major Swedish banks (SEB, SHB and Swedbank). We use data for Q1 and Q2 2020 and our estimates begin in Q3 2020.

6 For lending to households, we differentiate between mortgages and consumer credit. Lending to corporates is divided into loans to small and medium-size businesses, loans collateralised by commercial real estate and other corporate lending. Countries and regions are broken down into Sweden, other Nordic countries (except Iceland), the Baltic states, and other countries. Other countries are primarily Germany and the UK.

7 This includes losses of SEK 8 billion the banks have reported during the first half of 2020.

8 The reason why we need to allocate the losses over a time span is that we assume it will take time before the very sudden and deep economic downturn causes losses, which our model does not take into account.

Significant credit losses arise in all regions (see Table 2). The average loss ratio is lowest in Sweden and highest in the Baltic states and the group 'other countries'. These differences partly reflect different scenarios, with greater reductions in GDP in the UK and Germany, which are included in the group 'other countries'. However, it also reflects how our model takes into consideration the fact that historical losses have been lower in Sweden and other Nordic countries than in the Baltic states and other countries. Furthermore, the banks' exposures in Sweden are more concentrated in mortgages, which have lower credit loss ratios than other sectors. As a result of these factors, about half of the losses arise in Sweden (see Table 3). This is significantly lower than the proportion of lending in Sweden, which amounts to two thirds.

The loss ratios are highest for unsecured loans to households and businesses and are about four per cent (see Table 2). This reflects the fact that historical losses have been highest for these categories. Mortgages, which constitute around 45 per cent of total exposures, have the lowest loss ratio. Loans collateralised by commercial real estate in Sweden have a loss ratio of 2.1 per cent. Alternative analyses based on microdata of exposures to the commercial real estate sector and households with new mortgages in Sweden indicate lower losses than those that are estimated using these time series models. One reason for this difference may be that microdata estimates are based on data concerning the current portfolio risk, not historical data.[9] Just over three quarters of total losses arise from lending to corporates (see Table 3).

Table 2. Credit loss ratios in the scenario
Percentage of exposures

	Sweden	Other Nordic countries	The Baltic region	Other countries	Average
Mortgage	0.5	0.5	0.7	1.7	0.6
Consumer credit	3.9	3.4	5.3	6.1	4.1
CRE	2.1	2.2	2.9	5.9	2.7
SME	3.4	3.4	4.4	6.4	3.9
Other corporate	3.5	3.2	4.9	5.5	4.1
Average	1.5	2.3	2.9	5.0	2.2

Source: FI
Note: Refers to total losses between 2020 and 2022. The three business categories are CRE (loans collateralised by commercial real estate), SME (unsecured loans to small and medium-sized enterprises) and other corporate (unsecured loans to primarily large firms). The regions are other Nordic countries (Norway, Denmark, Finland), the Baltic region (Estonia, Latvia, Lithuania), and other countries (primarily the UK and Germany).

9 See Axelsson et al. (2020) and Aranki et al. (2020).

Table 3. Proportion of estimated credit losses in the scenario
Percentage of total credit losses

	Sweden	Other Nordic countries	The Baltic region	Other countries	Average
Mortgage	9	1	1	2	12
Consumer credit	6	1	1	1	9
CRE	17	5	1	10	32
SME	3	1	1	1	6
Other corporate	13	8	3	16	40
Average	47	16	7	30	100

Source: FI

2.3 The banks' balance sheets and risk-weighted assets

This section describes our assumptions about the banks' exposure volumes, risk-weights for credit risk and the combined effect of these on the banks' risk-weighted assets.

2.3.1 Exposure volumes

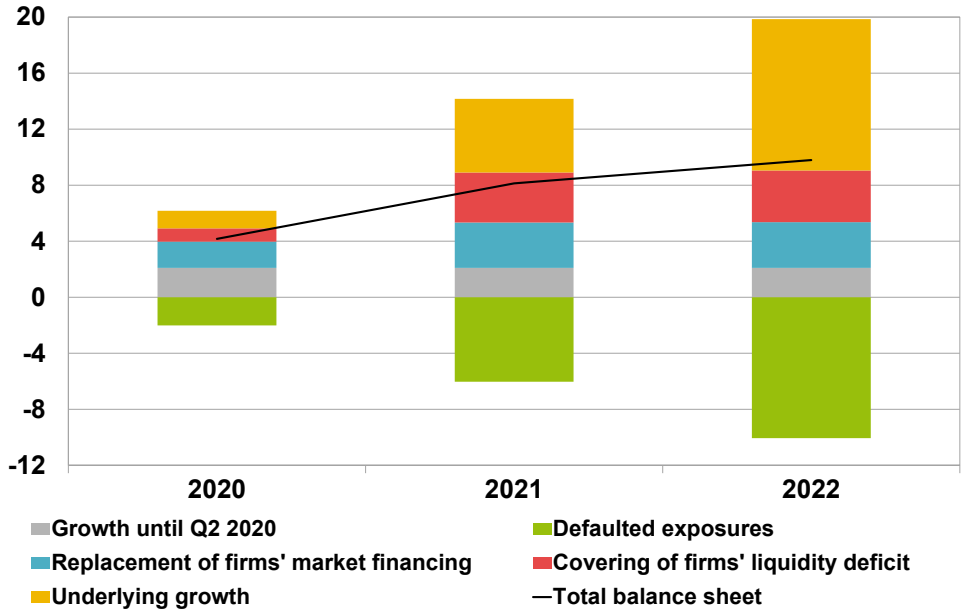
As it is important for the economy that banks have the capacity to provide loans, we assume that the banks increase their lending despite this not reflecting historical circumstances in all respects or – more generally – how a crisis normally unfolds.[10] The purpose is to investigate whether there is a risk of banks being restricted from lending due to capital ratios being too low and thus a risk of a crisis being exacerbated. For more details, see Appendix 1.

During a stressed period, large non-financial firms that are financed via the capital market may experience difficulties renewing commercial paper and bonds and the risk appetite in the capital market may deteriorate. Consequently, we assume that the firms replace all market financing that matures during the period from the third quarter of 2020 to the second quarter of 2021 with bank loans by using existing credit facilities and taking out new loans (the blue bars in Diagram 4). As a result of revenue falling in the current crisis, non-financial firms may also need to borrow money in order to manage their liquidity. We therefore estimate how much these firms need to borrow from banks in order to cover their liquidity needs over the period from the third quarter of 2020 to the second quarter of 2021 (the red bars). This combined borrowing need results in the banks' exposures to corporates increasing by 13 per cent in one year. We then assume that banks' lending to corporates increases in line with the historical average (five per cent per year) and we make the same assumption for lending to households throughout the entire scenario (the yellow bars).

10 For example, Swedish banks' lending portfolio shrunk by 22 per cent during the banking crisis in the 1990s.

At the same time, the banks' exposures decrease as credit losses arise (the green bars in Diagram 4). The net effect of increased exposures and defaulted loans is that the banks' balance sheets expand by just under ten per cent throughout the entire scenario (black line).

