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October 22, 2020

TECHNICAL NOTE

RISK ANALYSIS AND STRESS TESTING

Prepared By
Monetary and Capital Markets Department

This report is based on the work of the Financial Sector Assessment Program (FSAP) mission that visited Norway in 2020. The FSAP findings were discussed with the authorities during the Article IV Consultation mission in February 2020.

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Glossary

BCBS	Basel Committee on Banking Supervision
BMA	Bayesian Model Averaging
BU	Bottom-up
CBC	Counterbalancing Capacity
CCB	Capital Conservation Buffer
CCyB	Counter-cyclical Buffer
CPI	Consumer Price Index
CRE	Commercial Real Estate
CRR/CRDIV	Capital Requirements Regulation/Capital Requirements Directive IV
CRRA	Constant Relative Risk Aversion
CVA	Credit Value Adjustment
DSGE	Dynamic Stochastic General Equilibrium
D-SIB	Domestic Systemically Important Bank
ECB	European Central Bank
EDF	Expected default Frequency
EU	European Union
EUR	Euro
EVE	Economic Value of Equity
FSA	Financial Supervisory Authority (Finanstilsynet)
FSAP	Financial Sector Assessment Program
FSGM	Flexible System of Global Models
FX	Foreign Exchange
GDP	Gross Domestic Product
GPF-G	Government Pension Fund Global
HQLA	High Quality Liquid Assets
ICR	Interest Coverage Ratio
IFRS	International Financial Reporting Standards
IMF	International Monetary Fund
IRB	Internal Ratings-Based
IRRBB	Interest Rate Risk in the Banking Book
LCR	Liquidity Coverage Ratio
LGD	Loss Given Default
LTV	Loan to Value
NAM	Norwegian Aggregate Model
NEMO	Norwegian Economy Model
NIBOR	Norwegian InterBank Offered Rate
NII	Net Interest Income
NOK	Norwegian Krona
NPL	Non-Performing Loan
NTNU	Norwegian University of Science and Technology
OECD	Organization for Economic Co-operation and Development

OSEAX	Oslo Stock Exchange All-Share index
PD	Probability of Default
RRE	Residential Real Estate
SEBRA	Firm Bankruptcy Probability Model (Enterprise Sector Model)
SRB	Systemic Risk Buffer
SVAR	Structural Vector Autoregression
USD	United States Dollar
VAR	Vector Autoregression
WEO	World Economic Outlook

EXECUTIVE SUMMARY[1]

Much of the work of the FSAP was conducted prior to the COVID-19 outbreak. The risk and vulnerability analysis integrates the original work with a quantification of the impact of the COVID-19 crisis on bank solvency under two separate scenarios. The original 'market shock' scenario explores additional risks that feature less prominently in the COVID scenarios.

The stress tests suggest that banks entered the COVID-19 crisis well-prepared, but the current uncertainty calls for vigilance. The solvency stress tests show resilience of the banking sector under all scenarios, although in the most severe one the CET1 capital ratio would decline by around 5 percentage points on average and three banks would almost or completely exhaust their capital buffers above the conservative hurdle rates of about 10 percent CET1 ratio. However, there would be no material breach of the remaining buffers and requirements, a result that confirms the overall adequacy of the banks' current capital levels.

Norges Bank and Finanstilsynet ran 'top-down' stress tests in parallel with the Fund staff, based on the *market shock* scenario, adopting the same assumptions. Their simulations produced broadly similar results, but with larger declines in the capital ratios in the case of Norges Bank. The three largest domestic banks also participated in the exercise, running a 'bottom-up' version of the solvency stress test under the same scenario and assumptions and complementing it with sensitivity tests. The results of their solvency stress tests are more moderate, in terms of losses incurred and declines in the capital ratios, than the three top-down exercises.

An analysis of banks' liquidity risks reveals resilience over the one-month horizon, but some weaknesses emerge when extending the analysis to longer horizons. While the results of the stressed Liquidity Coverage Ratio (LCR) simulations point to a solid liquidity situation in the short term—with the average LCR across the 11 banks remaining above the regulatory threshold even under extreme scenarios—the analysis of cash flows beyond the 1-month horizon of the LCR reveals the potential for counterbalancing capacity gaps for the whole system under severely adverse circumstances. This is the result, in particular, of assuming severe limitations in the roll-over of maturing debt issuances and derivative transactions.

Because of their high reliance on international capital markets for their funding, banks are exposed to rollover risks in case of market turbulence. Moreover, given the structural interest rate and currency transformation inherent in their business models, banks systematically hedge their exposures in the derivatives markets. This leaves them generally with contained interest rate and exchange rate risks. However, at the same time, the hedging activities increase their exposure to other, more subtle risks in case of extreme market shocks. This includes liquidity-draining margin calls or spikes in their counterparty risk. Capturing these types of risks requires a forward-looking analysis of the banks' exposures, supported by granular data on derivative transactions. This

[1] This Technical Note was prepared by Pierpaolo Grippa and Samuel Mann (both Monetary and Capital Markets Department, IMF) with excellent research assistance from Wenyue Yang (IMF) at headquarters.

granularity of information is not available yet, even though the authorities are investing in this direction.

The availability of data on derivative exposures would significantly improve the analysis of interconnectedness and contagion in the system. The interbank deposit and repo markets are not particularly developed in Norway. On the other hand, banks are closely interlinked through their derivative exposures and the cross-holding of securities—especially covered bonds, which in Norway represent a larger pool of highly liquid assets than government bonds. A joint analysis of the different channels through which contagion could spread across the system—in the logic of the multi-layer networks—would materially strengthen the authorities' capacity to analyze and monitor the evolution of interconnectedness in the system. The authorities are aware of the importance of developing data collection and modelling capacity to implement this type of analysis of the direct links among banks. Norges Bank carried out an assessment of direct and indirect contagion effects within the Norwegian banking sector. This analysis found that contagion effects may lead to declines in banks' capital, although these are small on average, and large effects are unlikely.[2]

The mission explored a selection of propagation channels for climate-related transition risk to the financial system. The transition to a low carbon economy can be a source of new business opportunities for banks, but also of risks. This is especially so in a country that is highly reliant on fossil fuel production and exports, such as Norway. The team's analysis focused, in particular, on the impact of an abrupt increase in carbon pricing, possibly accompanied by other measures aimed at curbing the supply and demand of fossil fuels at global level. Two potential propagation channels were explored. In particular:

- Domestic cost of emissions. The focus is on the impact on firms' earnings following a higher domestic carbon price and the implications for their lenders; and,
- External demand. Estimate of the impact on the Norwegian economy and banks of a fall in oil sector revenues caused by a higher global carbon price.

The estimated impacts on the banks and the financial system at large—within the limits of a static, single-factor, partial equilibrium analysis—are relatively contained, but non-negligible. The mission tentatively explored also a potential portfolio channel where the emphasis is put on the reductions in oil production necessary to meet the Paris agreement goals, and how this could affect the valuations of oil-related companies as well as the financial wealth of households and other economic sectors. The overall results underline the importance for financial institutions and their micro and macro-prudential supervisory authorities, of adequately identifying, measuring, and managing this emerging source of risk.

[2] See Bjørland C., T, Kockerols "A macroprudential contagion stress test framework", Norges Bank Staff Memo 4/2020 for a description of the framework and 'Assessment of Contagion Effects in The Banking Sector', Financial Stability Report 2019, Norges Bank.

Table 1. Norway: Key Recommendations on Vulnerability Analysis and Stress Testing		
Recommendation	**Agency**	**Time[1]**
Data		
Maintain accurate, updated, and easily retrievable maps of the major corporate groups	Finanstilsynet (FSA)	I
Collect granular data for defaults on bank loans, including on residential and commercial mortgages	Norges Bank, FSA	ST
Continue to collect and manage data from trade repositories and build models to analyze the risks and contagion effects arising from the network of derivative exposures across banks	Norges Bank, FSA	I
Collect from banks assets and liabilities data at a consolidated level, with breakdown by maturity bucket for time of repricing or duration and with the hedging positions	FSA	MT
Collect data on the liquidity positions of foreign bank branches	FSA	MT
Methodology		
Build more analytical and granular satellite models for credit risk, to link the macro landscape with the relevant variables (PDs, LGDs, etc.) at bank and asset class level	Norges Bank, FSA	ST
Deepen the analysis of margining arrangements adopted by banks and mortgage companies for derivative transactions and of related counterparty and liquidity risks	Norges Bank, FSA	I
Implement stressed LCR and cash-flow analysis based on EU common reporting as useful complementary diagnostic tools for liquidity risk analysis	FSA	MT

[1] I Immediate (within 1 year); ST Short term (within 1-2 years); MT Medium Term (within 3-5 years)

INTRODUCTION

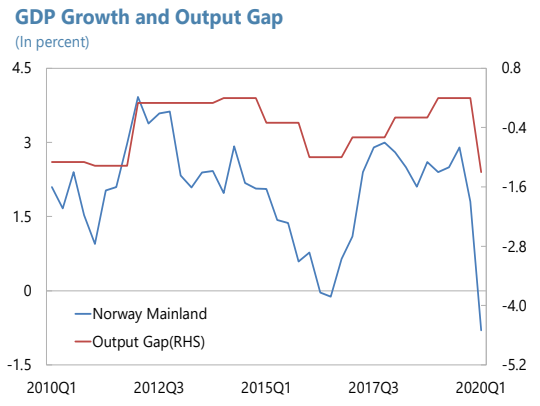
1. The Norwegian economy had shown strong performance since the last FSAP, until the COVID-19 pandemic caused major disruptions. Following a slowdown after the 2014-oil shock, growth recovered strongly during 2016–18, supported by rebounding oil prices, accommodative policies, and krone depreciation (Figure 1, left panel). Subsequently, the economy maintained this growth momentum, with a strong labor market and core inflation rising above target, until, starting from late February 2020, the global COVID-19 shock hit Norway hard, including on account of a nation-wide lockdown and the sharp drop in oil prices. The adverse developments triggered a sharp decline in economic activity, a spike in unemployment, and substantial further depreciation of the krone. Whereas Norges Bank had raised its key policy rate four times between September 2018 and September 2019, to 1.5 percent, during March–May 2020 it cut rates to zero percent in three quick steps.

2. Credit had grown at high rates in the past years, slowing down more recently (Figure 1, right panel). The credit gap was positive when the COVID-19 crisis hit, although at its lowest point since the Global Financial Crisis (GFC). Banks and mortgage companies represent the bulk of the financial sector, holding more than three-quarters of all financial assets in the system.

3. Much of the work of the 2020 FSAP was conducted prior to the COVID-19 outbreak. This technical note has been updated after the missions to incorporate new risk analysis aimed at quantifying the possible impact of the COVID-19 crisis on bank solvency.

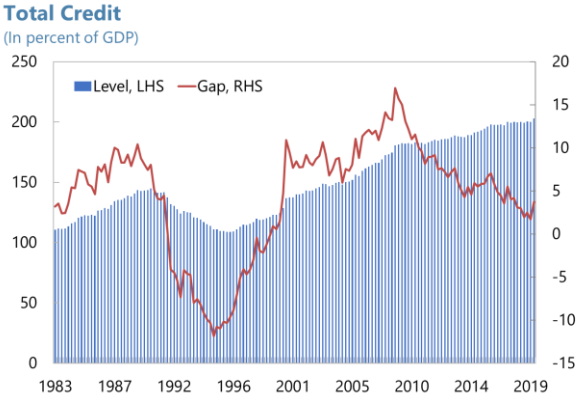
Figure 1. Norway: Broad Macrofinancial Developments

The Norwegian economy was performing well when the COVID-19 shock hit and caused major disruption.



Sources: Haver Analytics, IMF staff calculations, Norges Bank.

Norway was in a late stage of the credit cycle and the credit gap had been on a downward trend since the GFC.



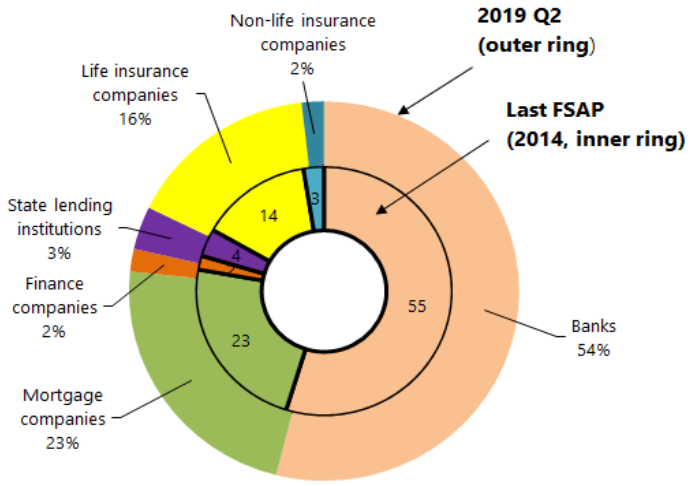
Sources: Statistics Norway, IMF staff calculations.

A. Structure of The Financial System

4. The Norwegian financial sector is sizable. Financial sector assets, excluding the globally-invested government pension fund (GPF-G), total 290 percent of the gross domestic product (GDP). The GPF-G represents another 230 percent of GDP. Banks represent 54 percent of

the financial system, in terms of total assets, and mortgage companies—in large part owned by banks—23 percent (Figure 2).

Figure 2. Norway: Evolution of Financial System Structure
(Percent of total assets; 2019: Q2 versus at last FSAP) [1, 2, 3]



[1] System assets total about 10.2 trillion NOK (1.2 trillion USD, or 290 percent of GDP), excluding the GPF-G, which at mid-2019 had assets of about 9.2 trillion NOK, or 260 percent of GDP.
[2] Inner ring is for 2014, outer for 2019: Q2 as reported in November 2019 Norway Financial Stability Report
[3] The "Banks" category includes branches of foreign banks.
Source: Norges Bank, 2019.

Banks

5. At the end of 2018 the banking sector comprised 141 domestic and foreign commercial banks. Approximately two-thirds of their assets are loans, with financial instruments representing 18 percent of the total. Apart from one subsidiary of a foreign bank (Santander Consumer Bank), all other foreign banks in Norway operate through branches. They are mainly from the Nordic region and account for about one-quarter of banking system assets, making up about 35 percent of lending to corporates and 20 percent of retail lending, with similar shares for deposits (Figure 3, top left panel).

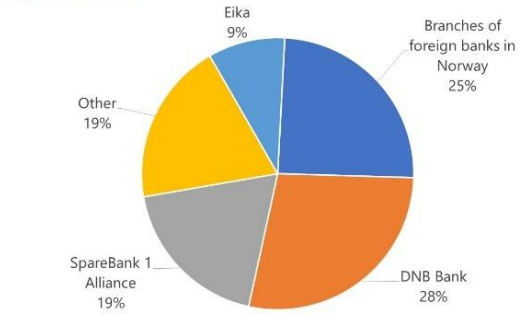
6. Banks have high exposures to real estate. Overall, close to 60 percent of banks' lending is related to property-related lending (residential and commercial real estate and construction sector). This makes banks vulnerable to adverse developments in these markets.

7. Variable rate loans are the prevalent form of lending. Variable interest rates on mortgages, which make up over 90 percent of all Norwegian residential mortgages, may be changed at a lenders discretion after a six-week customer notification period. This gives banks flexibility in passing through funding costs to their customers. Because of the variable rate environment, banks are obligated to stress test mortgage applications for higher rates in the future.

Figure 3. Norway: Banking Asset-Liability Structure, 2019: Q2 or Latest Available

The banking system is dominated by one large domestic bank while branches of foreign banks are significant

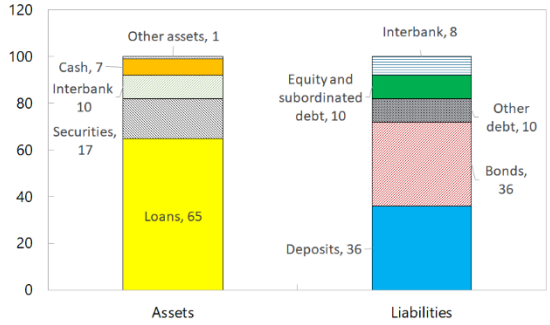
Lending Shares in Banking System (Overall)
(In percent of total)



Source: Norges Bank, IMF Staff Estimates (2019)

Banks rely heavily on market-based funding…

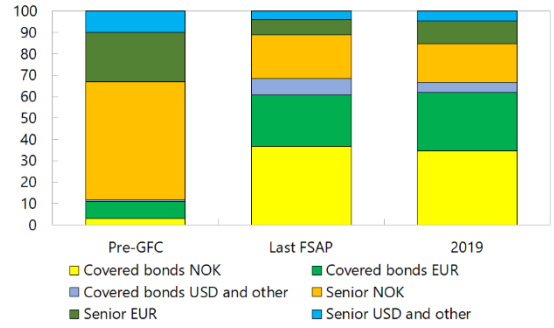
Bank Assets and Liabilities
(Percent)



Source: Norges Bank

…including from covered bonds and in foreign currencies

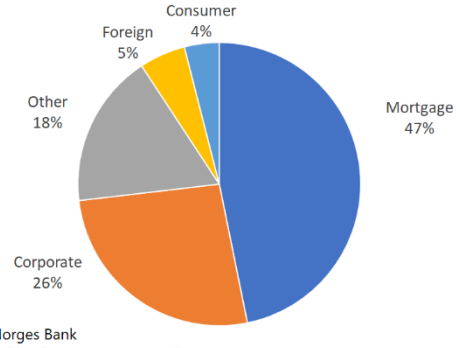
Composition of Wholesale Funding
(Percent)



Source: Norges Bank

Banks have significant exposure to real estate assets ……

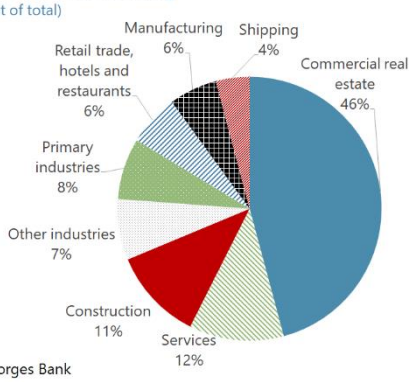
Banks' Loan Portfolio
(In percent of total)



Source: Norges Bank
Note: Total lending is NOK 5720 million.