Diagram 4. Balance sheets in the scenario
Change in per cent compared to Q4 of 2019



Source: FI

2.3.2 Risk weights and risk-weighted assets

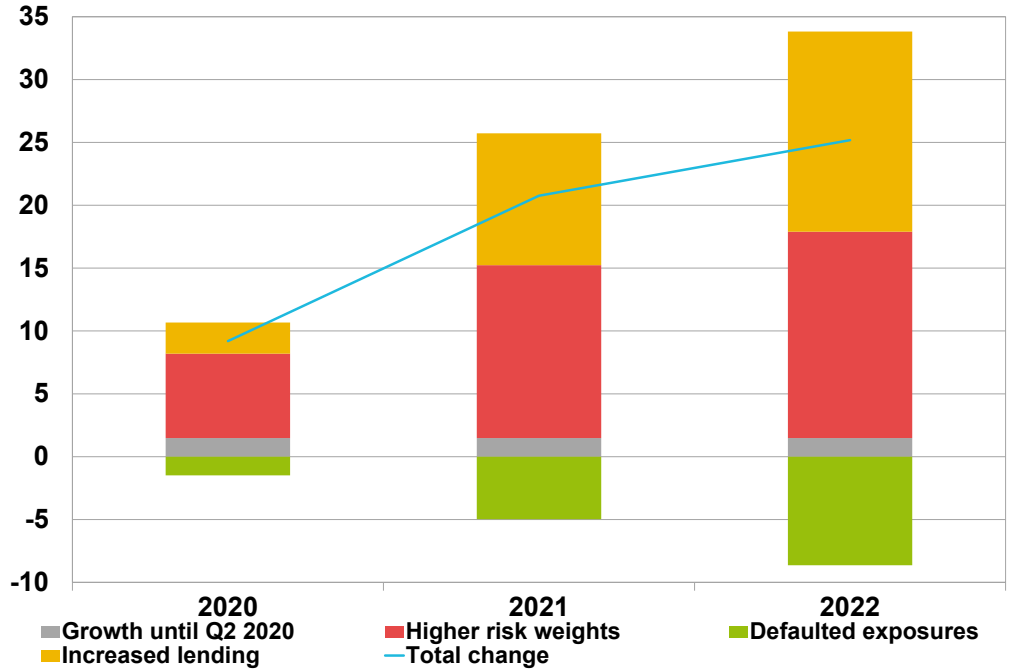
In addition to increased lending, the banks' risk-weighted assets are also affected by changes in risk-weights for credit risk. Risk-weighted assets are a risk adjusted measure of the bank's assets that is used to calculate capital requirements, and they increase when the underlying credit risk increases. When risk-weighted assets increase, the banks' capital adequacy weakens.

The purpose of our methodology is to calculate the change in risk weights for credit risk in a manner that is consistent with our estimate of credit losses. Even if the aim of the capital adequacy regulations is for the banks' risk weights to be stable throughout economic cycles, the credit quality may deteriorate to the degree that risk weights increase in a severe economic downturn. We assume that the realised credit losses gradually contribute to increasing the expected losses for each portfolio when compared with the level prior to the scenario. The cyclically adjusted probability of default (PD) then increases, as does, to some extent, the loss given default (LGD) and thus the risk weight. However, the increase in average risk weight is significantly suppressed due to application of the risk weight floor for Swedish mortgages. For more details, see Appendix 1.

Total risk-weighted assets are estimated to increase by an average of 25 per cent during the scenario period (see Diagram 5). Increased lending contributes

to this increase to around the same extent as higher risk weights. We assume that defaulting loans does not need to be covered, which tends to suppress this growth. The largest net increases occurs during 2020 and 2021.[11]

Diagram 5. Risk-weighted assets in the scenario
Change in per cent compared to Q4 of 2019



Source: FI
Note: Change in risk-weighted assets for market risk and operational risk are not shown separately (they amount to less than one percentage point).

The largest increase in risk-weighted assets for credit risk arises in the category other corporate (see Table 4). This is mainly due to the estimated credit losses for this category (see Table 3) being high in relation to the expected losses prior to the stressed period. For loans to small and medium-sized enterprises, the risk-weighted assets are reduced as a result of the implementation of the European Commission's revised support factor for small and medium-sized enterprises (known as the SME discount factor).[12] The risk-weighted assets for Swedish mortgages only increase due to increased volumes because risk weights are kept constant due to the risk weight floor. The differences between regions are more or less consistent with the differences in the average credit loss ratio.

11 For the development of risk-weighted assets for market risk and operational risk we use the outcome for the banks of the European Banking Authority's (EBA) stress test in 2018. Risk-weighted assets for other risks (excluding the risk weight floor for Swedish mortgages) is assumed to remain unchanged from the quarter prior to the scenario.

12 We assume that the rest of the SME discount factor is introduced in Q3 of 2020 in addition to the part that was introduced in Q2 of 2020. This involves a capital reduction factor in the amount of capital the banks must have for prudential reasons when it comes to the loans they grant to small and medium-sized enterprises.

Table 4. Proportions of the change in credit-risk risk-weighted assets in the scenario

Percentage of the total increase in risk-weighted assets for credit risk

	Sweden	Other Nordic countries	The Baltic region	Other countries	Average
Mortgage	16	1	1	0	17
Consumer credit	1	0	0	0	0
CRE	6	0	3	2	11
SME	-4	-2	0	-1	-6
Other corporate	28	19	7	24	78
Average	46	19	11	24	100

Source: FI
Note: Other risk-weighted assets, that reflect primarily the risk weight floor for Swedish mortgages, are included in the figures.

2.4 The banks' earnings

In addition to credit losses and changes in risk-weighted assets, the banks' capital situation is also affected by how their earnings develop over the course of the scenario. The banks' earnings primarily consist of net interest income and net fee and commission income, but other income statement items also make a contribution, primarily net financial income.

2.4.1 Net interest income

Net interest income is the major Swedish banks' most important source of income. It consists of the difference between the banks' interest income from lending and the interest expenses they have for their financing. We use the average of the outcome from two different methods in order to estimate how the net interest income may develop in the scenario (see Appendix 1), and take into account the changes in exposures we described in Section 2.3.1.

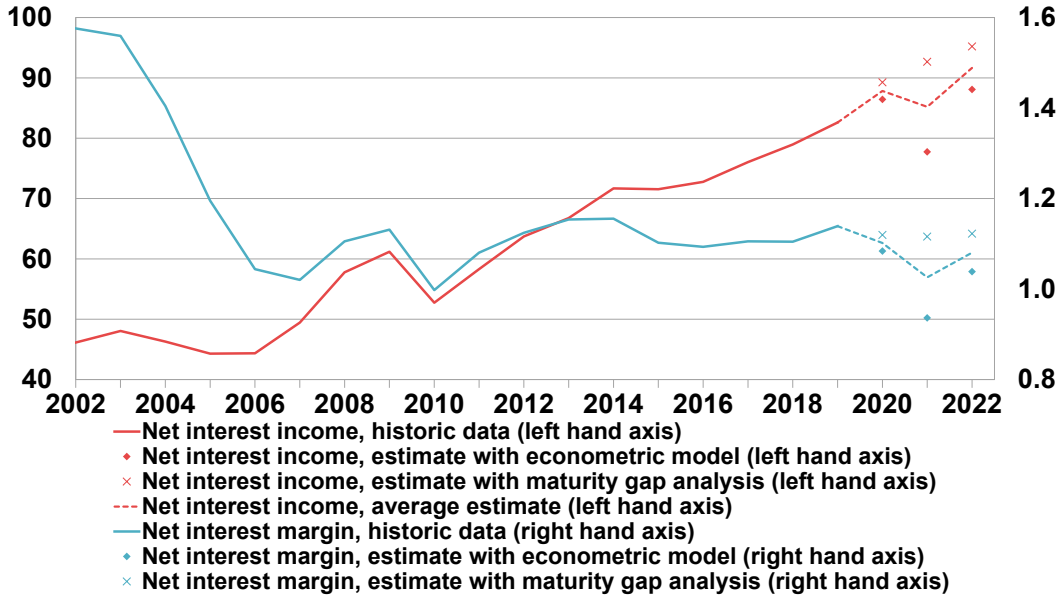
The first method is based on two separate econometric models. These are based on historical relationships between the interest income margin and the interest expense margin, i.e. interest income and interest expenses as proportions of lending, and macroeconomic and financial variables, primarily GDP growth and interest rates. The other method is based on each individual bank's maturity gap, i.e. the difference in interest rate adjustment period or maturity between interest-bearing assets and liabilities, including derivatives. The net interest income in this model is affected by changes in market rates (risk-free interest rate) and by any maturity gaps between assets and liabilities. In addition, a bank's interest margins may change when, in a stressed scenario, the financing margin increases without the bank being able to compensate for this fully through a higher lending margin.