…including for commercial properties

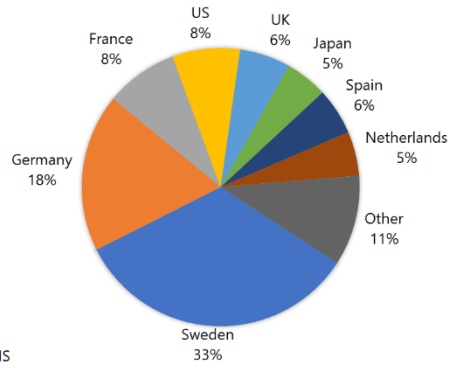
Banks' Corporate Lending
(In percent of total)



Source: Norges Bank

Cross-border liabilities are mainly within the EU

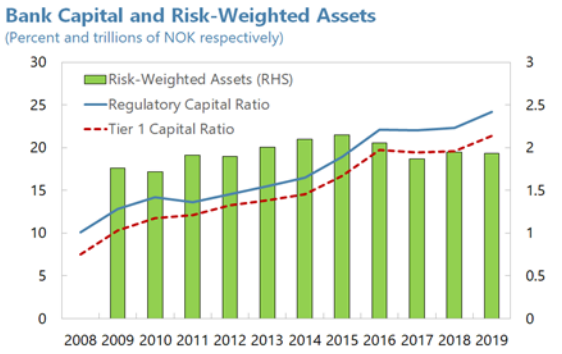
Cross-Border Liabilities of Banks in Norway
(In percent of total)



Source: BIS

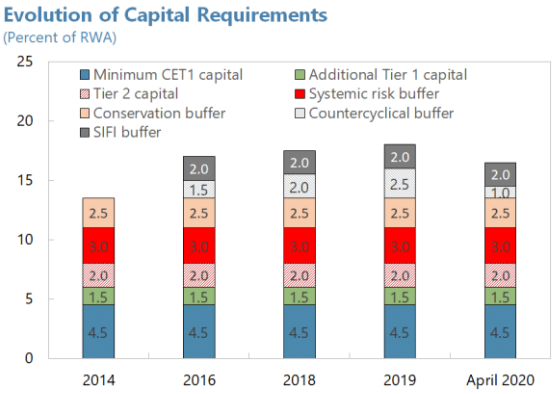
Figure 4. Norway: Banking Developments, 2019: Q4 or Latest Available

Bank capital has risen over the past decade…



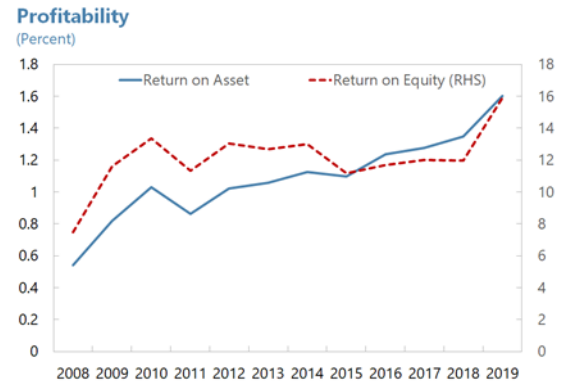
Source: IMF FSI

…as the authorities raised capital requirements



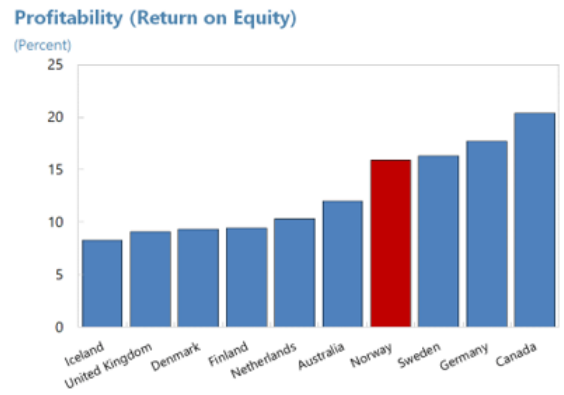
Note: The requirement on the systemic risk buffer will be calculated on domestic exposures from the end of 2020

Banking profitability has been high…



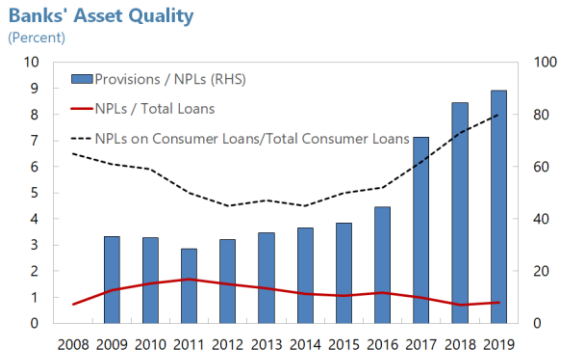
Source: IMF FSI database

…also when compared across developed countries



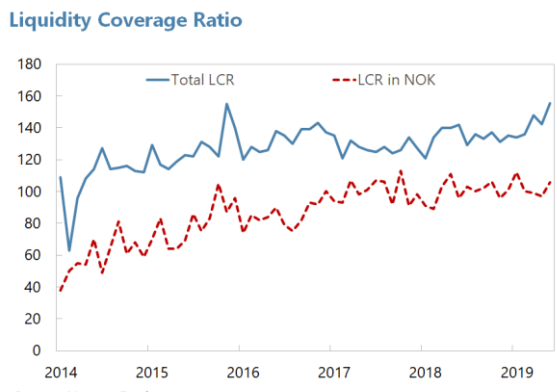
Source: IMF FSI database

Loan loss provisions increased in the past years from relatively low levels



Sources: IMF FSI, Finanstilsynet and staff calculations
Note: Consumer loans for 2019 reflects 2019Q1

Banks' liquidity coverage has improved although domestic currency LCR remains relatively weak



Source: Norges Bank

8. Wholesale markets are an important source of funding. As credit demand structurally exceeds deposits and the scope for expanding the deposit base is limited, Norwegian banks obtain nearly half their overall funding from wholesale markets and foreign exchange (FX) issuances (Figure 3, middle left panel). The maturity of such funding has lengthened since the last FSAP. About two-thirds of wholesale funding comes from covered bonds, which are split evenly between domestic and foreign currency issuances. These covered bond issuances have partially substituted for other riskier sources of wholesale funding, such as senior-unsecured and short-term wholesale funding. There is substantial cross- ownership of covered bonds between banks, however, as they hold these as HQLA. This further adds to the real estate exposure on the asset side of banks.

9. Twelve banks have been authorized by the FSA to use their internal ratings-based (IRB) models for regulatory purposes. The models are used to estimate probability of default (PD) and loss given default (LGD) parameters for the corporate, residential mortgage, and other retail portfolios. No banks are currently authorized to use their internal models for market risk and counterpart risk.

10. Banks entered the COVID-19 crisis with high capitalization and liquidity ratios and solid profitability (Figure 4). Banks' total regulatory capital ratio was 24.2 percent as of end-2019, with a CET1 capital ratio of 18.0 percent, in line with local regulatory requirements that are consistent with Basel III standards. Two domestic systemically important institutions face an additional two percent requirement. Banks' liquidity levels were in full compliance with the LCR requirements, which follow the European Union (EU) framework. Liquidity coverage in foreign currencies generally exceeded that in Norwegian krone owing to a shortage of domestic HQLA. Bank profitability was strong in peer comparison, owing to low operating expenses (partly due to high digitalization) and low credit losses. Asset quality was high overall, with nonperforming loans (NPLs) below one percent, though NPLs on consumer loans (five percent of bank lending) were much higher at nine percent. Banks' provisions ensured about 85 percent coverage of NPLs.

Mortgage Companies

11. Covered bond mortgage companies represent a fundamental component in each banking group or alliance. By law, covered bonds can only be issued by separate and dedicated entities within a banking group. They acquire the mortgage loans from their parent banks on a 'true sale' basis.

12. Covered bond mortgage companies are subject to the same capitalization requirements as for all banks. They are also required to maintain a degree of overcollateralization of at least two percent, although many operate well above that threshold and can also count on the availability, within their banking group, of eligible and unencumbered assets ready to be transferred to their cover pools if needed.

13. While covered bond mortgage companies dominate the Norwegian mortgage bond market, not all mortgage companies are authorized to issue covered bonds. The mortgage companies not authorized to issue covered bonds primarily issue ordinary unsecured senior bonds

instead. They are mostly small, with two notable exceptions being Kommunalbanken and Eksportfinans. Kommunalbanken is wholly owned by the government and issues almost all its long-term debt abroad. This issuance of bonds and notes on the international capital markets is used to finance lending to local government. It has been declared a Domestic Systemically Important Bank (D-SIB), as DNB.

KEY RISKS AND VULNERABILITIES

14. Key underlying vulnerabilities in Norway pertain to banks' high exposure to domestic real estate—both residential and commercial—and reliance on wholesale funding (see Risk Assessment Matrix in Annex I). A deterioration in the ability of highly-leveraged households or corporates to service their loans, a sharp real estate price correction, or a combination of these, would affect banks' asset quality. Banks' high reliance on wholesale funding, including covered bonds backed by residential mortgages, compounds the risks.

15. Real estate prices and household debt have risen strongly over past decades. Continuing an uptrend that started in the 1990s, residential real estate (RRE) prices increased by 70 percent over the last decade, while rising more in the larger cities (particularly Oslo, where they doubled). The housing boom can be attributed to a combination of factors including population growth, cheap financing in the prolonged low-interest rate environment, and supply constraints. Higher house prices have led households to take out larger mortgages, which has fueled household debt levels. These now exceed 200 percent of disposable income on average, high compared to peers. The distribution of household debt is an additional concern as the share of households with debt levels exceeding five times their gross income has been on an upward trajectory. Commercial real estate (CRE) has also boomed especially Oslo's prime office market. Corporate debt levels are about average in international peer comparison.

16. Already before the COVID-19 outbreak, monetary and macroprudential policy tightening led to some cooling of the residential housing market, but commercial property prices continued to rise. Stepwise increases in the countercyclical capital buffer (to be set at its upper level under normal circumstances of 2½ percent from end-2019), and the introduction of temporary household sector tools—including a stressed-interest rate debt servicing test for borrowers, loan-to-value (LTV) and debt-to-income (DTI) caps, and amortization requirements—aided by Norges Bank's policy rate increases, have had some success in curbing RRE price increases in more recent years: survey results indicate that the share of new loans in breach of the requirements fell after they were introduced (e.g., interest-only loans with LTV ratio above 60 percent fell from almost 9 to below 3 percent between 2016 and 2018). CRE price increases, however, continue unabated. The sharp downturn caused by the COVID-19 crisis may now cool real estate markets, although data through May 2020 has shown resilience thus far. In any event, historical experience suggests that housing market tensions are likely to eventually return once a recovery takes hold.

17. While default rates on mortgage loans have been historically low, supported by a strong debt-servicing attitude, consumer lending is a higher risk business. In Norway mortgage lending is full recourse; hence homeowners have a strong incentive to avoid default and the main driver of mortgage loan defaults is typically rising unemployment. Consumer credit is growing considerably, although from a modest base. It represents an increasing source of concern over the growing indebtedness of households. The FSA in 2018 found that 470,000 consumer loans became the subject of debt collection procedures, for a total of NOK 21bn (approx. 18 percent of total consumer loans for the surveyed banks), a figure 18 percent higher than in 2017.

18. The banking system is generally liquid, but its liquidity relies materially on wholesale funding and the recourse to derivatives markets. Because of the relatively low contributions of deposits to their funding, Norwegian banking groups depend importantly on the issuance of debt securities (mainly covered bonds by their mortgage companies and unsecured senior bonds by the parent banks). Their domestic issuances tend to match the prevalently floating rate characteristics of their assets (residential mortgages, in particular); however, the domestic market is not sufficient to provide the amount of funding required, and banking groups regularly tap the global capital markets with issuances better tailored to international investors, in foreign currency (mainly EUR and USD) and, generally, fixed rates. As a result, the banking groups' typical balance-sheet shows an asset side prevalently floating rate and NOK-denominated, financed by a mix of fixed/floating rate and NOK/FX funding.

19. As a result of their typical balance-sheet structure, banks generally stand to lose from decreasing interest rates and depreciating NOK. Consequently, their hedging (derivatives) positions generally are fix-receiving on interest rates (to swap the floating rate payments they receive on their loans into fixed rate) and long on FX (to swap NOK payments into FX ones). Consequently, they are exposed to margin calls when interest rates increase and/or NOK appreciates; on the other hand, they are exposed to increased counterparty risk (especially on over-the-counter transactions) when interest rates decrease and/or NOK depreciates.

20. As banks and mortgage companies tend to actively manage their interest rate and FX risks, they get increasingly exposed to other types of risks linked to their reliance on international capital markets. They remain exposed, in particular, to:

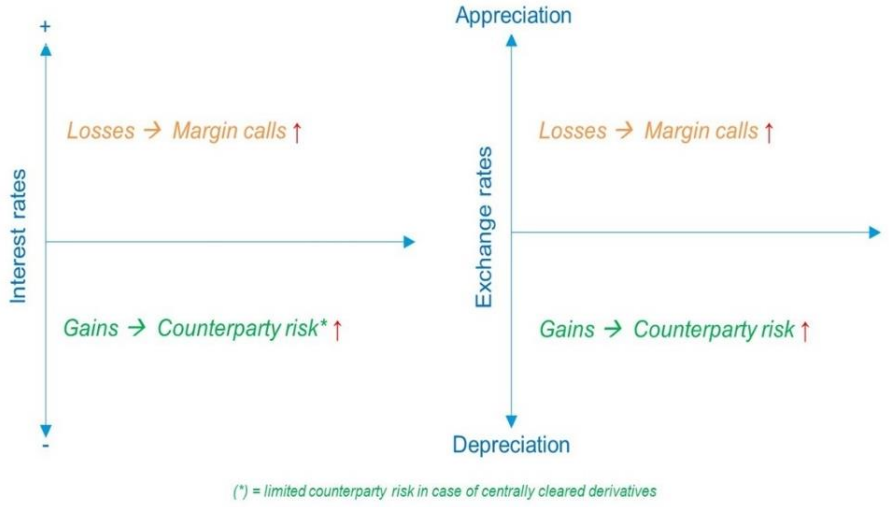
- **liquidity risk**, in the form of both rollover risk (i.e., the inability to execute their planned issuances and the unavailability or high cost of any alternative) and potential liquidity drains from margin calls in case of adverse market shocks (variation margin) and/or increase in market volatility (potential request of additional initial margin);

- **counterparty risk**, in case of favorable market price changes, that can lead to credit losses (in case of a counterpart's default) or an increase in credit valuation adjustments (CVA) and related capital requirements (CVA capital charge), also short of counterparts' default;

- **concentration risk**, from their reliance on a single or few—possibly connected—counterparts (for bilateral transactions) and/or direct or indirect clearing members (for cleared transactions).

Figure 5. Norway: Schematic Representation of Banks' Risk Exposure from their Hedging Transactions

Norwegian banks' hedges expose them to liquidity and counterparty risks



Source: IMF Staff Estimate

21. Other significant structural sources of risk relate to climate change, cybersecurity threats, and financial integrity. While physical risks from climate change are low by international comparison, the impact of an abrupt transition to a low-carbon economy (so called transition risk) could be high given Norway's reliance on the production and export of oil. Operational risks are important as well. A cyber-attack on a critical payment infrastructure could result in severe dislocations in Norway's mostly cashless system. This could hurt confidence and lead to contraction of deposits. The emergence of more episodes of financial misconduct or violations of market integrity—as the alleged breach of customer due diligence rules at DNB, Norway's largest bank—could also lead to a loss of confidence and financial losses, including from sanctions.

SOLVENCY STRESS TESTS

A. Assumptions and Scenarios

22. The solvency of banks was analyzed under three separate scenarios ('COVID Central', 'COVID Downside' and 'Market Shock') over a three-year horizon. The Financial Supervisory Authority (FSA) and Norges Bank ran top-down solvency stress tests in parallel with the FSAP, based on the *Market Shock* scenario. The risk horizon considered is from end-2019 to end-2022 The COVID scenarios incorporate the effects of the measures already taken by the authorities to ease financial conditions (Box 1).

Box 1. Financial Sector Policy Response to COVID-19

COVID-19 has had a major impact on Norwegian society and on economic activity. As COVID-19 cases started to emerge in Norway from February/March 2020, the government swiftly implemented measures to contain the spread of the disease, including travel restrictions, social distancing measures, and closures of schools, universities and businesses. As elsewhere in the world, these measures had a deep negative impact on economic activity, which was compounded by the tightening of global financial conditions and a sharp drop in oil prices. In this backdrop, the authorities have taken wide-ranging policy measures to stabilize the economy—including extensive fiscal support to corporates and households—and to ensure financial stability. The latter set of financial sector measures is elaborated below.

Key Policy Measures to Safeguard Financial Stability:

- ***Monetary policy*** actions have focused on providing liquidity to the financial sector to address heightened interest rate volatility and higher risk premia in money markets as the crisis unfolded. The actions also included three rate cuts, which have brought the main policy rate to zero percent (from 1.5 percent). The measures aim to lower borrowing costs for corporates and households, while supporting banks' asset quality.
  - Norges Bank has provided liquidity support to banks through extraordinary NOK loans with maturities ranging from 1-week to 1-year and with full allotment. Collateral requirements for liquidity support were also eased by removing limits on the use of non-government securities. Meanwhile, the FSA underscored that the use by banks of high-quality liquid assets held to satisfy the LCR requirement is permitted, provided it is properly reported.
  - Norges bank agreed a U.S. dollar swap line with the Federal Reserve for up to US$30 billion and has provided U.S. dollar liquidity to Norwegian banks.
- ***Macroprudential measures*** include a relaxation of the countercyclical capital buffer (CCyB) from 2.5 percent to 1 percent, to ease constraints on bank lending and thereby support continued provision of financial services. The authorities also indicated that no increase in the CCyB is anticipated until at least the first quarter of 2022. Mortgage lending regulation was also relaxed by temporarily allowing banks to deviate from LTV, DTI, and other requirements for up to 20 percent of new loans during 2020:Q2 and Q3, compared to a previous "speed limit" of 10 percent (8 percent in Oslo). This could support debt restructuring and temporary home-equity withdrawals to reduce borrowers' financial distress.
- ***Microprudential actions*** include appeals by the FSA and MoF on banks and insurers to restrict dividend payouts until economic uncertainty is reduced. Regulatory reporting of short sales of domestic equity shares has been enhanced.

23. The exercise was based on a quasi-static allocation balance sheet assumption. This means that the asset allocation and the composition of funding sources are assumed to remain the same throughout the risk horizon. Banks' interest income is derived from the evolution of interest-bearing assets and liabilities and of the interest rates applied by banks to their lending and borrowing operations, while non-interest income is assumed to evolve in line with the growth of

assets. Dividends are assumed to be paid out only in case of positive income, at a payout ratio consistent with Norway's historical experience.[3]

24. The resilience of the banks was measured in terms of capital ratios, against the current and future requirements and some of the capital buffers. In particular, the usual distinct capital ratio requirements—in terms of Common Equity Tier 1 (CET1), Tier 1 (T1), and Total Capital—were used as hurdle rates, inclusive of Pillar 2 requirements (as of end 2019), D-SIB buffers and Systemic Risk Buffer. In practice, this means that the hurdle rate includes all capital requirement and buffers, except for the Capital Conservation Buffer (CCB) and Countercyclical Buffer (CCyB): the CCB is excluded by definition, as it is meant to provide flexibility to banks when facing difficult circumstances (of either systemic or idiosyncratic nature), subject to restrictions in the distribution of earnings; the CCyB is excluded under the implicit assumption that it would be released in a downturn. This choice is closely aligned with the Basel Committee's guidelines on buffer usability,[4] except for the D-SIB buffer, considered structural in nature (as it addresses the systemic importance of a bank, unlikely to change in a downturn) and, as such, assumed to be unusable in the scenario.

25. Given the recent changes in the rules on capital adequacy in Norway, adjustments had to be made to both risk weighted assets and the hurdle rates. The EU capital requirements framework (CRR/CRD IV) entered into full force in Norway from end-2019. The new prudential regime introduces in the Norwegian system the SME 'supporting factor,' which lowers banks' capital requirements for lending to small and medium-sized enterprises and removes the Basel I floor previously imposed by the Norwegian authorities on IRB banks' capital calculations. Both changes lead to a reduction in risk-weighted assets (RWAs) for IRB banks (the removal of the floor only when it was binding under the old prudential regime). In order to compensate for this effect, the authorities have simultaneously increased the systemic risk buffer (SRB) from 3 percent to 4.5 percent, but the whole SRB of 4.5 percent applied only to domestic exposures (to be implemented end-2020 for IRB-banks and end-2022 for non-IRB banks). As the change will be in force across the whole risk horizon of the exercise, the RWAs had to be revised downward with respect to the figures available at the cut-off date (June 2019), while the hurdle rates were adjusted to reflect the change in the SRB level.