The outcome of the econometric model means that the average interest margin falls by no more than 18 per cent for the full year 2021, when compared with 2019 (see Diagram 6). The net interest income decreased to a smaller extent, by six per cent, as increased lending makes a positive contribution. The corresponding outcome with the maturity analysis included involves the average interest margin only falling by no more than two per cent, at the same

time as the net interest income increases substantially due to increased lending. An average of the outcomes from the two different models entails a decrease in the interest margin in 2020 and 2021 and then a recovery.

The outcome of the maturity analysis entails milder stress to the interest margin when compared with the econometric method. This can be explained partly by the development of interest rates and because the maturity analysis does not take into account the impaired macroeconomic development that is present in the econometric method through lower GDP growth.

Diagram 6. Net interest income, interest margin and outcome in the scenario
SEK billion (left axis) and percentage of interest-bearing assets (right axis)



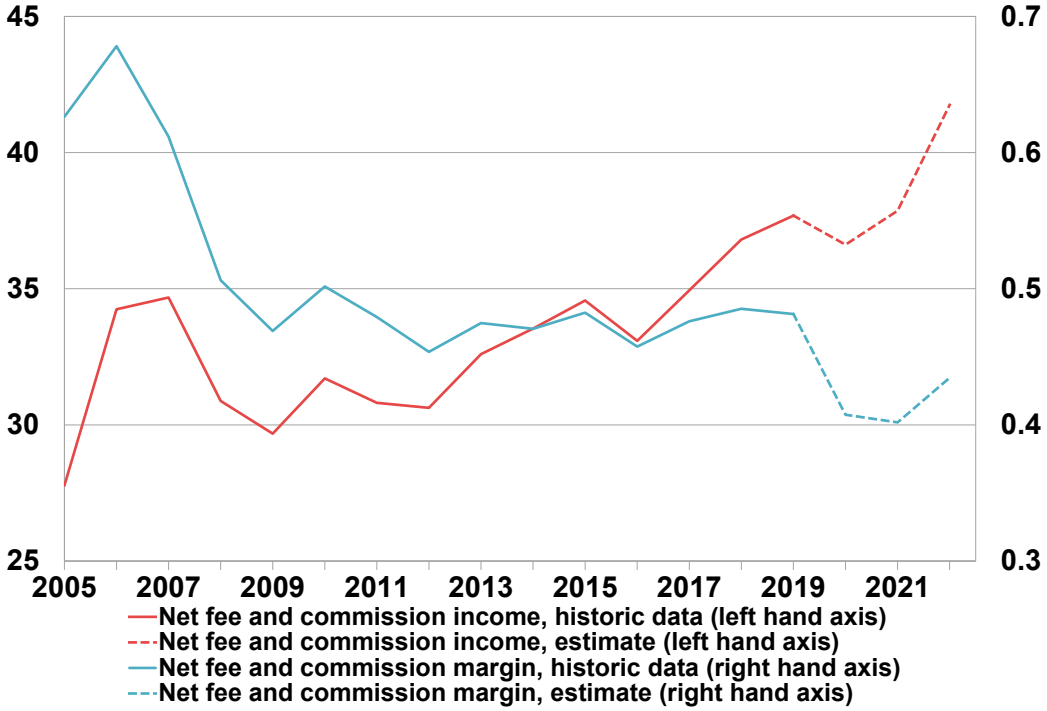
Source: FI

2.4.2 Net fee and commission income

Net fee and commission income is the banks' income minus expenses for fees and commissions. Important components are fee-based services such as cards, payments, asset management and equity trading. We use an econometric model that estimates the net commission margin, i.e. net fee and commission income divided by total assets as a function of primarily GDP growth and changes in share prices (see Appendix 1).

The outcome from this model involves the average net fee and commission margin falling by no more than 17 per cent for the full year 2021, when compared with 2019 (see Diagram 7). However, net fee and commission income is estimated only to decrease by three per cent and then increase due to total assets increasing sharply in the scenario.

Diagram 7. Net fee and commission income, fee and commission margin and outcome in the scenario
SEK billion (left axis) and percentage of total assets (right axis)



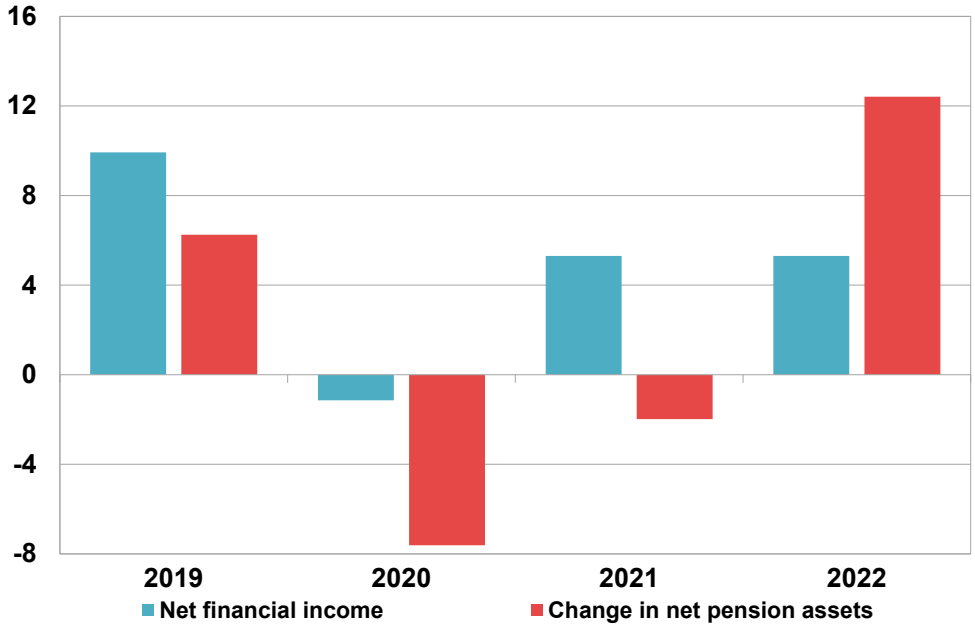
Source: FI

2.4.3 Net financial income

Net financial income is the banks' net income from trading in financial instruments. It primarily consists of changes in the value of various financial instruments, including derivative positions. This income statement item also consists of fees the bank's customers pay in order to execute financial transactions such as currency hedges. We estimate the development of net financial income with the method specified by the EBA for banks included in the EBA's stress test that do not have their own model (EBA, 2018) (see Appendix 1). In our stress test, net financial income decreases due to falling asset prices causing a remeasurement of the banks' own financial assets that are measured at fair value. In addition, it is assumed that the revenue generated by fees from customer activities decreases somewhat.

Net financial income is estimated to be negative for 2020 as a whole (see Diagram 8). This primarily reflects the effect of high market volatility and falling asset prices that arose at the start of the crisis in the first quarter of 2020. During the whole scenario, which starts in the third quarter of 2020, net financial income again becomes positive, but somewhat weaker than in 2019.

Diagram 8. Net financial income and changes in net pension assets the previous year and in the scenario
SEK billion



Source: FI
Note: Changes in net pension assets are reflected in the banks' other comprehensive income (OCI) (see Section 2.5 Net pension assets).

2.5 Net pension assets

Changes in net pension assets that are reserved for defined-benefit pension plans have an impact on the banks' other comprehensive income (OCI) and thus also on their own funds. Changes in any deficits are deducted from own funds and changes to any surpluses are added to own funds. In the scenario, we assume that the value of banks' pension assets − which consist of shares, bonds and real estate − develops in line with prices for these. The present value of liabilities increases when the discount rate, the long market rate in the scenario, decreases, and decreases when the discount rate increases.

The average change in net pension assets becomes, as does net financial income, negative in 2020, which has a negative impact on own funds (see Diagram 8). A recovery then takes place and the impact on capital is estimated to be positive in 2022.

2.6 Other revenue, costs and dividends

Other revenue, which consists of income from subsidiaries, joint ventures and associated companies, as well as dividends from investments is small. We assume that it decreases by 50 per cent compared to the year prior to the scenario. Administrative costs, which includes payroll expenses, are unchanged

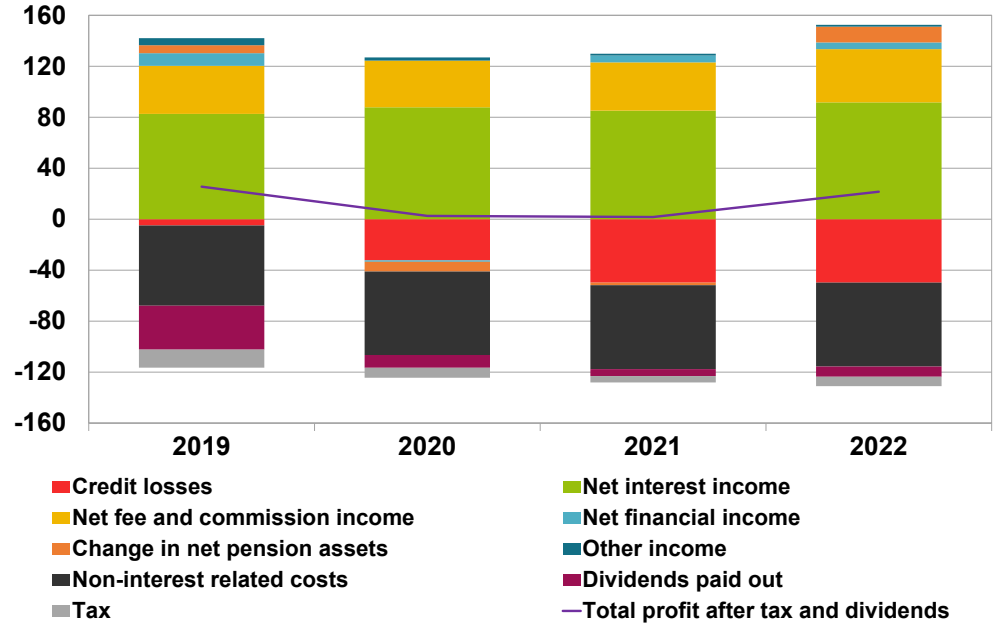
in the scenario when compared with the year prior to the scenario.[13] We have assumed a 30 per cent tax rate on any profit.

We conduct the analysis with two different assumptions for the banks' distribution of any profits to their shareholders. In the case where we assume banks pay dividends we are basing estimates on their dividend targets that have been communicated publicly.[14] In the other case we assume that no dividends will be paid during the scenario. We then also assume that the planned distribution of profits from 2019 and the first half of 2020, which has previously been provided for on the balance sheet and deducted from own funds, is returned to capital during the second half of 2020.

Diagram 9 and Appendix 2 show the development of the components on the income statement we have described thus far. When adding together all the components, the profit after tax and dividends is estimated to be small in 2020 and 2021 but then increase in 2022 (see the line in Diagram 9). Even if average earnings are positive throughout the scenario, they are much weaker than in normal years such as 2019 and some banks make losses in some quarters.

Diagram 9. Breakdown of profits the previous year and in the scenario

SEK billion



Source: FI

Note: We have assumed that dividends will be paid for 2019−2022.

13 We have adjusted SEB's and Swedbank's earnings for the costs of a one-off nature in the first half of 2020 due to administrative fines for failings in their anti-money laundering efforts.

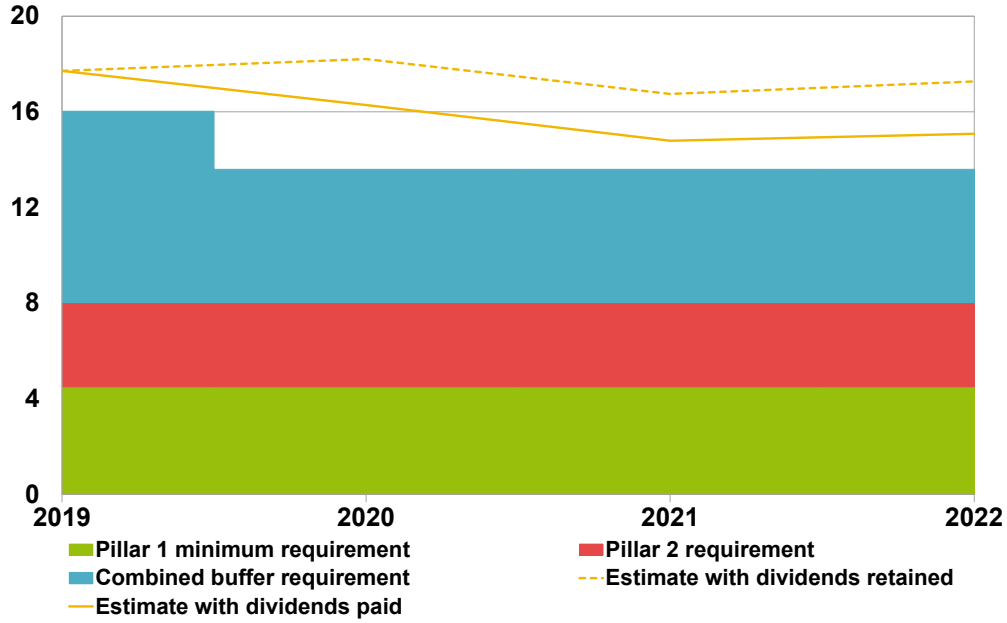
14 If a bank's dividend targets are stated as 'at least X per cent of profits' we use X per cent in our calculations.

2.7 Capital ratio and leverage ratio

The outcome of the stress test suggests that banks have significant resilience and the capacity to support the supply of credit to the economy. The average CET1 capital ratio decreases by a maximum of 2.8 percentage points in the scenario, from 17.6 per cent for the second quarter of 2020[15] to a lowest point of 14.8 per cent for the fourth quarter of 2021 if the banks distribute their profits from 2019–2022 in accordance with their dividend targets (see Diagram 10). The capital ratio decreases by about 1.5 percentage points in 2020 and to the same extent in 2021 and is almost unchanged in 2022.