26. While banks have adopted the new International Financial Reporting Standards (IFRS 9) accounting standard, the top-down exercises abstract from the three-stage classification. One of the major innovations introduced with IFRS 9 is the recognition of credit losses in a more forward-looking way than under the previous rules (Box 2). However, due to the lack of the information needed to run the stress test on an IFRS 9-compliant basis (in particular past data apt to approximate the transition rates between the three stages), the exercises run by the IMF, the FSA and Norges Bank have adopted a traditional, 'two-stage' approach, i.e., distinguishing only between

[3] Note, in the Norges Bank top-down stress test exercise (based on the 'market shock' scenario), a market loss is assumed for the first year. Owing to a fall in securities markets, banks have to write down the value of their stock of equities by 40 percent and fixed-income instruments by 5 percent. Moreover, dividends are not paid out in the stress period, regardless of positive or negative income. Bank lending grows at the same rate as credit.

[4] See https://www.bis.org/publ/bcbs_nl22.htm.

performing and non-performing loans and relying on banks' PDs and LGDs (for IRB exposures) or NPLs (for exposures under the standardized approach).

Box 2. IFRS 9 Implementation in the Norwegian Banking System[1]

Under the standard, the measurement of expected credit losses is based on an objective and probability-weighted analysis of alternative outcomes. Loan loss provisioning follows three stages: in Stage 1, which applies with loans with no sign of credit deterioration, loan loss provisions take into account credit risk over a 12-month horizon; a significant increase in credit risk will determine the transition of the position to Stage 2, where expected credit losses have to be estimated over the lifetime of the loan, but interest payments are still calculated on the gross carrying amount of the loan, without deducting for provisions; further objective evidence of impairment can determine the transition to Stage 3, where provisioning is also based on expected lifetime losses, but interest payments stop accruing on the provisioned portion of the loan.

The FSA has recently concluded a thematic review of IFRS 9 implementation in banks. The review covered, inter alia: the data used to estimate risk parameters; the methodology to determine whether a significant increase in credit risk has occurred; the criteria to opt between the cash flow method (individual evaluation) and the PD/LGD method in estimating stage 3 expected credit losses; the severe recession scenarios used when measuring expected credit losses.

The review also aims at improving the banks' disclosures in the banks' annual financial statements, in order to make the information more comprehensive and transparent and address any information gap.

[1] https://www.iasplus.com/en/standards/ifrs/ifrs9

Macroeconomic Scenarios

27. The following scenarios were simulated over a 3-year horizon: (Table 3 and Figure 6):

- The *COVID central* scenario reflects the projected baseline outlook—for Norway and the global economy—as of June 2020.[5] In this scenario, Norwegian mainland GDP contracts by almost 5½ percent in 2020. The economy starts to rebound from the second half of 2020.

- The *COVID downside* scenario corresponds to a situation of persistent uncertainty and a further deepening of the downturn. This is approximated by a downward divergence of a 1 standard deviation of the core variables (GDP, employment, oil price) from the central path, resulting in a GDP decline of about 7 percent in 2020 and a more gradual recovery from that point.[6]

[5] The COVID-19 stress tests are based on a preliminary version of the June WEO forecasts for Norway. The forecasts were subsequently revised up somewhat (the latest forecasts are shown in Table 3).

[6] The GDP path in the COVID downside scenario is comparable in severity to the adverse scenario in the June 2020 WEO Update, while the assumed oil price drop is substantially larger than in the WEO scenario. Market variables such as equity and house prices are estimated with models based on the path of the core macro variables.

- The *market shock* scenario envisages a steep decline of GDP in the first two years of the risk horizon, with a modest recovery in the third year. The assumed drop in GDP under the market shock scenario is more severe than the historical episodes of negative growth during the banking crisis of the late 1980s and the global financial crisis and is motivated by the sizeable vulnerabilities in terms of household indebtment and persistently high property prices. Property prices are assumed to drop significantly: approximately 35 percent over the risk horizon for residential and more than 50 percent for commercial real estate. Equity prices would decline by 40 percent in the first two years and over the same time span the price of oil would drop to US$27 per barrel (from around US$65 per barrel for Brent oil at the cut-off date of the exercise, end-June 2019).[7]

Table 2. Key Variables in the Macroeconomic Scenarios

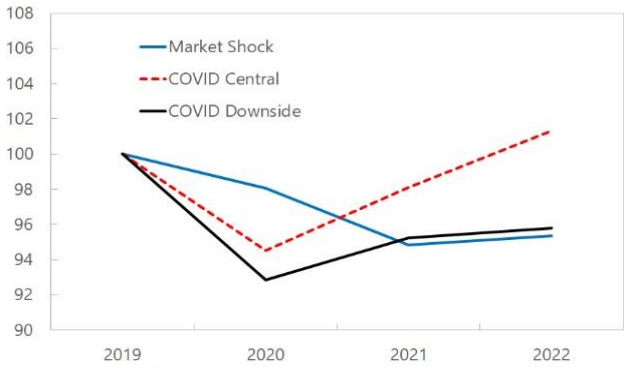
	COVID Central			COVID Downside			Market Shock		
	2020	2021	2022	2020	2021	2022	2020	2021	2022
Real GDP - Mainland (y/y percent change)	-5.5	3.8	3.3	-7.1	2.6	0.6	-1.94	-3.27	0.51
Unemployment rate	8.2	6.6	4.5	8.8	7.2	5.1	5.89	8.87	9.29
Consumer price index (y/y percent change)	2.5	2.8	2.0	2.5	2.8	2.0	2.1	2.2	2.2
Crude oil price	36.2	37.5	40.8	24.1	19.5	19.0	34.0	27.0	26.0
Equity index (OSEAX) (y/y percent change)	-24.2	35.3	30.7	-39.1	20.2	14.1	-33.0	-10.0	14.0
House price index (y/y percent change)	0.8	7.5	7.1	-1.8	7.2	6.0	-16.6	-11.9	-11.2
3-month money market rate (average)	1.0	0.3	0.3	1.0	0.3	0.3	2.6	3.2	3.3

Source: IMF staff.

[7] Given the GDP path under the scenario and the assumptions on the evolution of other variables (such as global oil price, domestic interest rates, house and equity prices), the remaining global variables were simulated via Flexible System of Global Models (FSGM), a suite of semi-structural macroeconomic model developed at the IMF, while the path for the domestic variables was estimated by Norges Bank with their own Dynamic Stochastic General Equilibrium (DSGE) model (NEMO).

Figure 6. Norway: GDP Growth Path Under the COVID and Market Shock Scenarios
(2019=100)

GDP drops sharply in the COVID scenarios, but the decline over the whole risk horizon does not exceed the market shock scenario



Source: IMF staff estimates

B. Staff's Top-Down Solvency Stress Test

Methodology

28. The evolution of credit risk is based on its statistical relationship with the variables covered in the macro scenarios. For banks under the standardized approach (and for exposures of IRB banks treated as standardized), credit loss estimates are based on satellite models linking NPL ratios to macro variables.[8] For corporate lending, quarterly time series of NPL ratios from 2014 were used, with a breakdown in 19 industries, of which 17 were individually modeled.[9] For retail lending a single quarterly series was used tracing back to 1990. The models were estimated via Bayesian Model Averaging (BMA) to address uncertainty in model selection.[10] The dependent variables were subject to logistic transformation; a number of macro variables were used as candidate regressors for each estimation, in differences when needed (i.e., for I(0) series) and with different orders of lags.[11] Default rates and loss rates were inferred—separately for the retail portfolio and for each

[8] The use of NPL ratios, which measure the stock of NPLs with respect to total loans, is generally not the preferred choice: stocks, by definition, are the net result of the interaction between inflows (i.e., new or 'returning' NPLs) and outflows (such as write-offs or loan recoveries), and hence provide a somehow blurred, slow-moving, and less decipherable picture of the evolution of credit risk. 'Flow' statistics (such as separate NPL inflows and outflows), default rates, or loss rates would generally be preferable; but the former two were not available, and the latter were also not amenable to use in satellite models, given the frequent occurrence of negative loss rates in several series.

[9] The 19 industries are listed in Annex III. Due to shorter time series, no satellite model could be estimated for the sectors 'Financial and insurance activities' and 'Public administration and defence,' for which the projections for the whole corporate sector were used, after rebasing them according to each of the two sectors' starting level.

[10] Gross, M. and F.J. Poblacion Garcia, "A False Sense of Security in Applying Handpicked Equations for Stress Test Purposes", European Central Bank (ECB) Working Paper No. 1845. The stress test team is grateful to Marco Gross (IMF) for the support provided with the Matlab code implementing the BMA estimations.

[11] The variables include: Real GDP, Real consumption, Gross capital formation, Unemployment, CPI, House prices, Oil price, 3-month money market rate, 10-Y government bond, Average lending rate.

industry segment in the corporate portfolio—from the NPL projections and based on judgmental assumptions about the other relevant parameters: for realized LGD a starting value of 30 percent was used for retail and 35 percent for corporate; the starting value for the write-off ratio was assumed to be 30 percent.[12] Both parameters are assumed to double under adverse conditions.

29. For the portfolios of IRB banks, the relevant parameters are calibrated on the base of the default rates inferred from the satellite model results. PDs are assumed to follow, under both scenarios, the same evolution as default rates, but with a sensitivity coefficient calibrated bank by bank, to capture the dynamic properties of each bank's PD models, i.e., how close its PD estimates are to a 'Through-the-Cycle' (TtC) vs 'Point-in-Time' (PiT) pattern. The sensitivity coefficient is estimated by regressing each bank's IRB corporate PDs on the average Expected Default Frequency (EDF) of Norwegian corporates.[13] The same sensitivity coefficient is applied to the PDs of each bank's other (non-corporate) IRB portfolios. As LGDs in IRB models are generally calibrated as 'downturn' parameters, they are assumed to increase under adverse conditions, but in a limited way: from their starting levels, they increase as a result of a drop of up to 15 percent in recovery rates (i.e., 1-LGD) over the horizon. The projections of PDs and LGDs under each scenario are then used to estimate RWAs and expected losses.

30. Interest income is assumed to change according to the changes in volumes and based on the path for lending and borrowing rates assumed in the macro scenario. Given the prevalence of variable rate instruments in Norway, the flexibility Norwegian banks typically have in passing on interest rate changes to customers, and the competitive nature of the banking sector, it is plausible to assume that each bank's lending and borrower rates would not deviate significantly from the average. A satellite model linking wholesale funding costs to the CET1 ratio (to capture a possible solvency-liquidity feedback) produced statistically significant, but economically negligible effects.[14] Non-interest income items are assumed to follow the growth of assets, i.e., to decrease under the adverse. Losses arise in the trading portfolios, under the *market shock* scenario, as a result of the sharp drop in equity prices and the increase in interest rates and credit spreads. Given the typically long positions of most Norwegian banks on foreign currency, they tend to realize gains under the *market shock* scenario, with the NOK appreciating; however, the gains are modest, given the limited open positions.

[12] While judgmental, the calibration of these parameters was inspired by some studies on credit risk by Norges Bank staff, such as Andersen H., H. Winje, "Average risk weights for corporate exposures: what can 30 years of loss data for the Norwegian banking sector tell us?", Norges Bank Staff Memo n. 2, 2017 and Syversten et al., "The bank model and the stress test in the 2015 Financial Stability Report", Norges Bank Staff Memo n. 5, 2015.

[13] The EDFs, drawn from Moody's CreditEdge database, are a useful benchmark, as they are considered a PiT measure of credit risk by construction, being based on market data (equity returns and equity volatilities).

[14] This result is most probably conditioned by the observation period available for the estimation (2015-19), which was relatively quiet for the banking system and thus might not provide the kind of statistical evidence needed to model the solvency-liquidity feedback, typically strongest in crisis periods.

Results—COVID Scenarios

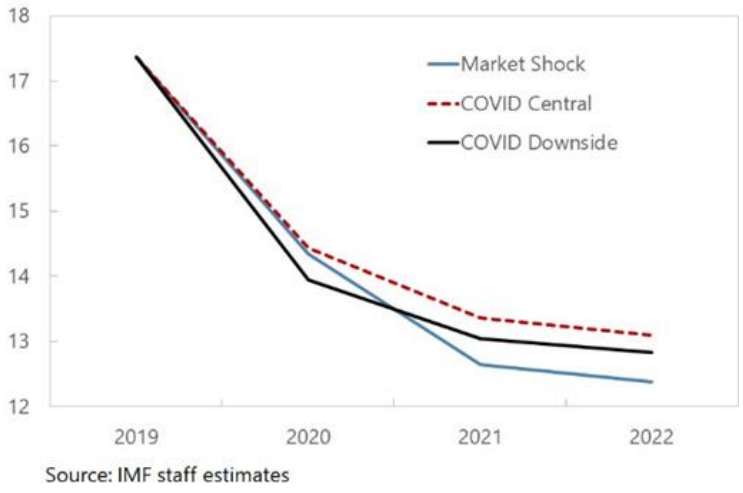
31. The scenarios show that the COVID-19 shock will likely have a large impact on banks, though they would continue to meet capital requirements. At the end of the risk horizon the aggregate CET1 ratio for the in-sample banks drops by about 4 percent under the central scenario and 4½ percent under the downside one. Under the COVID downside scenario, one bank would exhaust its buffers in excess of the hurdle rate, though without breaching it.

32. While uncertainty is high and worse outcomes are possible, the COVID scenarios show a somewhat less severe impact than the *market shock* scenario analyzed during the missions (Figure 7). Although the frontloaded profile of the COVID-19 shock causes a comparable or worse impact on capital in the first year of the stress tests, in the second and third years the *market shock* scenario leads to significantly larger losses (see below). The differences reflect both a comparatively faster recovery under the COVID scenarios and the easier financial conditions that help mitigate the real economic shock and prevent a sharper impact on banks' net income.

Figure 7. Norway: Solvency Stress Test—Aggregate CET1 Ratios

(In percent)

The impact of the market shock scenario on banks' capital is overall more pronounced



Source: IMF staff estimates

Results—Market Shock Scenario

33. Under the market shock scenario, the banking system would be hit hard. NPL ratios would increase substantially, up to levels not seen since the mid-1990s. Loan loss rates would rise around 8 times the current level for retail lending and more than tenfold for corporate loans (Figure 8, bottom left panel). All market segments would be impacted, with the mining sector (including oil extraction and related services) and transport and storage particularly affected (Figure 8, bottom right panel). Assuming that about three quarters of the losses from retail loan

portfolios are related to mortgages),[15] about 30 percent of overall losses would be linked to real estate-related lending.

34. Loan loss provisions would be the main factor behind a sharp decline in capital ratios (Figure 9). Losses from debt and equity portfolios and the increase in risk-weighted assets would also contribute to the fall of capital ratios: the average CET1 ratio for the 11 banks in scope of the exercise would drop to 12.4 percent by the end of the risk horizon, from 17.4 at the end of 2019, an average 5 percentage points fall (Figure 7). Across banks, the worst drops in CET1 ratios would range from 1.1 to 6.8 percent. The decline in the average total capital ratio would be close to 6.2 percentage points.

35. Another important factor behind the declining capital ratios would be the increase in risk-weighted assets. While total assets are expected to shrink under the scenario, the increase in risk weights caused by rising PDs and LGDs (and, for banks with large exposures denominated in foreign currency, the depreciation of the NOK) would more than compensate that effect, contributing to the decline in capital ratios by 2.3, 1.8, and 1.3 percent in the years 2020 to 2022, respectively.

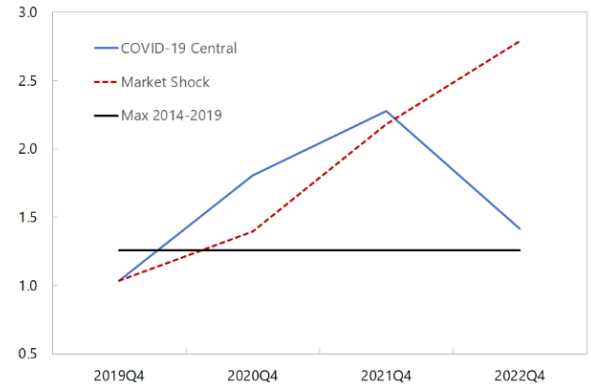
36. There would be, however, no material breaches of the hurdle rates. Buffers in excess of the hurdle rates would be depleted only partially for most banks and fully for three of them. For some banks the worst drop would occur in the second year and by the end of the risk horizon they would have recovered all or most of the decline in their ratios.

37. Applying the previous prudential regime, the decline in capital ratios would have been lower. The IMF FSAP simulation under the Market Shock scenario has also been used to compare the current prudential regime—aligned with the EU's CRR/CRDIV framework and now including a higher SRB—with the previous one. For the 11 banks in scope of the exercise, the average drop in the CET1 ratio would have been some 80 bps lower: the reduction in RWAs (because of the SME supporting factor and the removal of the Basel I floor) more than compensates the increase in the hurdle rates caused by the higher SRB requirement (Figure 10, bottom panel). Considering that the sample covers around 80 percent of total assets for the domestically incorporate banks, the result can be interpreted as a sign of the fact that the current regime most probably is, on average, less stringent than before.

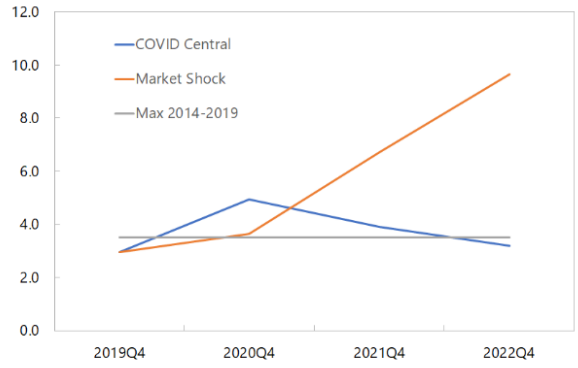
[15] The FSA stress test simulation suggests that the share is slightly above three quarters for the banks in the sample, while it is slightly below three quarters for the banking system as a whole.