Diagram 10. CET1 capital ratio in the scenario and the current capital requirement

Percentage of risk-weighted assets



Source: FI

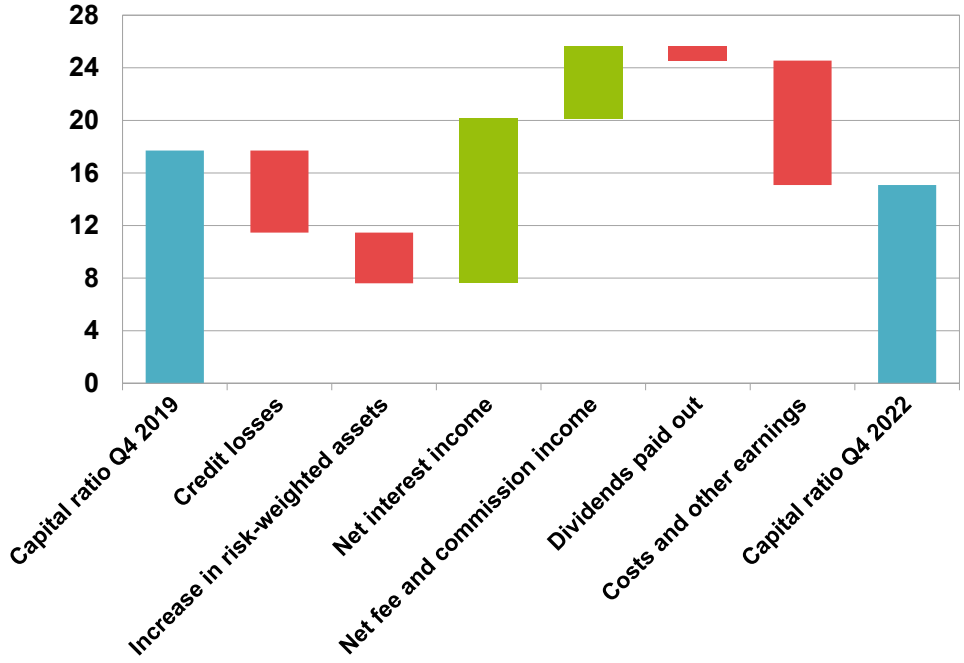
Note: Refers to the average for the three Swedish major banks and the CET1 capital ratio in Q4 of each year. The Pillar 2 requirement contains systemic risk. As of 2020, the combined buffer requirement contains the capital conservation buffer, the systemic risk buffer and a countercyclical capital buffer of 0.1 percentage points (based on other EEA countries' countercyclical buffer values).

In the scenario, the average margin of the current CET1 capital requirement is estimated then to decrease from four percentage points in the second quarter of 2020 to no lower than 1.2 percentage points. If the banks instead choose not to pay dividends in 2020–2022 for profits made during financial years 2019–2022, the corresponding reduction would be 0.9 percentage points, with a lowest level for the capital ratio at 16.7 per cent. In which case, the average margin to the capital requirements becomes even larger. The reduction in the capital ratio is mainly due to large credit losses and higher risk-weighted assets and is counteracted by earnings (see Diagram 11). Even though earnings

15 Corresponding figures for the fourth quarter of 2019 are a decrease by 2.9 percentage points from 17.7 per cent.

decrease in the scenario, the banks' underlying profitability constitutes a good buffer against credit losses.

Diagram 11. Factors driving the change in the capital ratio in the scenario
Percentage of risk-weighted assets



Source: FI
Note: Green bars show components that contribute to an increase, and red a decrease, in the capital ratio between the fourth quarter of 2019 and the fourth quarter of 2022. We have assumed that dividends will be paid for 2019−2022. Costs and other earnings encompasses primarily fixed non-interest expenses such as salaries and premises but also net financial income, income from subsidiaries, joint ventures and associated companies, dividends received, other comprehensive income (OCI) and taxes.

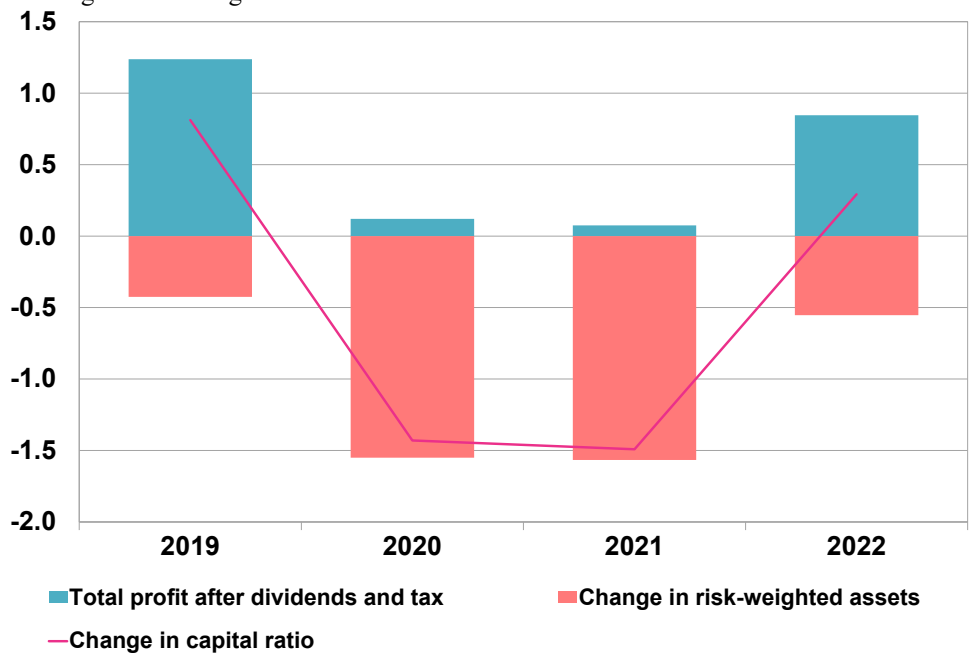
The profit after tax and dividends is positive throughout the scenario (see Diagram 9) and thus contributes to an increase in the capital ratio (see Diagram 12). The reduction in the capital ratio is instead explained by increased risk-weighted assets. The increase in risk-weighted assets as a result of increased lending more than counteracts the positive effect that increased lending has on the banks' earnings.

In the scenario, the average leverage ratio decreased from 4.3 per cent for the second quarter of 2020[16] to a minimum of 4.0 per cent (see Diagram 13). This reflects not only lower Tier 1 capital as a result of losses in the early part of the scenario but also increased exposures. This would mean a lowest margin of one percentage points to the forthcoming minimum capital requirement of three per cent. If the banks withhold planned dividends, the average lowest level becomes 4.5 per cent.

16 The corresponding figure for the fourth quarter of 2019 is 5.1 per cent.

Diagram 12. Annual change in the capital ratio the previous year and in the scenario

Percentage of risk-weighted assets

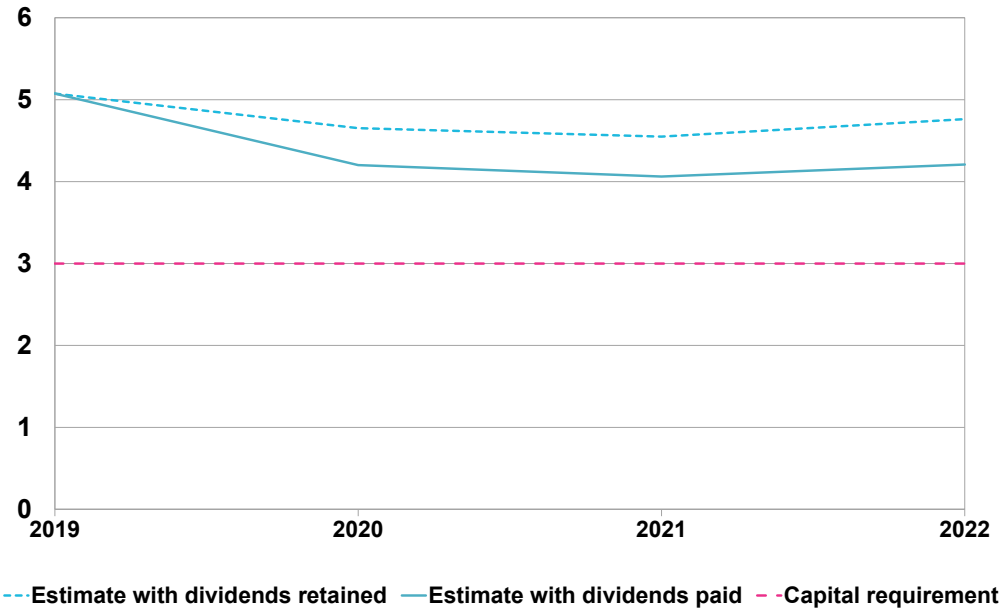


Source: FI

Note: We have assumed that dividends will be paid for 2019–2022.

Diagram 13. Leverage ratio in the scenario

Per cent



Source: FI

Note: Refers to leverage ratio in Q4 of each year. The minimum requirement enters into force on 28 June 2021.

3 Concluding remarks

Stress tests based on macroeconomic scenarios are an important tool for assessing the resilience of individual banks and the financial system to economic downturns. In this memorandum, we have described FI's current method for conducting macro-based stress tests for the major Swedish banks. This methodology is a work in progress and is continuously being developed.

We have also described the results presented in the stability report in more detail. The scenario we have used entails a further deepening of the prevailing economic crisis. The results indicate that the banks have an ability to continue supporting the supply of credit to the economy over the years ahead without jeopardising their solvency, even under more unfavourable circumstances.

There is great uncertainty about how capital ratios may develop in the years ahead. The models only illustrate a potential course of events. We have not identified all the fiscal policy and monetary policy support measures that contribute to decreasing the banks' credit risk and reducing their financing costs. This means that the historical relationships used in some of our models may lead to an overestimation of the banks' losses. In contrast to the financial crisis of 2008−2009, the current crisis is so far a real economic crisis, which may reduce the link between the economy and the banks' resilience. At the same time, there is a risk that the macroeconomy − and by extension the banks' credit risk and earnings − develop more negatively than is illustrated here.

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Appendix 1: Models and assumptions

Scenarios

We use scenarios for GDP and unemployment in Sweden and other countries that are produced by established forecasters. We have then expanded these scenarios to encompass the development of asset prices, i.e. prices of shares, homes and commercial real estate (CRE), but also the development for key financial variables, primarily interest rates and interest rate spreads. The development of commercial real estate prices is taken from our microdata model, which has been produced in order to stress firms and especially the commercial real estate sector.[17]

Exposure volumes

This section describes two channels for the non-financial firms' emergency borrowing needs which we assess may arise in the scenario during the period from the third quarter of 2020 to the second quarter of 2021 as a result of the deepening financial recession caused by the pandemic.

Firstly, reduced income means that the firms have less money to pay fixed costs such as salaries, rent and interest. If a firm is viable in the long-term, there may be justification for temporarily increasing lending in order to cope with the deficit that still arises. At the same time, the Government has introduced extensive temporary fiscal support measures such as the opportunity for temporary lay-offs and support for firms that have lost a large part of their turnover.[18] That keeps demand for borrowing down.

In order to analyse how demand for loans to cover liquidity needs may develop during the crisis, we have made a rough estimate of a potential trend. We base this on aggregate data (Statistics Sweden's Business Register) concerning the number of firms and employees per size category in Sweden. The calculation is then performed in stages:

1. We calculate the payroll expenses including statutory employers' contributions based on a median salary of SEK 30,900.[19] We add a standardised 30 per cent supplement to the payroll expenses to cover statutory employers' contributions.
2. We add other fixed costs for the firms by assuming that they amount to 50 per cent of payroll expenses.
3. We adjust the fixed cost for temporary lay-offs. We have assumed in this calculation that 25 per cent of firms utilise temporary lay-offs[20] and

17 For more information, see Aranki et al.

18 https://www.regeringen.se/regeringens-politik/regeringens-arbete-med-anledning-av-nya-coronaviruset/foretag/

19 https://www.scb.se/hitta-statistik/sverige-i-siffror/utbildning-jobb-och-pengar/medianloner-i-sverige/

20 According to https://www.regeringen.se/artiklar/2020/03/om-forslaget-korttidspermittering/ and https://www.regeringen.se/4968f1/contentassets/ed6d8bec41444046964237aee797942d/rakneexempel-forslag-om-korttidspermittering-i-extra-andringsbudget-med-anledning-av-coronaviruset.pdf

that these involve a 40 per cent reduction in working hours. This means that one quarter of firms have their payroll expenses reduced by 36 per cent.

4. We arrive at a liquidity need for each month by assuming that income covers half of fixed costs after temporary lay-offs.
5. Finally, we assume that one fifth of firms borrow money in order to cope with liquidity problems.

When assessing the corresponding exposure that needs to be covered, we assume that the Swedish loans are taken out within the Swedish National Debt Office's guarantee programme for firms (Företagsakuten), where the government guarantees 70 per cent of the credit risk.[21] This means that the risk weight for these loans is significantly lower than for existing loans to equivalent customers.

In the same way that there may be increased demand for credit from Swedish firms, there may be increased demand from foreign firms. We have estimated a borrowing need in proportion to that which arises for Swedish firms in existing lending in various regions.

The other channel for firms' emergency borrowing need is as replacement for their financing from the capital markets. We make an estimate that is based on actual maturity of certificates and bonds issued by Swedish firms during the period from the third quarter of 2020 to the second quarter of 2021. Large firms often have lines of credit with banks. We therefore assume that these firms utilise existing lines of credit to replace market financing to the extent this is possible. The borrowing need in excess of what is possible to cover using existing lines of credit becomes new loans.

We adjust the banks' exposures to credit losses in accordance with

$$Exposure_{t+1} = Exposure_t - \frac{credit\ losses_t}{LGD_t}$$

We assume that the banks do not replace defaulted loans with new loans and that the actual provisions the bank makes for defaulted credit in the scenario corresponds to the capital the bank is holding for defaulted credit (minimum capital requirement) in stressed situations. Note that defaulted loans still need to be financed. Loans on the balance sheet that have not defaulted are reinstated with respect to the remaining maturity at the beginning of each calculation period.

21 The proposal involves the state guaranteeing 70 per cent of new loans from the banks to firms that have found themselves in financial difficulties due to the novel coronavirus but are otherwise viable. The guarantees are issued to the banks, which then provide guaranteed loans to the firms. The loan guarantee is primarily aimed at small and medium-sized enterprises but there is no formal limit to the size of the firm in order to be eligible to participate in the programme.

Risk-weighted assets

Our approach to calculating the change in risk-weighted assets for credit risk in the scenario is based on our estimates for exposure volumes and also on how the risk-weights for credit risk develop. We use a similar method for risk weights as the one used by the International Monetary Fund (IMF) for the stress test included in its examination of the Swedish financial sector and the authorities' work with financial stability (Financial Sector Assessment Program, FSAP) 2016.

We extrapolate estimates of the banks' expected credit losses in the scenario in the year ahead and calculate how this can affect risk weights. We calculate the change in risk weights for the same regions and categories as for credit losses. The realised credit losses from our credit loss models gradually contribute to increasing the banks' average expected losses over an assumed business cycle of 15 years. The method requires us to make assumptions about how a change in expected losses is due to changes in probability of default (PD) changes to loss given default (LGD). As probability of default is judged to be more sensitive to economic fluctuations, we allocate 90 per cent of the change in expected losses to PD and ten per cent to LGD. Finally we use the extrapolated risk parameters to calculate new risk weights for each quarter in the scenario.[22]

For the development of risk-weighted assets for market risk and operational risk we use the outcome for the banks' from the EBA stress test of 2018. Risk-weighted assets for other risks (excluding the risk weight floor for Swedish mortgages) are assumed to be unchanged compared to the quarter prior to the scenario.