Figure 8. Norway: Solvency Stress Test Results—NPL Ratios and Loan Losses

NPL Ratio in Retail Sector
(percent)

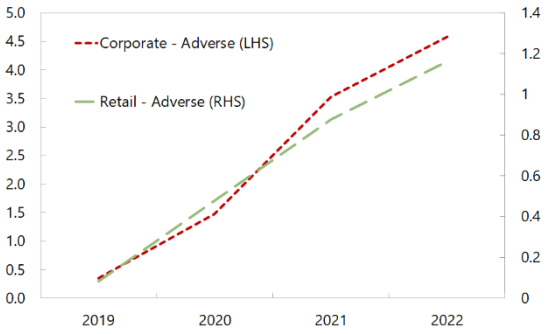


NPL Ratio in Corporate Sector
(percent)



Loss rates would rise several times over current levels …

Loan Loss Rates Under Market Shock Scenario
(percent)



Source: IMF staff estimates

…and losses would spread across all market segments, with mining and transport hit particularly hard

Distribution of Losses Over the Risk Horizon Under Market Shock Scenario

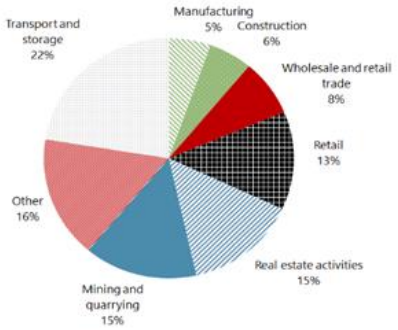
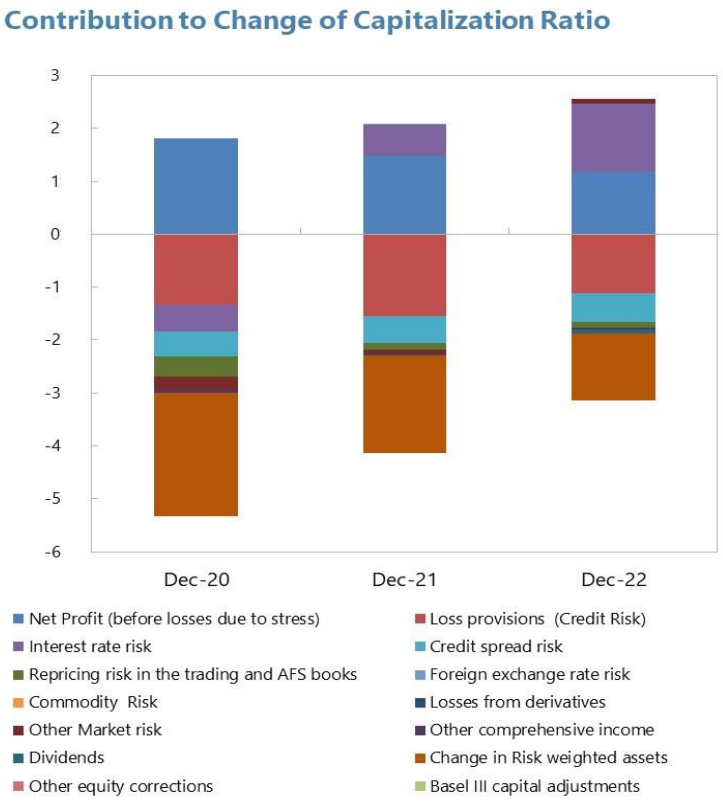


Figure 9. Norway: Solvency Stress Test Results—Capital Ratios Under the Market Shock Scenario

Loan losses and the increase in risk-weighted assets would be the main factor behind the change in capital ratios



C. The Authorities' Top-Down Solvency Stress Test

38. The FSA conducted a top-down stress test on 20 banks as well as a 'macro bank' which included the 11 banks from the FSAP top-down stress test. The stress test is based on the FSA's Norwegian Aggregate Model (NAM) with FSA overlay, as well as a PD-generating satellite model (SEBRA) and bank profitability and solvency model. In line with the FSAP stress test, the time horizon is 3 years and the adverse scenario very closely follows the FSAP/Norges Bank-generated *market shock* scenario. Total loan losses on non-financial corporations are distributed between all banks in Norway based on each bank's share of total exposure-weighted SEBRA PD. If no SEBRA PD is available, alternatives are used: a proxy PD, the average SEBRA PD of the branch/industry a non-financial corporation belongs to, or a bank's own PD.

39. In the FSA stress test only two banks breach the assumed CET1 requirements under the adverse scenario. On average, CET1 ratio is reduced from 17.4 percent to 12.3percent, while the reduction for individual banks varies between 1.6 and 6.7 percentage points. 9 of the 20 banks in the stress test reach their lowest CET1 level in 2021. The remaining banks reach the lowest level in 2022. Except for three banks, all banks breach their current CET1 requirements and buffers at the end of

the scenario horizon. That said, excluding CCB and CCyB, only two banks (not within the 11 of the FSAP stress test exercise) are in breach of the lower CET1 requirement. Loan losses are the main driver of the fall in capital ratios. Overall, combined net profits across all banks are negative and accumulate to NOK -93 bn over 3 years. Loan losses sum to a total of NOK 185 bn.

40. Norges Bank's top down stress test is modeled on a macro bank comprising nine large banks.[16] On the basis of a global layer provided by the FSAP team for the *market shock* scenario, Norges Bank generated a scenario in the central bank's macro model Norwegian Economic Model (NEMO) under the assumption that the policy rate is not changed, while capital adequacy is projected in a separate satellite bank model. Loan losses are calculated using the IMF's "rule of thumb,"[17] adjusted for the introduction of IFRS9, and cross-checked with other empirical evidence in the same way as in the Norges Bank *Financial Stability Report 2019*. Changes in lending rates follow the changes projected in the baseline in NEMO.

41. In the Norges Bank stress test the macro bank sees a fall of CET1 to the level of the crisis hurdle rate, but without being in breach of requirements. Total loan losses for the macro bank amount to around 2 to 3 percent per year. With the removal of the CCB and CCyB during the stress period, the macro bank is not in breach of requirements, but sees a fall to the level of the hurdle rate.

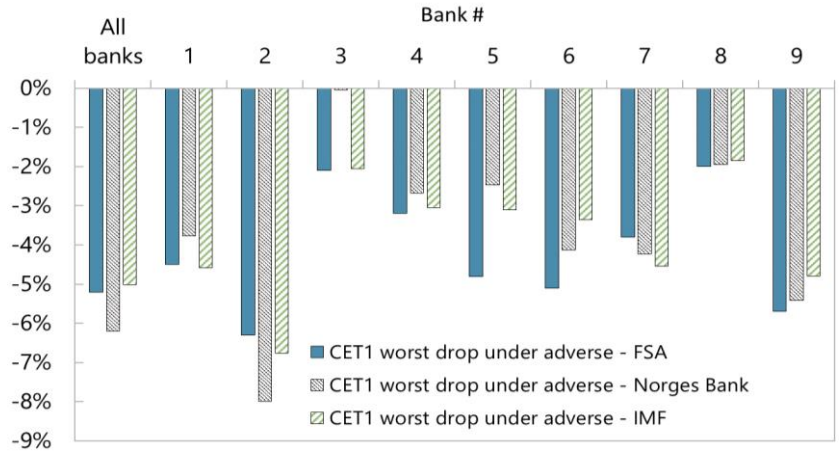
42. A comparison across the three exercises reveals broad consistency in the results. The comparison is made on the results, in term of worst CET1 ratio drop, for the nine banks covered by all the three exercises. The FSAP and FSA results are very similar on average, while the exercise performed by Norges Bank estimates a larger average drop in the CET1 ratio, in the order of -6.2 percentage points (Figure 10, top panel).

[16] All the nine banks are also part of the FSA and IMF sample.

[17] Hardy D. and C. Schmieder, 'Rules of Thumb for Bank Solvency Stress Testing', IMF, 2013.

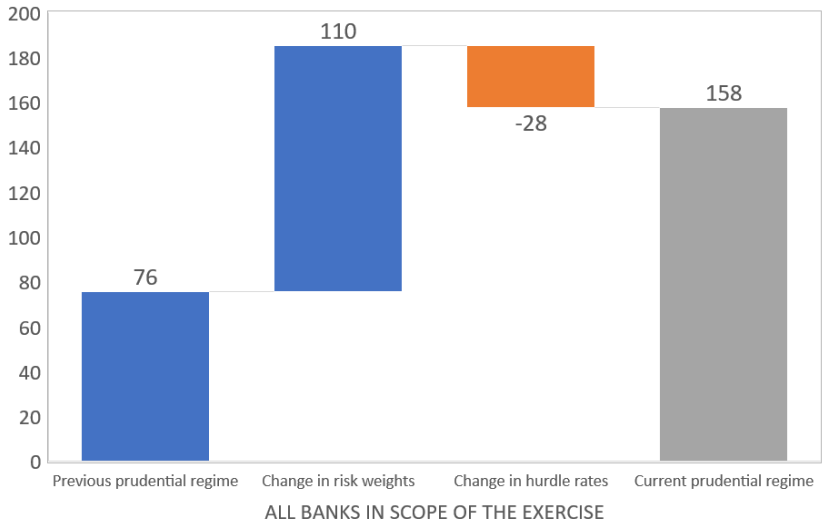
Figure 10. Norway: Solvency Stress Test—Comparison with Authorities' Results and Previous Regulation Under the Market Shock Scenario

The worst CET1 ratio declines over the risk horizon are broadly consistent across the FSA, Norges Bank, and IMF exercises



Sources: Finanstilsynet, Norges Bank, IMF

The excess CET1 at the end of the risk horizon is larger under the current prudential regime than it would have been under the previous one.[1]



[1] Capital Ratio – Hurdle Rate, in bp, end 2022

D. The Banks' (Bottom-Up) Solvency Stress Test

43. In the bottom-up stress tests, banks do not breach hurdle rates despite significant declines in capital adequacy ratios. Following the same *market shock* assumptions used for the top-down exercises, three Norwegian banks performed bottom-up solvency stress tests and sensitivity analyses. Two of the three banks experience the lowest levels of their capital ratios in the third year of the stress-test horizon, while one bank sees its capital ratio fall to the lowest level in year two, with a subsequent recovery in year three. Across the three banks, all measures of capital adequacy are between 3 and 4 percentage points lower under the adverse scenario compared to the baseline. The measures include total regulatory capital, common equity, and tier 1 capital.

E. Recommendations

44. The authorities should consider:

- collecting data useful to build historical series of default rates, analyze residential mortgages (based on stock information, i.e., existing loans), regularly monitor commercial real estate evolution and performance;
- building more analytical and granular satellite models for credit risk, able to link the macro landscape with the relevant variables (PDs, LGDs, etc.) at bank and asset class level;
- deepening the analysis of the margining arrangements adopted by banks and mortgage companies for derivative and security lending transactions (e.g., centrally cleared vs bilateral transactions, symmetric vs asymmetric margining, etc.) and of the related counterparty risk, for its impact on profits and losses (via CVA) and risk-weighted assets (via CVA capital charges);
- proceeding swiftly with their plan to collect data from trade repositories and build models to analyze the counterparty risk arising from the network of derivative exposures across banks;
- developing an IFRS 9-compatible top-down credit loss model to better capture the loan loss impact (more frontloaded than under an incurred loss accounting regime) under hypothetical downturn scenarios in top-down solvency stress tests.

SENSITIVITY TESTS

A. Staff Sensitivity Tests

Interest Rate Risk in the Banking Book (IRRBB) and FX Risk.

45. Risks from changes in interest rates and exchange rates are actively hedged by the banks. A direct analysis of these risks was not possible due to data limitations: information on the hedging positions, in particular, were not available, and for IRRBB the breakdown of assets and liabilities by maturity bucket was only available at solo level. However, based on both the results of the banks' own analyses, as regularly reported to the FSA, and of the sensitivity tests specifically run by the banks in scope of the bottom-up (BU) stress test (see below), what emerges is a picture of contained levels of risk, consistently with the banks' active hedging of their exposures.

46. For IRRBB, banks are required to use the Basel Committee standard approach. [18] Based on the Basel approach, IRRBB is analyzed from two different perspectives: (i) Economic Value of Equity (EVE), i.e., the change in the net present value of a bank's assets and liabilities under a stressed interest rate scenario, representing a 'stock' perspective; and (ii) Net Interest Income (NII), i.e., the difference between total interest income and total interest expense within a 1 year horizon, given a certain scenario, representing a 'flow' perspective. The tests are based on the derivation of six interest rate shock scenarios: (i) parallel shock up; (ii) parallel shock down; (iii) steepener shock

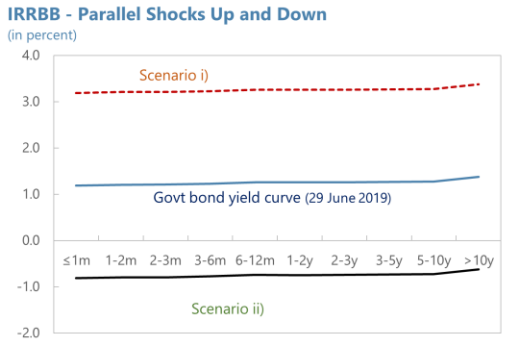
[18] Basel Committee on Banking Supervision (BCBS), "Interest rate risk in the banking book," April 2016.

(short rates down and long rates up); (iv) flattener shock (short rates up and long rates down); (v) short rates shock up; and (vi) short rates shock down. The three parameters that drive the shocks in the scenarios have been set by the FSA at the following levels: 1) parallel shock: 200 bps; 2) short-term rate shock: 300 bps; 3) long-term rate shock: 150 bps. Applying the Basel methodology with this shock calibration to the government bond yield curve at the end of 2019: Q2 produces the changes in the terms structure of interest rates shown in Figure 11.

47. Interest rate risk in the banking book is modest for all banks, with exposures to non-parallel shocks often emerging as the relatively most important. The results reported by the banks at the end of 2019 in terms of EVE are all well below the 15 percent of Tier 1 capital indicated by the Basel Committee as the threshold for the identification of "outlier banks" (to be subject to further investigations) (see Figure 11, bottom right panel). Interestingly, the parallel shock 'up' is not always the one entailing the largest potential losses, as it is almost always the case for banks engaged in traditional maturity transformation: for some banks a steepening of the curve is more damaging, while for others the largest EVE losses are linked to shocks in the short term end of the curve (for some a spike, for others a drop in short term rates). Given the low values of the EVE shock, this is not a source of concern, but highlights how the active hedging of exposures largely frees banks from the risk of parallel shocks to the yield curve, while leaving them relatively more exposed to non-parallel shocks, generally less straightforward to hedge. The impact on banks in terms of NII are also generally contained, always below 3 percent of Tier 1 capital.

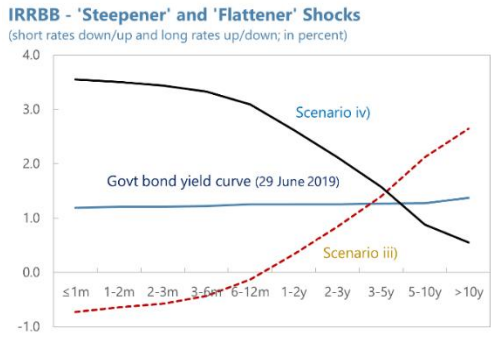
Figure 11. Norway: Interest Rate Risk in the Banking Book

Banks are required to estimate their exposures to parallel shocks to the term structure of interest rates…



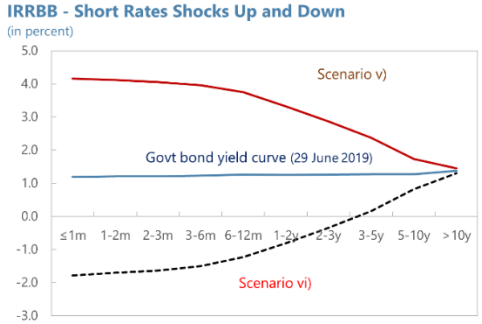
Sources: IMF

… as well as to changes in its slope…



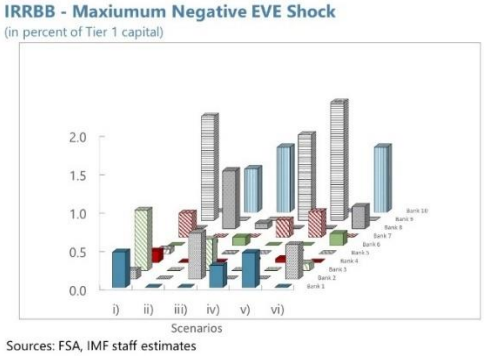
Sources: IMF

…and decoupling between the short and the long end of the curve



Sources: IMF

Norwegian banks have generally low exposures to IRRBB, some of them relatively larger ones to non-parallel shocks



Sources: FSA, IMF staff estimates

Market Risk

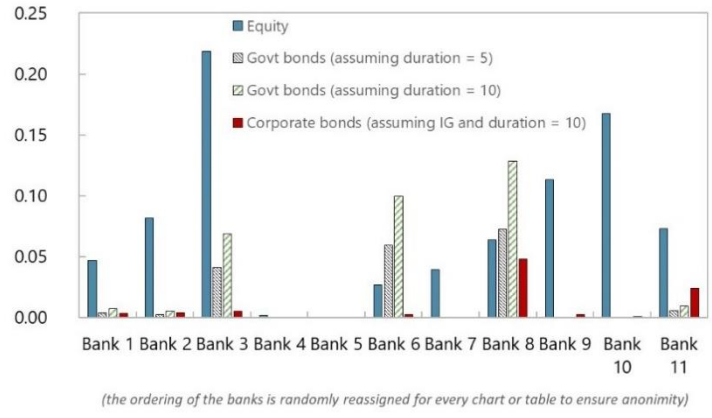
48. The banks' exposure to equity risk appears limited. Equity holdings represent a modest share of banks' assets, between 0 and 1 percent for the banks in scope of the top-down exercise. Equity risk was estimated with a Value-at-Risk approach, via historical simulation of the largest loss—at the 1 percent confidence level and over a 1-month horizon—from each bank's current holding of equity exposures. The simulation was based on the Oslo Stock Exchange All-Share index (OSEAX) daily quotes since 2013 and it shows that the reduction in capital ratios from losses on their equity portfolio would not exceed 25 bps, at that confidence level and horizon (Figure 12).

49. A similar simulation on the banks' holding of government and corporate bonds also produces relatively modest losses. The simulation on government bonds took into account the co-movement, since 1990, of the yields of 10-year benchmark bonds issued by the Norwegian government and by the government of Austria, Canada, Germany, Finland, Sweden, United States. Given the lack of information on the duration of the bank's portfolios, a standard assumption has been used of duration equal to 5 or 10. Applying the same historical simulation as for the equity portfolio, the results point, again, to a contained level of risk: at the 1 percent confidence level and over a 1-month horizon losses would impact on capital ratios by no more than 15 bps. For corporate bonds the simulation was based on the daily quotes of the S&P Norway 10+ Year Investment Grade Corporate Bond Index since 2010. At the same confidence level and over the same horizon losses would affect capital ratios by no more than 5 bps. The results overall confirm the limited trading activity of Norwegian banks.

Figure 12. Norway: Sensitivity Test—Market Risk

(In percent RWA at end-2019: Q2)

The banks' exposure to market risk—measured as historical Value-at-Risk at a 1 percent confidence level—is contained, consistently with their limited trading activity.



Sources: Oslo Stock Exchange, Standard & Poor's, OECD, IMF

B. The Banks' Sensitivity Tests

50. Sensitivity tests were also conducted directly by the banks in scope of the bottom-up exercise. As part of the exercise the three banks were involved in, they were invited to provide estimates of their exposures to IRRBB and FX risk. For IRRBB, they were asked to follow the same standard (Basel) approach described in the previous section. For FX risk they were asked to assess the impact of extreme movements in the exchange rates against major currencies on their net open positions. The test was based—for the overall net open position and separately for the exposures in significant currencies (EUR, USD and GBP, as a minimum)—on a historical simulation of FX losses based on 12 years of daily changes at a 99 percent confidence level over different risk horizons: 1 week, 1 month, 3 months, 1 year.

51. The overall results of the sensitivity tests indicate that IRRBB and FX risk are small across the banks in scope of the bottom-up stress test. Their EVE and NII exposures remain below 2 percent of Tier 1 capital, while for FX risk they don't reach 1 percent even at the longest horizons. As already mentioned, this is the result of their systematic hedging of such risks.

52. Concentration risk is also contained. For concentration risk banks were requested to conduct a reverse stress test by ordering all large exposures per group of connected clients from the largest to the smallest, assuming a direct impact on capital, and calculating how many exposures would have to default to exhaust the available surplus capital in excess of the capital requirement (Pillar 1 and 2 requirements and all regulatory capital buffers, including CCB and CCyB). The reverse stress test was conducted for Common Equity, Tier 1 capital and Total capital. The results show that, assuming a 50 percent LGD, it would take the simultaneous default of no less than the top 10 counterparts to exhaust the banks' surplus Tier 1 capital. In the logic of reverse stress tests, the result indicates a low degree of concentration.

C. Recommendations

53. Maturity ladder for IRRBB. The FSA is encouraged to collect from the banks data on assets and liabilities at consolidated level, with a breakdown by maturity bucket for time of repricing (or, better, duration) and including the hedging positions.

LIQUIDITY STRESS TESTS

54. The liquidity situation of Norwegian banks is dictated, in large part, by their mortgage-centered business model. With property-related lending representing, on average, close to 60 percent of their loan portfolios and mortgages used as collateral for the issuance of covered bonds, a link is established between the evolution of property prices and their ability to fund their operations.