Net interest income

The econometric models for the banks' net interest income are based on quarterly data from the period 2002 to 2018, added together for the major banks.[23] We have calibrated separate autoregressive models for the effective interest rates of interest-bearing assets and liabilities. Significant explanatory variables are the three-month Euribor interest rate, the slope of the yield curve and annual change in GDP (see Table A1). The slope of the yield curve is calculated as the difference between the interest of the ten-year Swedish government bond and the three-month Swedish treasury bill. The annual change in GDP is calculated as a weighted mean using the major banks' average exposures to each country. Historically, net interest income shows a strong serial correlation between quarters, so the models allow net interest income to depend on net interest income in the previous quarter.

22 The risk weight floor for mortgages applies from 31 December 2018 in Pillar 1, which means that the increase in total risk-weighted assets − i.e. for credit risk and other − is smaller than would have been the case with the regulation that applied previously.

23 The models are based on aggregate data for SEB, SHB, Swedbank and Nordea at a group level.

Table A1. Regression results for the net interest income models

Variable	Interest income margin	Interest expense margin
Interest margin, previous quarter (%)	0,86*** (0,020)	0,79*** (0,030)
3-month Euribor rate (%)	0,087*** (0,015)	0,12*** (0,018)
GDP, annual change (%)	0,031*** (0,0040)	0,026*** (0,0045)
Slope of yield curve (%)	-0,054*** (0,013)	-0,048*** (0,013)

Source: FI.

Note: The figures represent estimated regression coefficients and standard deviations (in parentheses). The estimated constant is not reported, *, ** and *** denotes statistical significance at the 10, 5 and 1 per cent level, respectively.

The strong serial correlation in historical net interest income may mean that the assessment of net interest income becomes more uncertain if the historical correlations are not maintained in a stressed situation. This can occur if the banks have a different exposure to interest rate risk now or if the proportion of financing from the capital markets varies over time.

Consequently, we supplement the time series approach with an alternative maturity method that has bank-specific data. This is based on a simplified variant of the one used in the EBA's stress test. The interest rate risk is reflected in how both the structural and the commercial margin changes in the scenario. In somewhat simplified terms, the structural margin is what the banks earns on the maturity transfer, financing itself with short maturities and lending with long maturities. The commercial margin can be seen as the difference between the premium on the risk-free interest rate that the banks' customers pay and the premium that the bank itself pays.

The structural margin is identified with the ten-year Swedish government bond rate, which affects both interest income and interest expenses. Changes in the commercial margin have more of an impact on financing costs than the margin on lending. In our approach, the increase in financing costs is bank-specific and is primarily affected by the banks' initial credit rating and financing mix. The financing cost increase more for banks that have a lower credit rating or smaller proportion of deposits.

The change in the financing margin and the lending margin, respectively, are described schematically (EBA, 2018):

Fin. margin (t) = Fin. margin (t_0) + γ max (0, Δ sov spread (t), Δ idiosyncratic component)

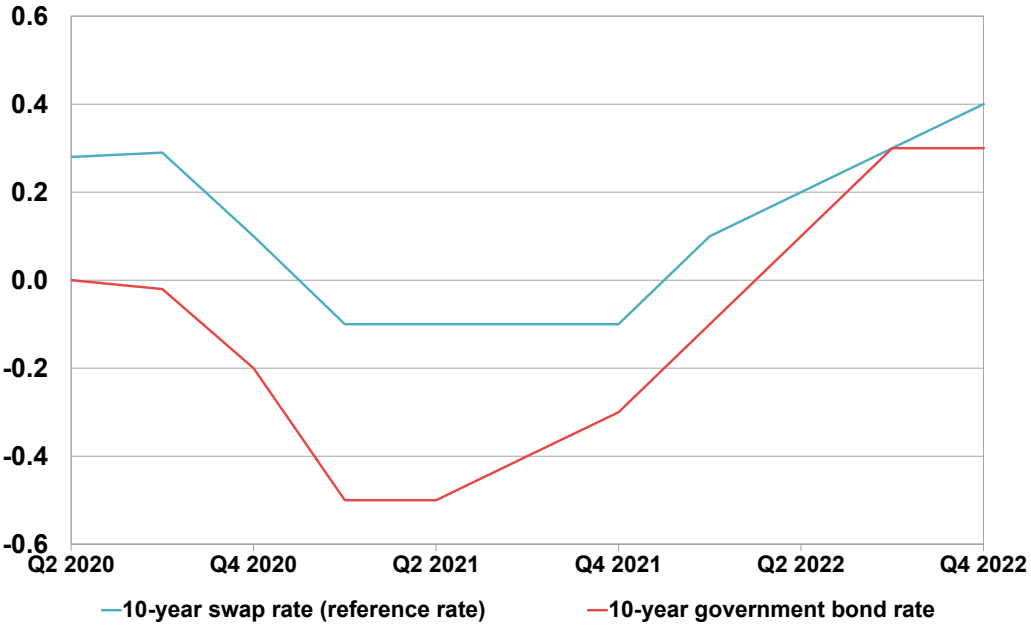
Len. margin (t) = Len. margin (t_0) + λ max (Δ sov spread (t), 0)

where t_0 is the last quarter prior to the scenario. The variable 'Δ sov spread' represents the change in the Swedish state's credit risk (sovereign spread) relative to the starting position t_0. This is defined as the difference between the interest rate on a ten-year government bond and the swap rate with the same maturity. The change in the idiosyncratic component is a bank-specific constant that is relatively high for banks with low credit ratings from Standard & Poor's (S&P rating).[24] The quantities γ and λ are constants between 0 and 1 and their size depends on how sensitive the bank's assets and liabilities are expected to be to a general increase in credit risk.

Diagrams A1–A3 summarise the development of market rates, risk parameters and interest margins in the scenario. As the change in the idiosyncratic factor exceeds the change in sovereign spread, it is the idiosyncratic risk that affects the change in the banks' financing margins. Consequently, the financing margin increases without the banks being able to compensate for this fully through a higher lending margin.

Diagram A1. Market rates in the scenario

Per cent

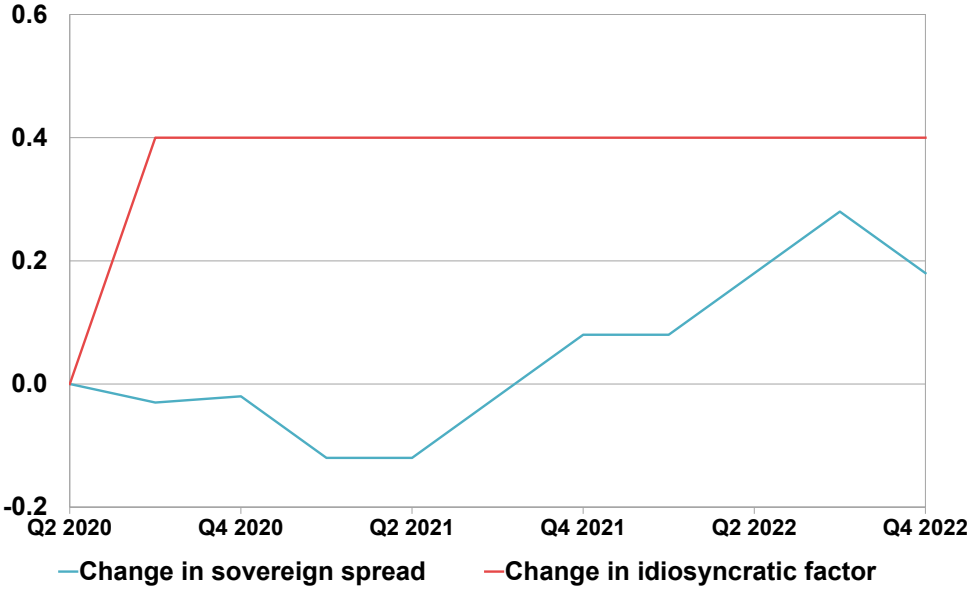


Source: FI

24 The increase in idiosyncratic spread is calibrated so as to correspond to the increase in financing costs due to a reduction in the credit rating for the bank's covered bonds.