55. The potential for direct negative spillovers to funding from drops in real estate prices is regularly monitored by the FSA. The degree of actual or potential overcollateralization of covered bond issuances is generally high. Actual collateralization refers to the collateral, in excess of

the amount required, that is already available at a mortgage company; the potential one refers to the availability, within the group, of eligible and unencumbered assets that could be transferred to the mortgage company if needed. The FSA regularly collects data from each banking group on the availability of collateral (residential and commercial real estate) to top up the cover pool in the mortgage companies. The banks are also required to subject the amounts reported to a standard stress test assumption of a 30 percent fall in real estate prices. Under that assumption, there would be no lack of collateral across the system to ensure adequate coverage for covered bonds backed by residential real estate. Based on the available data, the mission could not delve further into covered bond impairment risks.

56. The high reliance on wholesale funding, though, requires careful planning and exposes the banks to the risks stemming from potential turmoil in capital markets. Given the relatively low incidence of deposits on banks' funding, banks rely on a continuative issuance of covered bond and unsecured senior bonds. Also, the interest rate and currency mismatch between their assets (prevalently NOK-denominated and floating-rate) and the large share of their liabilities denominated in foreign currency and fixed rate requires them to constantly hedge the interest rate and FX risk in their portfolios via derivative transactions.

57. Liquidity stress tests should capture the risks generated by these structural funding characteristics, but not all the necessary data are available. The reliance on regular securities issuance exposes the banks to roll-over risks in case of turbulence in the capital markets, while their hedging activity might entail liquidity-draining margin calls in case of sharp changes in interest rates and/or exchange rates. Scenario analysis can help in gauging the exposure of banks to the former type of risk. Accurately modeling the latter risk, however, would require granular data on derivative transactions to get a forward-looking view of the potential future margin calls. The only information available from supervisory reporting, instead, is represented by a backward-looking account of margin calls in the past two years (part of LCR reporting).

58. Norwegian banks were able to weather the recent market turbulence related to the COVID-19 outbreak and its consequences for the global economy. During the international financial turmoil surrounding the onset of the COVID-19 crisis in March 2020, Norwegian banks' liquidity held up well—including with precautionary nonstandard central bank FX liquidity support—and potential tensions did not materialize.

59. Banks' liquidity stress tests assessed coverage of net outflows for the standard Basel 1-month horizon (LCR) as well as over longer time horizons. 11 banks (the same as in the top-down solvency stress test) were assessed by stressing the LCR standard assumptions and through a cash-flow analysis.

A. Stressed LCR

60. The LCR is designed to ensure that banks hold a sufficient reserve of HQLA to allow them to survive a period of significant liquidity stress lasting 30 calendar days. Banks are required to hold a stock of HQLA at least as large as expected total net cash outflows over the stress

period. However, this floor can be breached during periods of stress, based on supervisory guidance on the usability of HQLA. The net outflows are calculated under a standard scenario that combines elements of bank-specific liquidity and market-wide stress and includes many of the shocks experienced between 2007 and 2012. The 30-calendar-day stress period is the minimum period deemed necessary for corrective action to be taken by the bank's management or by supervisors.

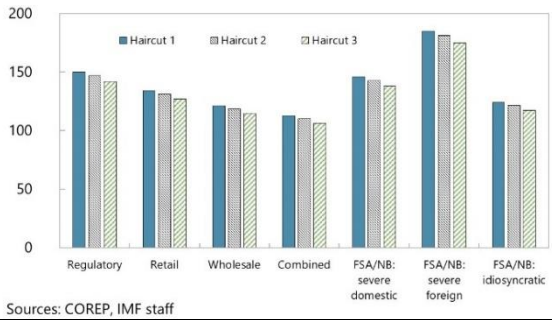
61. For stress-testing purposes, the assumptions underlying the standard LCR are revised in order to augment the severity of the scenario. This is achieved, in particular, by increasing the run-off rates applied to the outflows (e.g., rates at which deposits are withdrawn and securities issuances cannot be rolled over) and the haircuts applied to all or part of the HQLA.

62. The stressed LCR simulation is based on the combination of three "haircut" scenarios with seven "outflows" scenarios (see Annex II for details).[19] The haircut scenarios assume increasing haircuts, starting from the LCR standard assumptions, on the counterbalancing capacity (i.e., the assets a bank can rely on to obtain additional liquidity in secondary markets, by selling securities, or through standard central bank facilities). The outflow scenarios include one regulatory scenario, three stress scenarios routinely used in FSAPs—assuming shocks on retail funding, wholesale funding, or both—and three stress scenarios designed by the FSA and Norges Bank to be consistent with their own liquidity stress test.

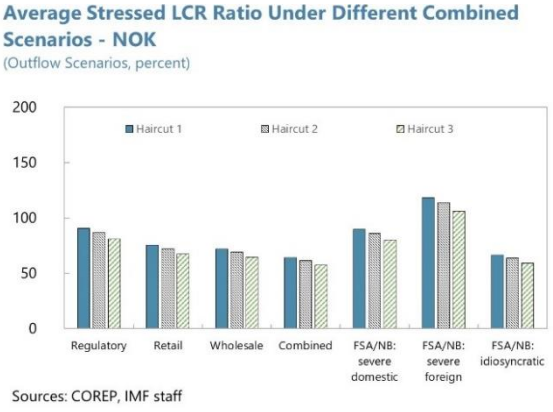
63. On average, banks' HQLA are sufficient to fully cover the assumed net outflows over the 1-month horizon. In all scenario combinations, the average LCR across the 11 banks would remain above 100 percent over a one-month horizon, though some banks would breach the threshold under the most severe scenario combinations (Figure 13, left panel). Similarly, the LCR in domestic currency (for which a 50 percent threshold is imposed on some banks) always remained above the threshold on average, with only one bank experiencing difficulties under some combination of severe scenarios (Figure 13 right panel). Norwegian banks are generally very liquid in EUR and USD and their LCR in these currencies remain well above 100 percent in all cases.

Figure 13. Norway: Liquidity Stress Test Results—Stressed LCR

Liquidity appears solid within the 1-month horizon of the LCR, both overall …



….and when assessed separately for the domestic and most significant foreign currencies



[19] The stress test team is grateful to Dimitrios Laliotis (IMF) for the support provided with the Matlab code implementing the LCR simulations.

B. Cash Flow Analysis

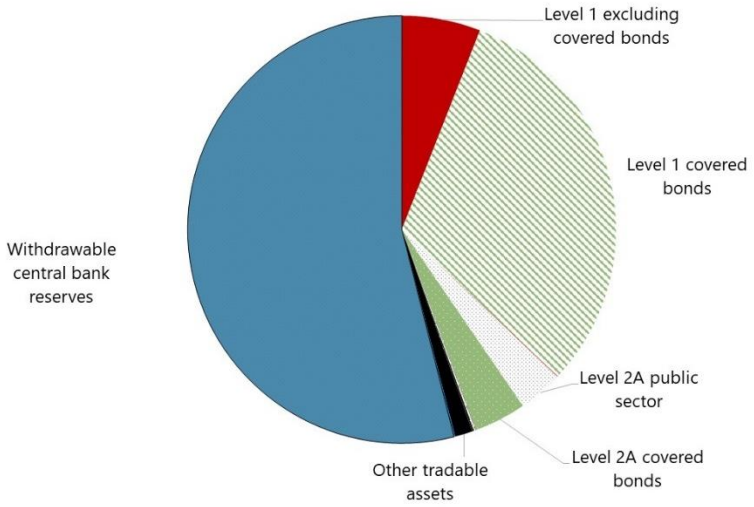
64. The cash flow analysis is a useful complement to the stressed LCR assessment. It explores the balance between outflows, inflows, and counterbalancing capacity (initial HQLA augmented by net inflows through time) over 18 maturity buckets (from overnight to one year).

65. The quality of the counterbalancing capacity (CBC) is as crucial as its quantity for a bank's capacity to withstand the net outflows it faces. For the 11 banks covered by the simulation, CBC is comprised for more than half of central bank reserves,[20] while more than ⅓ is represented by covered bonds. Government bonds, unlike in many other advanced countries, make a modest share of the overall CBC (Figure 14).

Figure 14. Norway: Initial Counterbalancing Capacity

(June 2019)

The counterbalancing capacity of ten among the largest domestically incorporated banks is dominated by central banks reserves and covered bonds.



Sources: COREP, IMF Staff

66. The cash flow analysis applied a mildly adverse and a severely adverse scenario. Run-off and haircut rates are calibrated accordingly (see Annex II).

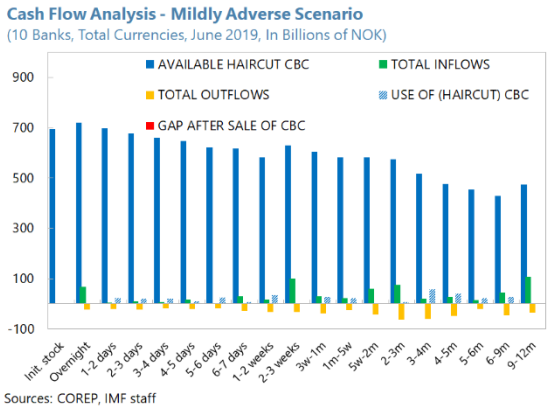
67. The severely adverse scenario reveals the relative weakness of some banks beyond the 1-month horizon of the LCR. While all banks would comfortably handle all net outflows up to one year with their initial counterbalancing capacity under a mildly adverse scenario, some would encounter difficulties under a severely adverse one, and the whole system would experience negative counterbalancing capacity gaps starting from the 3-4 months bucket (Figure 15, top panels).

[20] The high share of central bank reserves is due to one single bank. Note that CBC varies substantially between different currencies, with central bank reserves mainly in EUR and USD.

68. The analysis of outflows highlights the potential points of weakness in the temporal distribution of cash flows. A drilldown into the banks' outflow structure brings to evidence the delicate role played by debt issuance, highlighting the rollover risk banks would face in case of dislocations in the capital markets (Figure 15, bottom panels). Risks would also materialize in case of difficulties in rolling over the derivative transactions banks need to hedge their interest rate and FX risk. Those difficulties could be compounded by the liquidity drains caused by margin calls, in case of sharp market movements and spikes in volatility. However, an assessment of how such drains could imperil the banks' liquidity conditions would require detailed data at transaction level that are currently not available.[21]

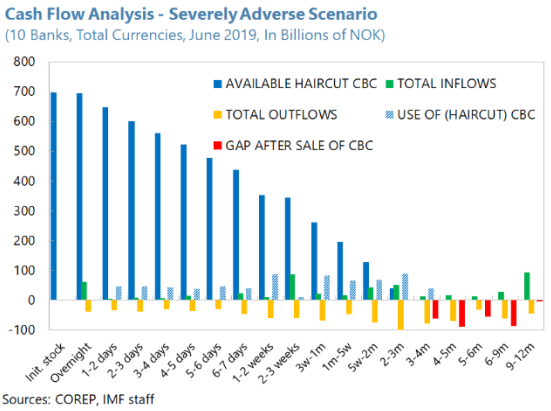
Figure 15. Norway: Liquidity Stress Test Results—Cash Flow Analysis

The cash flow analysis reveals no major issues under a mildly adverse scenario …



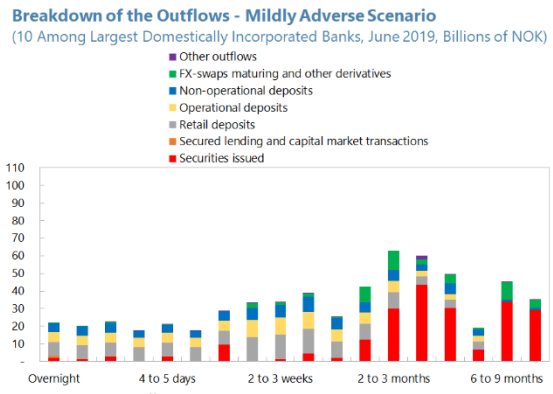
Sources: COREP, IMF staff

…but potential tensions could emerge beyond 1 month, under severely adverse conditions…



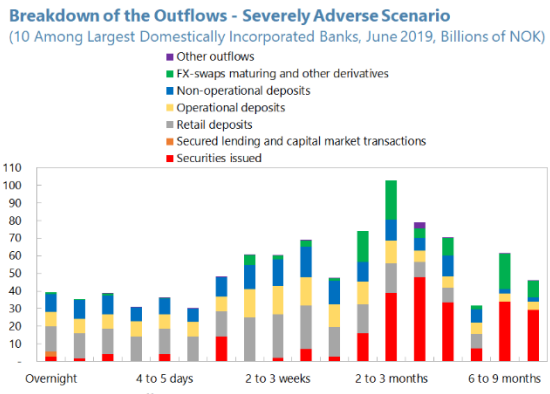
Sources: COREP, IMF staff

…as a result of sizeable potential net outflows if the rollover of debt issuance …



Sources: COREP, IMF staff

….and derivative contracts is threatened by dislocations in international markets



Sources: COREP, IMF staff

[21] For this purpose, the authorities are planning to exploit the information collected by trade repositories.

C. Recommendations

69. The authorities should consider:

- implementing stressed LCR and cash-flow analysis as useful complementary diagnostic tools;
- deepening the analysis of the margining arrangements adopted by banks and mortgage companies for derivative and security lending transactions (e.g., centrally cleared vs bilateral transactions, symmetric vs asymmetric margining, etc.) and their implications for liquidity risk;
- proceeding swiftly with their plan to utilize the data collected from trade repositories and build models to analyze the liquidity risks arising from derivative exposures (in particular as a results of liquidity drains caused by margin calls in turbulent market conditions);
- establishing a regular collection of data on the liquidity position of branches of foreign banks.

INTERCONNECTEDNESS AND CONTAGION ANALYSIS

A. Inter-Sector Financial Linkages

70. The evolution of the financial sector in the past twenty years has been continuous and gradual, with the introduction of the covered bond law being the main factor behind the most notable change. An analysis of the Statistics Norway data on financial accounts by sector helps to shed light on the financial linkages among the different sectors of the Norwegian economy and with the rest of the world. The covered bonds legislation introduced in 2007 deeply reshaped those linkages, increasing the prominence of mortgage companies in the financial network.

71. Mortgage companies have become increasingly important as net financial exposures in Norway evolved between 1998 and 2018. In 1998 the largest net financial exposures were those of central government and households towards non-financial corporations (esp. equity holdings) and of households towards insurance companies and pension funds (insurance policies and, more prominently, pension entitlements). The banks' position, meanwhile, was quite balanced, with credit to households and non-financial corporations being somewhat larger than borrowing from the above sectors. Mortgage companies' role in the financial system was overall negligible. In 2008 the picture was largely similar, but with a more relevant role of banks and mortgage companies in financing the private sector. Ten years later, in 2018, the most relevant change appears to be the importance acquired by mortgage companies in the financing of households.

72. When Norwegian pension funds and insurance companies purchase Norwegian covered bonds that have been issued abroad, this is recorded in official statistics as "foreign" funding of mortgage companies. This creates difficulties when it comes to disentangling whether Norwegian assets are held by domestic or foreign investors. Moreover, Norwegian insurance companies and pension funds increasingly hold assets through mutual funds, posing additional challenges for the analysis of interconnectedness.

73. Norwegian households hold a large amount of assets in insurance companies and pension funds, in line with exposures seen in other Organization for Economic Co-operation and Development (OECD) countries. To a large extent, this reflects pension entitlements of Norwegian households on top of the public pillar I pension system. In fact, households' assets towards insurers are on average larger than their bank deposits. The relatively low share of liquid assets may in part be explained by Norway's strong welfare system.

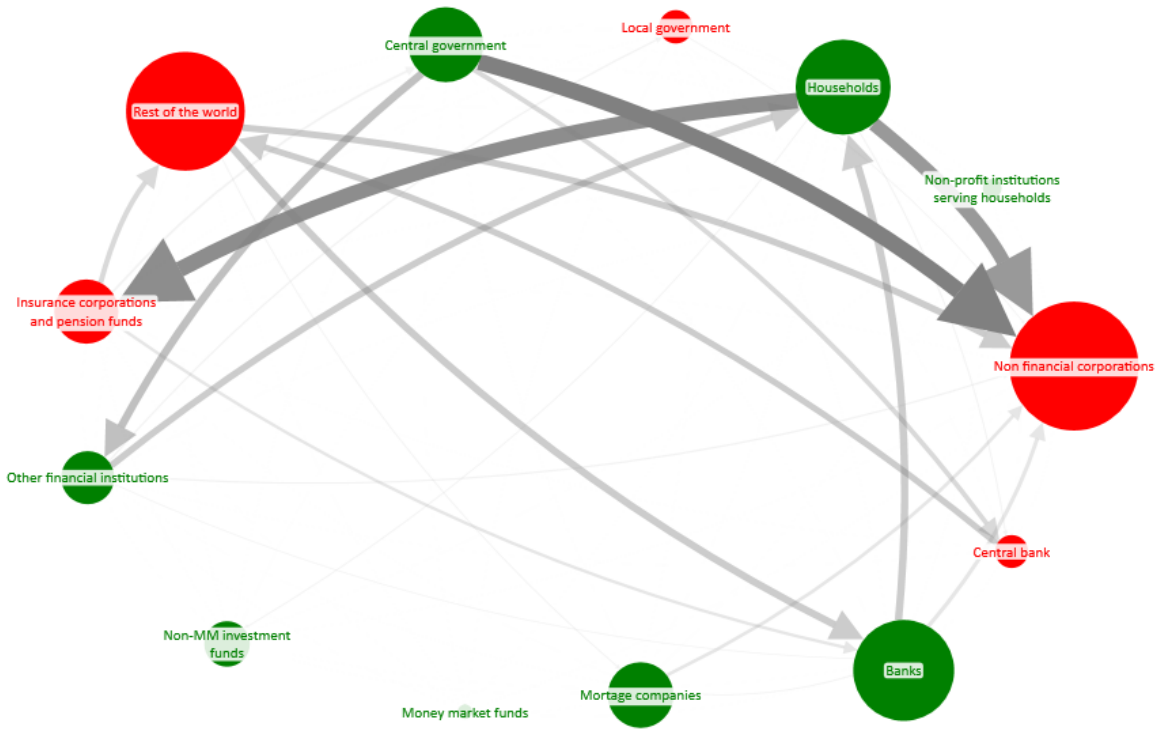
Box 3. Evolution of Net Financial Exposures (1998–2018)

The following graphs provide a synthetic representation of the evolution of net financial assets (i.e., financial assets—financial liabilities) among the different sectors of the Norwegian economy and with the rest of the world between 1998 and 2018.[1/]

*Each vertex of the graph represents a sector, with the size of the vertex proportional to the total assets of that sector and the color showing its net position (**green** for net lenders, **red** for net borrowers).*

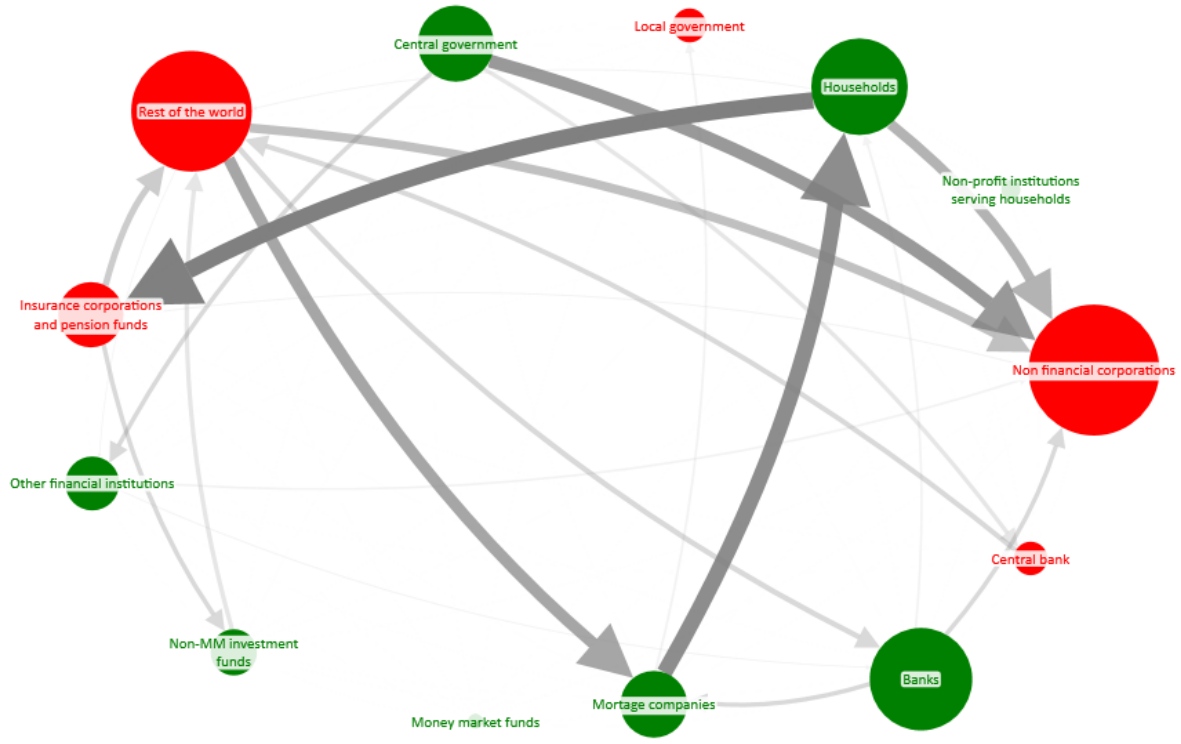
Each edge between two vertices represents the net bilateral exposure between two sectors (in the direction of the arrow, from net lender to net borrower), with the edge's thickness proportional to the size of the net exposure.