Diagram A2. Risk parameters for net interest income in the scenario

Percentage points

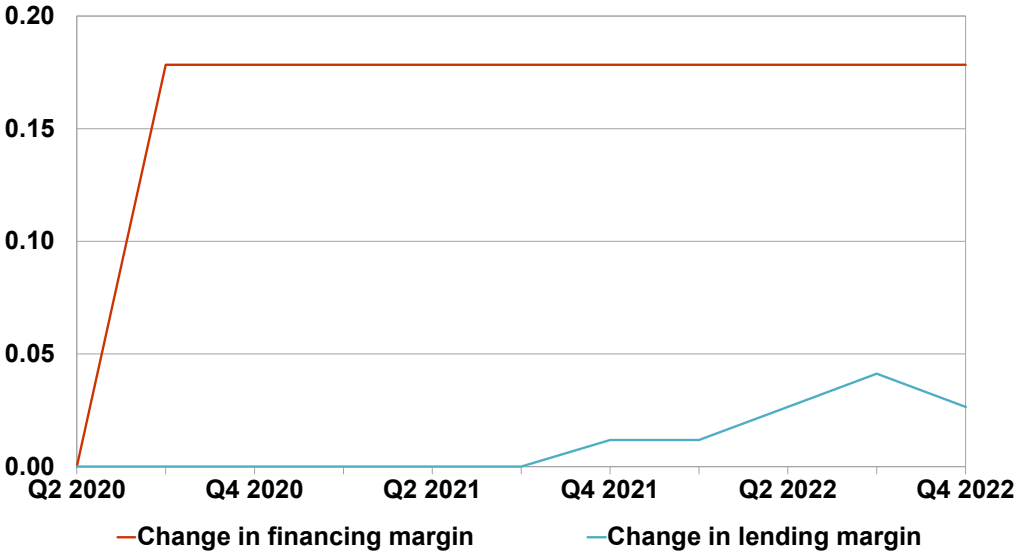


Source: FI

Note: Change compared to Q2 2020.

Diagram A3. Changes in interest margins in the scenario

Percentage points



Source: FI

Note: Change compared to Q2 2020.

Net fee and commission income

We model the net fee and commission margin with an autoregressive panel data model (David, 2019). The model has been estimated using full-year data from between 2005 and 2018 for 30 European banks, with the foreign banks having been assessed to have similar business models to the major Swedish banks. The model is calibrated with an annual change in the OMXS30 share index and an annual change in GDP for Sweden, together with bank-specific fixed differences (see Table A2).

Table A2. Regression results for the net fee and commission income model

Variable	Net fee and commission income
Net fee and commission income, previous year (%)	0,84*** (0,030)
GDP, annual change (%)	0,0078*** (0,0021)
Equity price index, annual change (%)	0,0012*** (0,00023)

Source: FI.

Note: The figures represent estimated regression coefficients and standard deviations (in parentheses). Estimates for constant and fixed differences between the banks are not reported. *, ** and *** denote statistical significance at the 10. 5 and 1 per cent level, respectively.

Net financial income

We use the EBA's standardised approach for net financial income (NFI) which provides for a negative effect on earnings in the first period of the scenario when asset prices fall and banks are then forced to revalue their own financial assets that are measured at fair value. In addition, it is assumed that banks are able to maintain their earnings through fees from customer activity. This item corresponds to 75 per cent of an assessed historically stable level for net financial income. What constitutes a stable level is calculated based on the banks' net financial income over the last five years.

$NFI_{\text{Stable level}}$ = min{average (NFI) last four years, average (NFI) last three years, max (0, average (NFI) last two years)}

$NFI_{\text{Stress, Q1}} = 0.75 * NFI_{\text{Stable level}}$

- 0.2% * sum total (|Assets in the trading book|, |Liabilities in the trading book|),

$NFI_{\text{Stress, Q2 and onwards}} = 0.75 * NFI_{\text{Stable level}}$

Appendix 2: Detailed outcome from the macro stress test

Table A3. Earnings and balance sheet in the scenario

SEK billion

	2019	H1 2020	2020	2021	2022
Credit losses	-5.0	-7.4	-32.3	-49.8	-49.8
Net interest income	82.6	44.5	87.8	85.2	91.6
Net fee and commission income	37.7	18.0	36.6	37.9	41.8
Net financial income	9.9	-3.1	-1.1	5.3	5.3
Dividends received	5.0	0.9	1.6	1.3	1.3
Income from subsidiaries, joint ventures and associated comp	0.5	0.1	0.2	0.1	0.1
Other income	0.1	0.8	0.8	0.0	0.0
Non-interest related income	*53.2*	*16.8*	*38.0*	*44.6*	*48.5*
Non-interest related costs	-62.9	-32.6	-65.5	-65.8	-65.8
Total profit before tax	*67.9*	*21.2*	*28.0*	*14.1*	*24.5*
Tax	-14.2	-5.5	-7.9	-5.0	-7.4
Dividends paid out	-34.5	-7.3	-10.0	-5.4	-7.9
Total profit after tax and dividends	*21.5*	*8.4*	*10.2*	*3.7*	*9.1*
Other comprehensive income (OCI)*	6.3	-3.5	-7.6	-2.0	12.4
Total income (change in capital)	*25.5*	*5.0*	*2.5*	*1.7*	*21.6*
Tier 1 capital	430.2	417.2	414.8	416.5	438.1
Common Equity Tier 1 (CET 1) capital	**374.0**	**377.8**	**375.4**	**377.1**	**398.6**
Risk-weighted assets for credit risk	1345.0	1324.0	1487.3	1736.9	1824.7
Risk-weighted assets for market risk	52.7	65.6	75.8	76.4	76.5
Risk-weighted assets for operational risk	182.0	187.0	182.2	184.3	184.3
Other risk-weighted assets	531.6	566.1	560.1	551.9	557.5
Total risk-weighted assets	**2111.3**	**2142.7**	**2305.4**	**2549.5**	**2643.0**
Exposures for leverage ratio	8477.3	9644.8	9871.2	10253.7	10410.3
CET 1 capital ratio	**17.7%**	**17.6%**	**16.3%**	**14.8%**	**15.1%**
Leverage ratio	5.1%	4.3%	4.2%	4.1%	4.2%
Pillar 1 minimum requirement	4.5%	4.5%	4.5%	4.5%	4.5%
Pillar 2 requirement	3.5%	3.5%	3.5%	3.5%	3.5%
Combined buffer requirement	8.0%	5.6%	5.6%	5.6%	5.6%
Total CET1 capital requirement	**16.0%**	**13.6%**	**13.6%**	**13.6%**	**13.6%**

*including change in net pension assets

Source: FI.