*In **1998** the largest net financial exposures were those of central government and households towards non-financial corporations (esp. equity holdings) and of households towards insurance companies (mainly pension claims).*



Box 3. Evolution of Net Financial Exposures (1998–2018) (Concluded)

*In **2018**, the most relevant change appears to be the importance acquired by mortgage companies in their financing of households.*



Source:

[1/] The central government's exposures are net of GPFG's assets.

B. Interbank Network

74. Interconnectedness among Norwegian banks and in the Nordic region has been analyzed following a market-based approach. The 2015 FSAP conducted an in-depth analysis mapping linkages and interconnectedness in the financial system, finding that these played an important role. The mission tried to infer from market data how those linkages have evolved since. Specifically, interconnectedness among banks was analyzed following the methodology of Diebold and Yilmaz.[22] The approach uses equity returns for a selection of Scandinavian banks to produce measures of interconnectedness among banks.

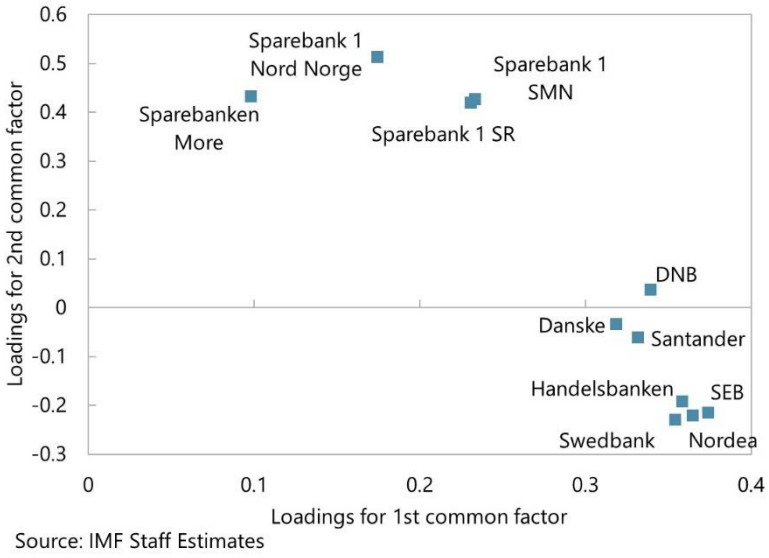
75. Principal component analysis applied to equity returns reveals differences between medium-sized Norwegian banks and the larger banks of the region. In the analysis, banks roughly fall into two clusters, where one cluster is formed by the major Scandinavian banks including DNB, and the other is formed of the medium-sized Norwegian savings banks (see Figure 16, which shows the loadings for the first two common factors from a principal component

[22] Diebold F. X. and K. Yilmaz (2014) *On the Network Topology of Variance Decompositions: Measuring the Connectedness of Financial Firms.* Journal of Econometrics 182 (1): 119–134.

analysis of daily equity returns of the largest Norwegian banks, as well as a selection of large banks from other Nordic countries). To get a better understanding of the interconnectedness among the larger banks, smaller savings banks were excluded from the next part of the analysis. Santander, which is the only subsidiary of a foreign bank in the sample, was also excluded to get a clearer picture of the interconnectedness among the Scandinavian banks.

Figure 16. Norway: Characterizing Banks Using Factor Loadings

Loadings from a principal component analysis of banks' daily stock returns from 2007 to 2020



Source: IMF Staff Estimates

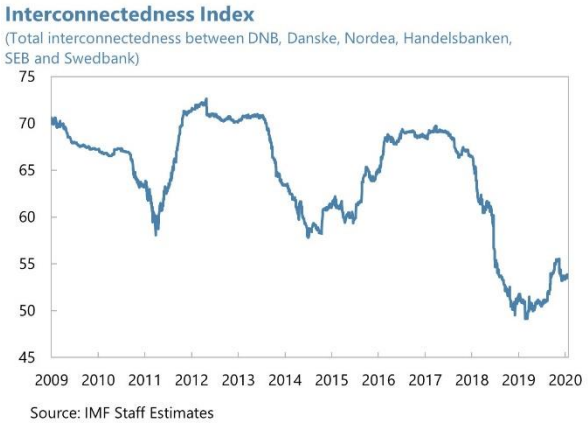
76. An index of interconnectedness after Diebold and Yilmaz (2014) shows considerable variation for banks in the Nordic region over the past 5 years. Daily returns data for share prices of banks across the Scandinavian region are used to estimate spillovers to and from a bank versus the rest of the sample. As described above, the analysis includes DNB, Danske, Nordea, Handelsbanken, SEB and Swedbank, starting in January 2007. Interconnectedness among the banks is estimated via a decomposition of 10-day ahead forecast errors from a vector autoregression (VAR) using daily stock returns. Employing a rolling window of 2 years makes it possible to follow the evolution of interconnectedness in the system.[23] The index of total interconnectedness in the system varied considerably through time, with a decline since 2017 (Chart 17, panel 1). The difference between the indicators of outward and inward spillovers for each bank allow to assess whether a bank has been a net contributor or receiver of spillovers. DNB and Danske, in particular, are estimated to have been at the receiving end of spillovers in the region (Figure 17, panel 2). Naturally, this result is conditional on the sample selected for the analysis and DNB turns into a net contributor of spillovers when compared to smaller Norwegian banks not present in this analysis.[24]

[23] To check for robustness of the results, the model is re-run with both shorter and longer rolling windows, but results are stable across all specifications.

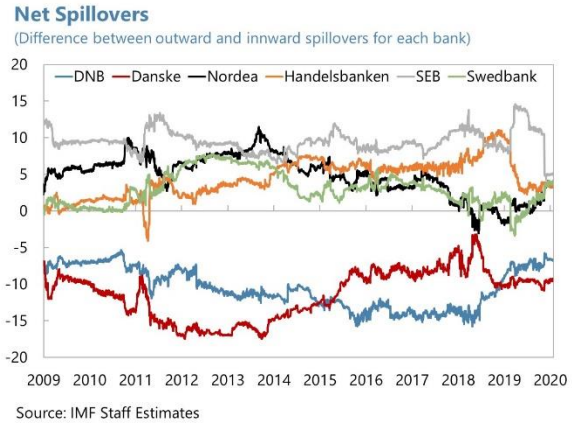
[24] Note that the approach of Diebold and Yilmaz relies on correlations in market data and consequently lends itself more to descriptive analysis, than any direct conclusions about causal relationships.

Figure 17. Diebold-Yilmaz Analysis of Interconnectedness Among Large Scandinavian Banks

Interconnectedness has rebounded from a low in 2019….



…with DNB and Danske typically on the receiving side



77. Due to data limitations, the exercise could not be complemented with an analysis based on bilateral exposure data. While data on cross-holdings of securities among banks were available, they allowed to capture only one of the layers of the interbank network. Other layers might be equally or more relevant and, more importantly, their mutual interaction could generate strong contagion effects that would otherwise be missed. Derivatives exposures among banks, for example, are potentially concentrated and could act as shock amplifiers through the network in case of extreme market volatility.

78. The assessment of direct and indirect contagion effects within the Norwegian banking sector shows that they are unlikely to significantly amplify shocks in the system. The framework of Norges Bank[25] looks at how fire sales of common asset holdings can lead to valuation losses for banks (indirect contagion), and how recapitalization of banks can lead to direct contagion. The model is calibrated on securities holdings and large exposures data. Losses due to contagion are on average 1 pp of the banking sectors CET1 ratio, but in some cases can reach 2.5 pp. The losses result almost exclusively from indirect contagion.

C. Recommendations

79. The authorities should consider:

- maintaining an accurate, updated, and easily retrievable map of the components and mutual relationships (in terms of control or other relevant influence) of the major corporate groups: especially the banking groups; but also the groups of borrowers. This would, for example, allow regular checks of the reliability of the group maps adopted by each bank for large exposures and concentration risk reporting;

[25] See Norges Bank Staff Memo 3/2020 (forthcoming) by Kockerols and Bjørland and Norges Bank Financial Stability Report, November 2019.

- proceeding swiftly with their plan to expand the contagion analysis to further layers of interconnectedness among banks, in particular using the data collected from trade repositories and building models to analyze the contagion effects arising from the network of derivative exposures across banks;

- adjusting or replacing the two indicators for the non-bank sector in the Norges Bank's heatmap, as they have been 'flashing red' for some time, without raising significant concerns upon closer inspection (as explained in the FSR). Maintaining them in their current form might demand repeated explanation of the reasons why they do not represent a source of concern and ultimately be perceived as a 'false alarm', possibly undermining the confidence of FSR readers in the reliability of the overall heatmap.

CLIMATE-RELATED RISKS: TRANSITION RISK ANALYSIS

80. "Transition risks" of climate change are the risks originating from the transition to an economy that emits fewer greenhouse gases. The existing literature treats *transition risks* as distinct from *physical risks*, with the latter being the immediate risks to assets from rising temperatures and natural disasters, such as risks related to flooding or hurricanes. Transition risks can be driven by changes in policy, advances in technology, or a combination of both.[26] While Norway as a country is not exempt from physical risks, it ranks high in terms of adaptability against a relatively low exposure, as measured by the University of Notre Dame Global Adaptation Index[27] (Figure 18) and underlined by the Norwegian government.[28] Transition risks, instead, are highly relevant for Norway, as a major producer of oil and gas.

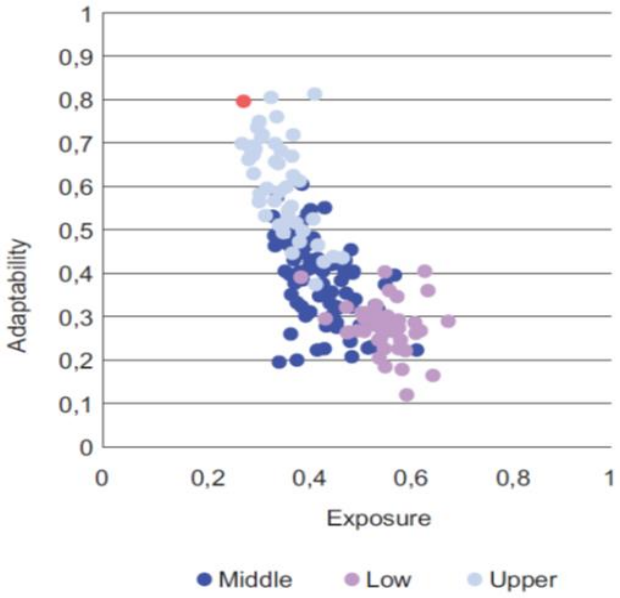
[26] Vermeulen, et al. (2018)

[27] "Adaptability" is understood as a country's readiness to leverage private and public sector investment for adaptive actions, and "exposure" stands for a country's current vulnerability to climate change. Chen et al. (2015) *University of Notre Dame Global Adaptation Index*. Technical Report, Notre Dame Global Adaptation Index, retrieved on 5 Feb 2020 from https://gain.nd.edu/assets/254377/nd_gain_technical_document_2015.pdf

[28] Official Norwegian Reports NOU 2018: 17 Summary, Climate risk and the Norwegian economy,

Figure 18. Norway: Exposure and Ability to Adapt to Climate Changes

Countries by level of economic development. Norway is indicated in red.



Source: University of Notre Dame Global Adaptation Index.

81. The focus of the analysis is on transition risks driven by policy action, such as an increase in carbon prices. The analysis tries to answer two questions. Firstly, how does an increase in domestic carbon prices impact Norwegian banks' credit exposures? And secondly, how does a fall in oil sector revenues affect Norwegian banks' loan losses? Looking for a response to these questions led the mission to identify two propagation channels. The mission considered also potential portfolio effects—with results to be considered still preliminary—where the emphasis is put on the reductions in oil production necessary to meet the Paris agreement goals, and how this could affect the valuations of oil-related companies, as well as the financial wealth of households and other economic sectors. The sensitivity tests are conducted in partial equilibrium and, among other simplifications, do not account for the use of revenues from higher carbon prices.

A. Carbon Pricing in Norway

82. In international comparison, current carbon pricing in Norway is advanced, complex and in a state of evolution. According to data collected by Statistics Norway, the average price paid per ton of CO2-equivalents in 2018 was NOK 266 (about US$30). This is well above the global average of US$2, but still outside the US$50–100 range considered necessary by the IMF to achieve the targets set out in the Paris Agreement (IMF, 2019). Current carbon pricing in Norway is complex, as rates differ substantially across industries. Moreover, some industries are covered only by national emissions charges, while others are covered also by the EU Emissions Trading System (EU ETS). Below, both are referred to as 'carbon taxes' or 'carbon prices.' As no breakdown of actual carbon tax rates across sectors is currently available for Norway, tax rates are approximated on the basis of actual carbon taxes paid by sectors, taking into account the total emissions of the respective sectors.

B. Two Propagation Channels

Corporate Cost of Emissions Channel: The Impact of Higher Domestic Carbon Prices

83. To analyze the impact of higher domestic carbon prices on financial stability, the analysis follows a firm-level balance sheet approach, calculating whether the additional cost from higher carbon taxes implies difficulties for firms to service their debt, thereby affecting stability of the financial sector. Throughout the analysis, two hypothetical scenarios are employed where carbon taxes increase to US$75[29] and US$150[30] per ton CO2-equivalent. In doing so, the immediate impact of the policy change is evaluated without consideration for a specific time horizon or dynamic effects. Aside from a uniform increase of the carbon tax rate to US$75 or US$150, the analysis also includes scenarios where the current differentiation in tax rates among sectors is preserved by shifting the whole tax curve to a higher level such that the average corresponds to US$75 or US$150. The output of this analysis is given by the change in debt at risk[31] for each bank operating in Norway.

84. A 'no-pass-through' assumption is adopted for higher carbon prices, implying that firms fully absorb additional costs. In reality, firms would likely adjust both the quantities and prices of their output, likely dampening the effect of higher carbon taxes on profitability. Outside of a general equilibrium framework, however, it is unfeasible to track the adjustments in demand and production processes along the various value chains in the economy. The assumption likely leads to some degree of overestimation of the impact of an increase in carbon pricing at firm level with respect to a full general equilibrium solution, although not necessarily for all firms and sectors. It is also assumed that individual firms are representative of the sectors they operate in. This allows for a transition between sector- and firm-level data in the analysis.

85. Calculating greenhouse gas emissions by firm allows an estimate of firm-level costs of higher carbon taxes. Scope 1 greenhouse gas emissions are estimated for all sectors in the scope of the analysis using input-output tables from Exiobase.[32] The sector emissions are then matched to firm-level data from Orbis.[33] The additional cost faced by each firm is calculated as the difference between old and new tax rate per NOK of output, multiplied by the output of a firm.

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[29] This value corresponds to the mid-point of the range estimated by the IMF as necessary to achieve Paris climate targets.

[30] The literature presents this value as supporting a more rapid transition to a low-carbon society. Kent et al. (2019), for example, find that a much higher 'impact' carbon price (in the range US$125–215), followed by a gradual decline, would be justified when assuming a specification of consumers' intertemporal preferences that is different from the usual assumption of constant relative risk aversion (CRRA).

[31] We define "debt at risk" as the share of firms (in each sector) for which the interest coverage ratio (ICR) drops below a threshold value due to the policy shock. Depending on the calibration, the threshold value is set either at 2 or 1.

[32] See, for example, Wood et al. (2015). The stress test team is grateful to Prof. Wood at the Norwegian University of Science and Technology (NTNU), for providing the data and to Robert Vermeulen at De Nederlandsche Bank, for sharing with us the code for data extraction.

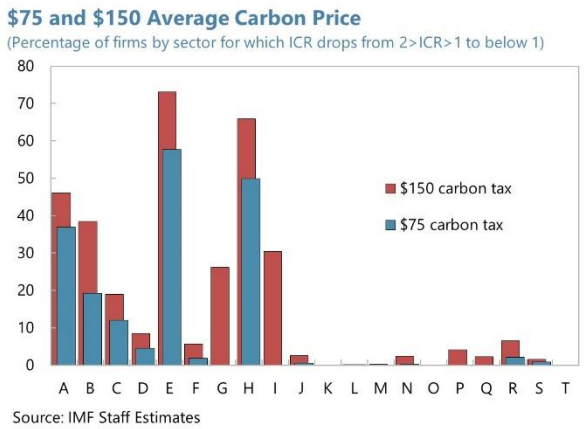
[33] While Orbis does not cover all firms in the Norwegian economy, it is assumed that the more than 300.000 firms in the dataset are representative of the economy as a whole.

86. For firms with low profits compared to interest expenses, higher carbon taxes could result in inability to service debt. To link increased firm-level costs to considerations of financial stability, firms' earnings are calculated before and after the increase in carbon prices, and compared to interest expenses to obtain firms' "interest coverage ratios" (ICRs). At sector level, the focus is on the share of companies for which the ICR drops from between one and two—an area of increased risk—to below one, where a company is likely no longer able to service its debt.[34] The focus on this particular area of ICRs makes it possible to uncover how firms are impacted by climate policy when their overall financial situation is already at risk. That said, when connecting results to bank lending in the next step of the analysis, all firms are taken into account, not just those with ICRs in a certain range.

87. Given a uniform increase of carbon prices to US$75, firms employed in certain sectors are more likely to be materially impacted. This is the case for the sectors agriculture, forestry and fishing; water supply, sewerage, waste management and remediation activities; as well as transportation and storage. Panel 1 in Figure 19 shows that the impact is strongest in sectors that currently have very low carbon taxes (industries such as waste management currently enjoy significant exemptions from emissions charges) while being carbon-intensive.

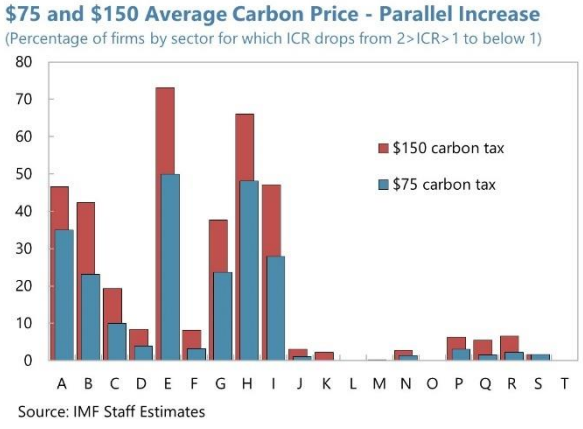
Figure 19. Norway: Share of Firms Per Sector with Debt at Risk Following Increase in Carbon Price

Agriculture, waste management and transportation…



Source: IMF Staff Estimates

…are most affected under all scenarios



Source: IMF Staff Estimates

Note: A = Agriculture, forestry and fishing; B = Mining and quarrying; C = Manufacturing; D = Electricity, gas, steam and air conditioning supply; E = Water supply; sewerage, waste management and remediation activities; F = Construction; G = Wholesale and retail trade; repair of motor vehicles and motorcycles; H = Transportation and storage; I = Accommodation and food service activities; J = Information and communication; K = Financial and insurance activities; L = Real estate activities; M = Professional, scientific and technical activities; N = Administrative and support service activities; O = Public administration and defence; compulsory social security; P = Education; Q = Human health and social work activities; R = Arts, entertainment and recreation; S = Other service activities; T = Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use; U = Activities of extraterritorial organizations and bodies.

[34] Changes in ICRs before and after the policy shock are calculated solely on the basis of increased costs to firms, while leaving everything else unchanged and without taking into account the possibility for firms to draw on cash or other reserves.

88. Under a carbon price of US$150, several other sectors are also at risk, notably wholesale and retail trade as well as accommodation and food services. Emissions-intensive sectors that already face a high carbon tax are affected at US$150 (while imposing a US$75 carbon tax in these cases did not imply a significant change from current carbon taxes).

89. Imposing a parallel shift up of current carbon prices, such that the average corresponds to US$75 or US$150, while preserving the differentiation across sectors, produces a roughly similar picture. That said, sectors that are unaffected under the uniform US$75 tax rate, due to already high carbon prices (e.g., G=wholesale and retail trade and I=accommodation and food service activities), would be impacted by a parallel shift.

90. Banks' debt at risk is small on average but can be significant when lending is concentrated on sectors at high risk, such as mining and transportation. Based on supervisory data, banks' debt at risk is calculated as the share of total sectoral exposure for which ICRs drop below a threshold value.[35] Table 4 shows various configurations, assuming carbon price hikes to uniform levels of US$75 and US$150, or parallel shifts up in current prices to an average of US$75 and US$150, as well as ICR thresholds of 2 and 1. Following a uniform carbon price hike to US$150, for example, about 4 percent of all corporate bank exposures see their ICR drop below 2, while the most affected bank in the sample[36] sees around 16 percent of corporate exposures drop below the threshold.

Table 3. Norway: Banks' Corporate Debt at Risk from Higher Carbon Prices

uniform carbon price of	**$75**		**$150**	
(in percent)	drop below ICR 2	drop below ICR 1	drop below ICR 2	drop below ICR 1
all banks	2.25	2.22	4.04	3.95
most exposed bank	9.03	9.08	15.87	15.78
parallel increase of price to	**$75 average**		**$150 average**	
(in percent)	drop below ICR 2	drop below ICR 1	drop below ICR 2	drop below ICR 1
all banks	2.20	2.15	4.34	4.27
most exposed bank	8.09	8.06	16.05	16.08

Source: IMF Staff Estimate

External Demand Channel: The Impact of Higher Global Carbon Prices

91. The Norwegian economy is heavily reliant on the oil sector, which makes up roughly 16 percent of GDP, about one fifth of total investments and state revenues, and over one third of total exports. As most of the extracted oil is exported abroad, changes in external demand are likely to play a major role for the Norwegian economy, with potential implications for financial stability.

92. The impact of lower Norwegian oil sector revenues on the Norwegian economy is estimated with a specific focus on bank loan losses. Assuming a globally coordinated increase in carbon prices, estimates of global and Norwegian supply and demand curves are used to model the

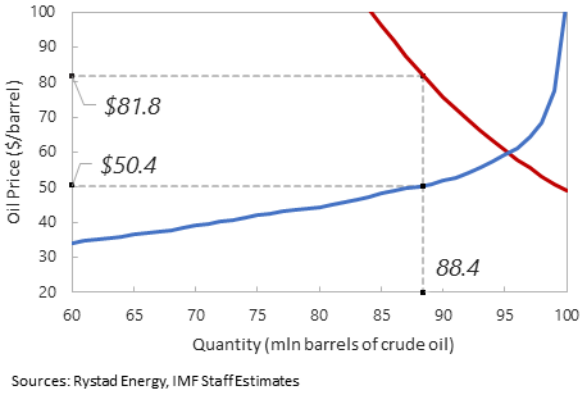
[35] Having no access to data on firm-by-firm exposures, the analysis assumes that the average firm in each sector is representative of the firms each bank is exposed to in that sector.

[36] The sample for this analysis also includes banks that are not in the scope of the FSAP's core stress tests.

change in global equilibrium prices and quantities (Figure 20). On the basis of these estimates, the change in oil supply by Norwegian producers is approximated, as is the consequent drop in their revenues. Changes in global oil markets following a US$75 carbon tax are estimated to lead to a reduction in Norwegian oil revenues of about 22 percent, while a US$150 carbon tax would lead to a reduction by more than 36 percent. This compares to a fall in revenues by about 43 percent during the 2014–16 drop in oil prices.[37, 38]

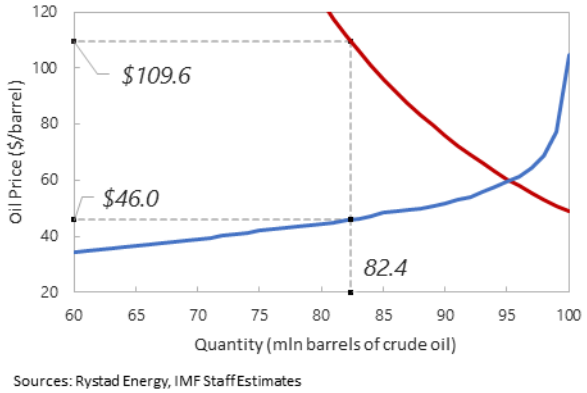
Figure 20. Norway: Global Equilibrium Quantities and Prices Following Increase of Carbon Price

Higher carbon prices would drive a wedge…



Sources: Rystad Energy, IMF Staff Estimates

…between consumer and producer prices of oil.



Sources: Rystad Energy, IMF Staff Estimates

Note: Supply curves are based on break-even prices for global oil production sites as provided by Rystad Energy. Demand curves are based on median prices elasticity of oil demand from estimates in the literature. The tax wedge is calculated on the basis of a standard estimate about embedded emissions in each barrel of oil (0.43 ton CO2/barrel) and a global carbon tax equal to either $75 or $150 per ton CO2-equivalent.

93. Such a fall in oil sector revenues leads to a significant increase in banks' and mortgage companies'[39] loan losses. Oil sector revenues are introduced into a structural vector-autoregressive model (SVAR) to better understand the interaction between the oil sector and the rest of the Norwegian economy. In the benchmark specification, the model is based on quarterly data from 2010: Q1 to 2019: Q2 for oil sector revenues, loan loss rates, GDP and the NOK/USD exchange rate. The results show that loan losses of banks and mortgage corporations exhibit a significant reaction to shocks in oil revenues (Figure 21). The maximum reaction occurs after 6 quarters and has an average size of roughly 1 standard deviation. The fall in revenues stemming from a carbon price of US$75 is estimated to increase loan losses rates by about 0.3 percentage points—a doubling from

[37] When comparing these numbers, a degree of caution is necessary, given fundamentally different assumptions about the persistence of the shock. During 2014–16, the oil price was expected to recover (to some degree), buffering investment responses. A carbon price hike, however, is likely to be seen as permanent by economic agents, leading to larger responses in consumption and investment.

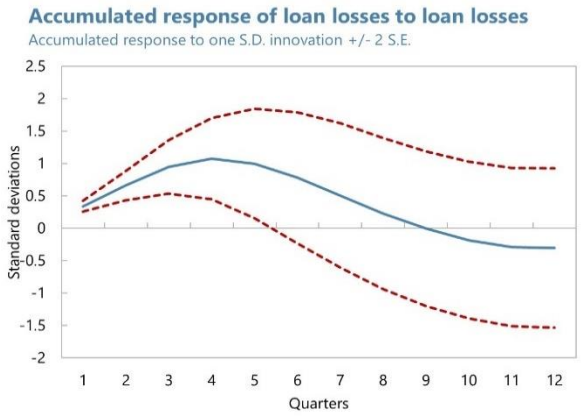
[38] The measures adopted worldwide since the first quarter of 2020 to reduce the spread of the SARS-COV-2 virus have led to a marked shift of the global oil demand curve to the left, with a consequent drastic oil price drop. The present analysis, being based on comparative statics, remains pertinent: it still provides an estimate of the potential decrease in oil revenues as a result of a carbon price shock. Assuming an initial oil price of $40 per barrel (close to the mid-2020 price for Brent oil), the reduction of producers' revenues at global level would be slightly smaller, but comparable: 21 percent with a $75/ton CO2 carbon price and 33 percent with $150 carbon price.

[39] Norwegian mortgage companies have large exposure to the oil sector through their corporate real estate portfolios. As such, any shock to the oil sector is expected to be reflected in mortgage companies' loan losses.

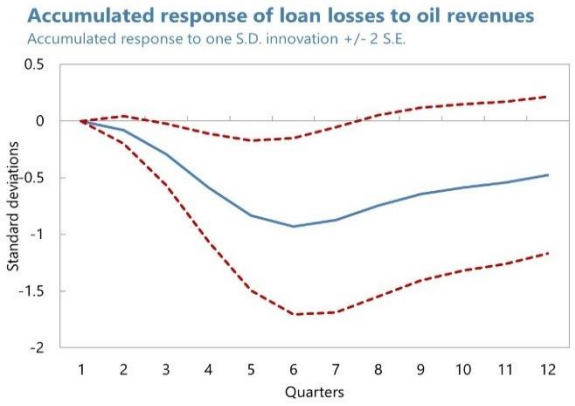
pre-COVID levels—while a carbon price of US$150 is estimated to lead to an increase by roughly 0.4 percentage points. The average loss rate stood at 0.21 percent in 2018 for the whole banking system and 0.6 percent in 2016 at the height of the problems caused by the drop in the oil price between 2014 and 2016. Robustness checks confirm the results both qualitatively and quantitatively.

Figure 21. Norway: Impulse Response Functions for Loan Losses in SVAR

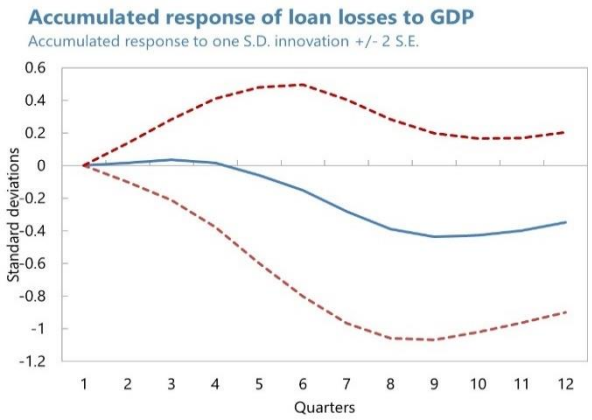
Loan losses of banks and mortgage corporations…



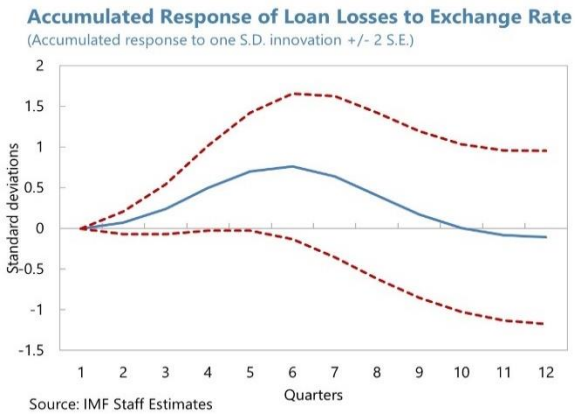
…show significant declines to a shock in oil revenues



Loan losses are resilient to a GDP shock…



…but tend to increase as the exchange rate appreciates



Note: Impulse response functions are calculated with an SVAR using quarterly data from 2010 to 2019. Series are standard-normalized and 4 lags are included. Identification is achieved through a Cholesky decomposition with the following ordering: loan losses, oil revenues, GDP, NOK/USD exchange rate.

Potential Portfolio Effects

94. While Norwegian oil producers are among the world's most advanced in terms of emissions generated during extraction (scope 1 and scope 2 emissions), high emissions are produced downstream as global consumers burn off the fossil fuels (scope 3 emissions). It is possible to envisage a scenario where climate policy forces a reduction of these scope 3 emissions by reducing the overall output generated by the oil sector. To achieve emissions that are consistent with Paris targets, the Carbon Tracker Initiative estimates that companies such as Equinor have to

reduce their overall output by about 45 percent before 2040.[40] If climate policy forces such a reduction by capping overall output generated in the oil sector, this is likely to be reflected in oil firms' valuations.[41]

95. Three scenarios are modeled to assess the impact of a forced reduction in oil production on the Norwegian economy.[42] In a first scenario, Norwegian oil majors' output is assumed to drop by 45 percent as a result of an unspecified mix of policy measures that do not entail a change in oil prices. In the remaining two scenarios, the output reduction is assumed to be partly achieved by increasing the global carbon price to US$75 or US$150. In each scenario, a given reduction of output is translated into lower earnings using an approximate breakdown of oil majors' fixed and variable costs, while the effect of the carbon price on earnings is calculated in line with the methodology of the external demand channel above.[43]

96. Climate policy to curb the oil sector's total output could reduce valuations of oil producers, implying portfolio effects for Norwegian households and asset managers. Depending on global oil prices and a firm's ability to innovate, a reduction of output by 45 percent could see an oil producer's income fall by up to 80 percent, as a result of a decreased margin over generally high fixed costs. The imposition of a carbon price of US$75–150 could further decrease output, by approximately 8-12 percent. Applying a dividend discount model, the fall in the share price for a company like Equinor is estimated to reach up to -50 percent, depending on the increase in carbon prices, as well as assumptions about the cost of capital and the growth rate of the company after the output reduction. All scenarios assume a linear reduction in output such that the desired level is reached by 2040.

97. The fall in oil-related shares can spill over to other Norwegian shares one-to-one. Using historical time-series of the Oslo Børs All-share Index and its components, other equities are found to correlate on average one-to-one with the oil sector over time horizons up to one year.[44] As a rule of thumb, this implies that a fall in oil shares could lead to an equally large drop in other Norwegian shares.

[40] Carbon Tracker Initiative (2019).

[41] If the reduction were induced, entirely or partially, by an increase in carbon pricing, oil producers' revenues could shrink further as a result of a lower producer price, as discussed in the previous analysis.

[42] Such a reduction could, for example, happen through a direct cap on the quantity of oil extracted, a limit on the greenhouse gases embedded in the extracted oil, or an assignment of allowances similar to the EU ETS. In practice, this might constrain the exploration and development of future oil fields, but might also limit extraction from existing fields.

[43] Policies that result in significant changes in output could potentially have large effects on the global oil price. Relaxing the above assumptions about the behavior of the oil price in future analysis could generate additional insight.

[44] These correlations can be largely explained by the structure of the Norwegian economy, which is not only dominated by the oil sector, but also features many industries that service the oil sector and are consequently closely tied to it.

98. Balance sheets of Norwegian households and asset managers could see meaningful impacts under this scenario. In 2018, Norwegian households on average held about 22 percent of their financial assets directly in domestic equity, and another 3 percent indirectly via their pension claims, life insurance policies, and holding of investment fund shares. Assuming that equity holdings are representative of the Oslo Børs All-share Index, the above reduction in oil production would lower the value of households' financial assets by about 12.5 percent. The same calculation for insurers and pension funds (which collectively hold 10.6 percent of their financial assets as domestic equity) would lead to a drop in the value of their portfolios in the range of 4 to 5 percent, while for non-money-market investment funds (who hold 11.7 percent of their portfolios in domestic equity), the potential drop would be between 5 and 6 percent.

99. The analysis of portfolio effects remains preliminary and is conditional on a number of assumptions. While the dynamics of oil firm valuations under a scenario of output reduction are likely to impact the balance sheets of Norwegian households and asset managers, results are to be treated as preliminary at this stage. Further work is necessary to integrate a number of side-effects into the analysis that could both weaken or strengthen the overall results.

Annex I. Risk Assessment Matrix

Nature/Source of Main Threats	Overall Level of Concern	
	Likelihood of Severe Realization of Threat in the Next 1–3 Years (high, medium, or low)	**Expected Impact on Financial Stability if Threat is Realized** (high, medium, or low)
1. Prolonged COVID-19 outbreak and more protectionism.	**High** • Extended containment measures and uncertainty about the intensity and duration of the COVID-19 outbreak reduce supply (through disruption of global value chains) and domestic and external demand, which result in a synchronized and prolonged growth slowdown globally. • Deteriorating economic fundamentals and the associated decline in risk appetite would result in a second wave of financial tightening and in debt service and refinancing difficulties for corporates and households. • Pandemic-prompted protectionist actions (such as export controls) stay in place, while weaker economic conditions re-ignite broader protectionist measures.	**Medium / High** • Reduced domestic consumption and external demand for exports along with weaker investment translates into lower domestic growth and rising unemployment. • The performance of banks' loans to corporates and households weakens significantly.
2. Widespread and prolonged real estate market downturn.	**Medium / High** • Rising unemployment due to temporary or permanent layoffs weakens already stretched household balance sheets, which leads to higher NPLs for banks and reduces bank risk appetite and the availability of credit for real estate purchases or refinancing reducing real estate market turnover. • Changes in work and shopping habits could affect CRE. • Shutdown of global funding markets for covered bonds, reduces credit available for purchase or refinancing of residential and commercial real estate, which weakens prices.	**Medium** • A substantial decline in the prices of residential and commercial real estate would weaken private consumption, lower residential and commercial investment, and lead to significant deterioration of banks' balance sheets on both asset and liability side. • A vicious feedback loop of falling house prices, higher non-performing loans, tighter bank credit, and lower activity amplifies the downturn.

Risk Assessment Matrix (Concluded)		
Nature/Source of Main Threats	**Overall Level of Concern**	
	Likelihood of Severe Realization of Threat in the Next 1–3 Years (high, medium, or low)	**Expected Impact on Financial Stability if Threat is Realized** (high, medium, or low)
3. Sharp rise in global risk premia.	**High** • Sustained rise in risk premia linked to concerns about debt sustainability globally on account of fiscal stimulus efforts by sovereigns and reduction in corporate earnings in relation to existing debt. • Political or social instability arising from extended lockdowns contributes to higher global risk premia.	**Medium** • Banks face more difficult and expensive funding conditions. • Banks' asset quality weakens sharply due to relatively high direct lending exposure to corporates. • Second round impact through slower growth on the overall quality of banks' assets.
4. Oversupply in the oil market.	**High** • Oil prices remain depressed for an extended period on account of global demand contraction. • Supply exceeds expectations due to failures of agreements between major suppliers to coordinate production cuts. • The global transition to a low- carbon economy accelerates.	**Medium** • The sharp decline in energy prices reduces demand for oil-related mainland goods and services, as in 2014–16. • Liquidity conditions tighten and lift the cost of capital. • Falling profit margins of energy-related companies weaken their debt-servicing ability and increase banks' corporate NPLs.
5. Cyber-attack.	**Low** • Cyber-security breaches and cyber-attacks engineered by state or non- state actors on a bank or critical payments infrastructure disrupt financial intermediation and the flow of goods and services.	**Medium** • Significant disruptions of banks or payment systems dent confidence in the financial system. • Individual institutions suffer large losses and potentially fail. • The cost of capital rises.

Annex II. Liquidity Stress Test—Assumptions

Annex II. Table 1. Stressed LCR: Haircut Scenarios
(In percent)

	Scenario 1	Scenario 2	Scenario 3
Total Unadjusted Liquid Assets			
Total Unadjusted Level 1 Assets			
Total unadjusted level 1 assets excluding extremely high quality covered bonds			
Coins and banknotes	100	100	100
Withdrawable central bank reserves	100	100	100
Central bank assets	100	100	100
Central government assets	100	100	95
Regional government / local authorities assets	100	95	90
Public Sector Entity assets	100	95	90
Recognisable domestic and foreign currency central government and central bank assets	100	100	100
Credit institution (protected by Member State government, promotional lender) assets	100	100	100
Multilateral development bank and international organisations assets	100	100	90
Qualifying CIU shares/units: underlying is coins/banknotes and/or central bank exposure	100	100	100
Qualifying CIU shares/units: underlying is Level 1 assets excluding extremely high quality covered bonds	95	95	85
Alternative Liquidity Approaches: Central bank credit facility	100	100	100
Central institutions: Level 1 assets excl. EHQ CB which are considered liquid assets for the depositing credit institution			
Alternative Liquidity Approaches: Inclusion of Level 2A assets recognised as Level 1	80	80	80
Total unadjusted level 1 extremely high quality covered bonds			
Extremely high quality covered bonds	93	90	85
Qualifying CIU shares/units: underlying is extremely high quality covered bonds	88	80	80
Central institutions: Level 1 EHQ covered bonds which are considered liquid assets for the depositing credit institution		80	80
Total Unadjusted Level 2 Assets			
Total unadjusted level 2A assets			
Regional government / local authorities or Public Sector Entity assets (Member State, RW20)	85	75	70
Central bank or central / regional government or local authorities or Public Sector Entity assets (Third Country, RW20)	85	80	70
High quality covered bonds (CQS2)	85	70	50
High quality covered bonds (Third Country, CQS1)	85	80	60
Corporate debt securities (CQS1)	85	80	70
Qualifying CIU shares/units: underlying is Level 2A assets	80	70	60
Central institutions: Level 2A assets which are considered liquid assets for the depositing credit institution			
Total unadjusted level 2B assets			
Asset-backed securities (residential, CQS1)	75	70	60
Asset-backed securities (auto, CQS1)	75	70	60
High quality covered bonds (RW35)	70	60	50
Asset-backed securities (commercial or individuals, Member State, CQS1)	65	60	55
Corporate debt securities (CQS2/3)	50	40	30

Annex II. Table 1. Stressed LCR: Haircut Scenarios (Concluded)

	Scenario 1	Scenario 2	Scenario 3
Corporate debt securities - non-interest bearing assets (held by credit institutions for religious reasons) (CQS1/2/3	50	30	30
Shares (major stock index)	50	25	0
Non-interest bearing assets (held by credit institutions for religious reasons) (CQS3-5)	50	50	50
Restricted-use central bank committed liquidity facilities	100	100	100
Qualifying CIU shares/units: underlying is asset-backed securities (residential or auto, CQS1)	70	60	50
Qualifying CIU shares/units: underlying is high quality covered bonds (RW35)	65	60	55
Qualifying CIU shares/units: underlying is asset-backed securities (commercial or individuals, Member State, CQS1)	60	60	60
Qualifying CIU shares/units: underlying is corporate debt securities (CQS2/3), shares (major stock index) or non-interest bearing assets (held by credit institutions for religious reasons) (CQS3-5)	45	40	35
Deposits by network member with central institution (no obligated investment)	75	75	75
Liquidity funding available to network member from central institution (non-specified collateralisation)	75	75	75
Central institutions: Level 2B assets which are considered liquid assets for the depositing credit institution			

Annex II. Table 2. Stressed LCR: Outflows Scenarios 1–4

(In percent)

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
		Regulatory	Retail	Wholesale	Combined
Outflows					
Outflows from Unsecured Transactions/Deposits					
Retail deposits					
deposits where the payout has been agreed within the following 30 days		100	100	100	100
deposits subject to higher outflows					
deposits subject to higher outflows	category 1	10	20		20
	category 2	15	30		30
stable deposits		5	10	5	10
derogated stable deposits		3	5	3	5
deposits in third countries where a higher outflow is applied					
other retail deposits		10	20	20	20
Operational deposits					
maintained for clearing, custody, cash management or other comparable services in the context of an established operational relationship					
maintained for clearing, custody, cash management or other comparable services in the context of an established operational relationship	covered by DGS	5	10	15	15
	not covered by DGS	25	25	35	35
maintained in the context of IPS or a cooperative network					
maintained in the context of IPS or a cooperative network	not treated as liquid assets for the depositing institution	25	35	25	35
	treated as liquid assets for the depositing credit institution	100	100	100	100
maintained in the context of an established operational relationship (other) with non-financial customers		25	25	35	35
maintained to obtain cash clearing and central credit institution services within a network		25	25	25	25
Non-operational deposits					
correspondent banking and provisions of prime brokerage deposits		100	100	100	100
deposits by financial customers		100	100	100	100
deposits by other customers					
deposits by other customers	covered by DGS	20	20	40	40
	not covered by DGS	40	40	60	60
Additional outflows					
collateral other than Level 1 assets collateral posted for derivatives		20	30	30	30
Level 1 EHQ Covered Bonds assets collateral posted for derivatives		10	25	25	25
material outflows due to deterioration of own credit quality		100	20	20	20
impact of an adverse market scenario on derivatives, financing transactions and other contracts					
impact of an adverse market scenario on derivatives, financing transactions and other contracts	hlba approach	100	100	100	100
	amao approach	100	100	100	100
outflows from derivatives		100	100	100	100
short positions					

Annex II. Table 2. Stressed LCR: Outflows Scenarios 1–4 (Continued)

			Scenario 1	Scenario 2	Scenario 3	Scenario 4
			Regulatory	Retail	Wholesale	Combined
short positions		covered by collateralized SFT	0	0	0	0
		other	100	100	100	100
callable excess collateral			100	100	100	100
due collateral			100	100	100	100
liquid asset collateral exchangeable for non-liquid asset collateral			100	100	100	100
loss of funding on structured financing activities						
loss of funding on structured financing activities		structured financing instruments	100	100	100	100
		financing facilities	100	100	100	100
assets borrowed on an unsecured basis			100	100	100	100
internal netting of client´s positions			50	50	50	50
Committed facilities						
credit facilities						
	to retail customers		5	10	5	10
	to non-financial customers other than retail customers		10	10	20	20
	to credit institutions					
		for funding promotional loans of retail customers	5	10	10	10
		for funding promotional loans of non-financial customers	10	20	20	20
credit facilities		other	40	60	60	60
	to regulated institutions other than credit institutions		40	75	75	75
	within a group or an IPS if subject to preferential treatment					
	within IPS or cooperative network if treated as liquid asset by the depositing institution		75	100	100	100
	to other financial customers		100	100	100	100
liquidity facilities						
	to retail customers		5	15	10	15
	to non-financial customers other than retail customers		30	40	50	50
	to personal investment companies		40	50	50	50
	to SSPEs					
		to purchase assets other than securities from non-financial customers	10	10	10	10
		other	100	100	100	100
	to credit institutions					
liquidity facilities		for funding promotional loans of retail customers	5	15	10	15
		for funding promotional loans of non-financial customers	30	40	50	50
		other	40	50	50	50
	within a group or an IPS if subject to preferential treatment					
	within IPS or cooperative network if treated as liquid asset by the depositing institution		75	100	100	100
	to other financial customers		100	100	100	100
liabilities resulting from operating expenses			0	0	0	0
in the form of debt securities if not treated as retail deposits			100	100	100	100
others			100	100	100	100

Annex II. Table 2. Stressed LCR: Outflows Scenarios 1–4 (Concluded)

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
		Regulatory	Retail	Wholesale	Combined
Outflows From Secured Lending And Capital Market-Driven Transactions					
Counterparty is central bank					
level 1 excl. EHQ Covered Bonds collateral		0	0	0	0
level 1 EHQ Covered Bonds collateral		0	0	0	0
level 2A collateral		0	0	0	0
level 2B asset-backed securities (residential or automobile, CQS1) collateral		0	0	0	0
level 2B covered bonds		0	0	0	0
level 2B asset-backed securities (commercial or individuals, Member State, CQS1) collateral		0	0	0	0
other Level 2B assets collateral		0	0	0	0
non-liquid assets collateral		0	0	0	0
Counterparty is non-central bank					0
level 1 excl. EHQ Covered Bonds collateral		0	0	0	0
level 1 EHQ Covered Bonds collateral		7	7	7	7
level 2A collateral		15	15	15	15
level 2B asset-backed securities (residential or automobile, CQS1) collateral		25	25	25	25
level 2B covered bonds		30	30	30	30
level 2B asset-backed securities (commercial or individuals, Member State, CQS1) collateral		35	35	35	35
other Level 2B assets collateral		50	50	50	50
non-liquid assets collateral					0
non-liquid assets collateral	counterparty is central govt, PSE<=RW20, MDB	25	25	25	25
	other counterparty	100	100	100	100

Annex II. Table 3. Stressed LCR: Outflows Scenarios 5–7

(In percent)

		Scenario 5	Scenario 6	Scenario 7
		FSA/Norges Bank: severe domestic	FSA/Norges Bank: severe foreign	FSA/Norges Bank: idiosyncratic
Outflows				
Outflows from Unsecured Transactions/Deposits				
Retail deposits				
deposits where the payout has been agreed within the following 30 days		100	100	100
deposits subject to higher outflows				
deposits subject to higher outflows	category 1	15	3	30
	category 2	20	5	40
stable deposits		5	2	10
derogated stable deposits		5	3	10
deposits in third countries where a higher outflow is applied				
other retail deposits		10	3	20
Operational deposits				
maintained for clearing, custody, cash management or other comparable services in the context of an established operational relationship				
maintained for clearing, custody, cash management or other comparable services in the context of an established operational relationship	covered by DGS	5	5	10
	not covered by DGS	25	25	40
maintained in the context of IPS or a cooperative network				
maintained in the context of IPS or a cooperative network	not treated as liquid assets for the depositing institution	35	35	40
	treated as liquid assets for the depositing credit institution	100	100	100
maintained in the context of an established operational relationship (other) with non-financial customers		25	25	40
maintained to obtain cash clearing and central credit institution services within a network		25	25	40
Non-operational deposits				
correspondent banking and provisions of prime brokerage deposits		100	100	100
deposits by financial customers		100	100	100
deposits by other customers				
deposits by other customers	covered by DGS	20	8	40
	not covered by DGS	40	10	60
Additional outflows				
collateral other than Level 1 assets collateral posted for derivatives		30	30	30
Level 1 EHQ Covered Bonds assets collateral posted for derivatives		25	25	25
material outflows due to deterioration of own credit quality		0	0	100
impact of an adverse market scenario on derivatives, financing transactions and other contracts				
impact of an adverse market scenario on derivatives, financing transactions and other contracts	hlba approach	150	150	0
	amao approach	150	150	0
outflows from derivatives		100	100	100
short positions				
short positions	covered by collateralized SFT	0	0	0
	other	100	100	100

Annex II. Table 3. Stressed LCR: Outflows Scenarios 5–7 (Continued)

			Scenario 5	Scenario 6	Scenario 7
			FSA/Norges Bank: severe domestic	FSA/Norges Bank: severe foreign	FSA/Norges Bank: idiosyncratic
	callable excess collateral		100	100	100
	due collateral		100	100	100
	liquid asset collateral exchangable for non-liquid asset collateral		100	100	100
	loss of funding on structured financing activites				
	loss of funding on structured financing activites	structured financing instruments	100	100	100
		financing facilites	100	100	100
	assets borrowed on an unsecured basis		100	100	100
	internal netting of client´s positions		50	50	50
Committed facilities					
	credit facilities				
		to retail customers	5	3	3
		to non-financial customers other than retail customers	10	5	5
		to credit institutions			
	credit facilities	for funding promotional loans of retail customers	10	10	10
		for funding promotional loans of non-financial customers	20	20	20
		other	40	40	40
		to regulated institutions other than credit institutions	40	40	40
		within a group or an IPS if subject to preferential treatment			
		within IPS or cooperative network if treated as liquid asset by the depositing institution	100	100	100
		to other financial customers	40	40	20
	liquidity facilities				
		to retail customers	5	3	2
		to non-financial customers other than retail customers	30	5	10
		to personal investment companies	70	70	70
		to SSPEs			
		to purchase assets other than securities from non-financial customers	10	10	10
		other	100	100	100
		to credit institutions			
	liquidity facilities	for funding promotional loans of retail customers	10	10	10
		for funding promotional loans of non-financial customers	20	20	20
		other	50	50	50
		within a group or an IPS if subject to preferential treatment			
		within IPS or cooperative network if treated as liquid asset by the depositing institution	100	100	100
		to other financial customers	100	100	50
	liabilities resulting from operating expenses		0	0	0
	in the form of debt securities if not treated as retail deposits		100	100	100
	others		100	100	100

Annex II. Table 3. Stressed LCR: Outflows Scenarios 5–7 (Concluded)

		Scenario 5	Scenario 6	Scenario 7
		FSA/Norges Bank: severe domestic	FSA/Norges Bank: severe foreign	FSA/Norges Bank: idiosyncratic
Outflows From Secured Lending And Capital Market-Driven Transactions				
Counterparty is central bank				
level 1 excl. EHQ Covered Bonds collateral		0	0	0
level 1 EHQ Covered Bonds collateral		0	0	0
level 2A collateral		0	0	0
level 2B asset-backed securities (residential or automobile, CQS1) collateral		0	0	0
level 2B covered bonds		0	0	0
level 2B asset-backed securities (commercial or individuals, Member State, CQS1) collateral		0	0	0
other Level 2B assets collateral		0	0	0
non-liquid assets collateral		0	0	0
Counterparty is non-central bank				
level 1 excl. EHQ Covered Bonds collateral		0	0	0
level 1 EHQ Covered Bonds collateral		15	15	0
level 2A collateral		20	20	0
level 2B asset-backed securities (residential or automobile, CQS1) collateral		25	25	0
level 2B covered bonds		30	30	0
level 2B asset-backed securities (commercial or individuals, Member State, CQS1) collateral		50	50	0
other Level 2B assets collateral		50	50	0
non-liquid assets collateral				
non-liquid assets collateral	counterparty is central govt, PSE<=RW20%, MDB	25	25	0
	other counterparty	100	100	0

Annex II. Table 4. Cashflow Analysis: Run-off Rates for Outflows

(In percent)

	Mildly adverse					Severely adverse				
	1 to 7 days	7 days up to 30 days	30 days to 90 days	90 days to 180 days	180 days to 365 days	1 to 7 days	7 days up to 30 days	30 days to 90 days	90 days to 180 days	180 days to 365 days
Liabilities resulting from securities issued (if not treated as retail deposits)										
Unsecured bonds due	50	50	50	50	50	75	75	65	55	50
Regulated covered bonds	50	50	50	50	50	65	65	55	55	50
Securitisations due	50	50	50	50	50	75	75	65	55	50
Other	50	50	50	50	50	75	75	65	55	50
Liabilities resulting from secured lending and capital market driven transactions collateralised by:										
Level 1 tradable assets										
Level 1 excluding covered bonds	0	0	0	0	0	0	0	0	0	0
Level 1 covered bonds (CQS1)	0	0	0	0	0	10	10	10	10	10
Level 2A tradable assets										
Level 2A corporate bonds (CQS1)	15	15	15	15	15	30	30	30	30	30
Level 2A covered bonds (CQS1, CQS2)	15	15	15	15	15	30	30	30	30	30
Level 2A public sector (CQS1, CQS2)	15	15	15	15	15	30	30	30	30	30
Level 2B tradable assets										
Level 2B ABS (CQS1)	25	25	25	25	25	50	50	50	50	50
Level 2B covered bonds (CQS1-6)	25	25	25	25	25	50	50	50	50	50
Level 2B: corporate bonds (CQ1-3)	25	25	25	25	25	50	50	50	50	50
Level 2B shares	25	25	25	25	25	50	50	50	50	50
Level 2B public sector (CQS 3-5)	25	25	25	25	25	50	50	50	50	50
Other tradable assets	50	50	50	50	50	100	100	100	100	100
Other assets	50	50	50	50	50	100	100	100	100	100
Liabilities not reported in 1.2, resulting from deposits received (excluding deposits received as collateral)										
Stable retail deposits - sight deposits	8.0					10.0				
Stable retail deposits - term deposits	6.0	4.0	2.0	0.0	0.0	8.0	6.0	4.0	2.0	0.0
Other retail deposits - sight deposits	14					30				
Other retail deposits - term deposits	8	4	2	0	0	10	8	6	4	2
Operational deposits	8	6	4	2	0	12	10	8	4	2
Non-operational deposits from credit institutions	30	25	15	15	10	60	50	30	30	20
Non-operational deposits from other financial customers	30	25	15	15	10	60	50	30	30	20
Non-operational deposits from central banks	0	0	0	0	0	0	0	0	0	0
Non-operational deposits from non-financial corporates	10	10	10	10	10	20	20	20	20	20
Non-operational deposits from other counterparties	10	10	10	10	10	20	20	20	20	20
FX-swaps maturing	20	20	20	20	20	40	40	40	40	40
Derivatives amount payables other than those reported in 1.4	20	20	20	20	20	40	40	40	40	40
Outflows from committed facilities										
Committed credit facilities	10	10	10	10	10	20	20	20	20	20
Liquidity facilities	15	15	15	15	15	30	30	30	30	30
Outflows due to downgrade triggers	0	0	0	0	0	50	50	50	50	50
Other outflows	50	50	50	50	50	75	75	75	75	75

Annex II. Table 5. Cashflow Analysis: Roll-off Rates for Inflows

(In percent)

	Mildly adverse					Severely adverse				
	1 to 7 days	7 days up to 30 days	30 days to 90 days	90 days to 180 days	180 days to 365 days	1 to 7 days	7 days up to 30 days	30 days to 90 days	90 days to 180 days	180 days to 365 days
Monies due from secured lending and capital market driven transactions collateralised by:										
Level 1 tradable assets										
Level 1 excluding covered bonds	100	100	100	100	100	80	80	80	80	80
Level 1 excluding covered bonds: Level 1 central bank										
Level 1 excluding covered bonds: Level 1 (CQS 1)										
Level 1 excluding covered bonds: Level 1 (CQS2, CQS3)										
Level 1 excluding covered bonds: Level 1 (CQS4+)										
Level 1 covered bonds (CQS1)	100	100	100	100	100	80	80	80	80	80
Level 2A tradable assets										
Level 2A corporate bonds (CQS1)	100	100	100	100	100	80	80	80	80	80
Level 2A covered bonds (CQS1, CQS2)	100	100	100	100	100	80	80	80	80	80
Level 2A public sector (CQS1, CQS2)	100	100	100	100	100	80	80	80	80	80
Level 2B tradable assets										
Level 2B ABS (CQS1)	100	100	100	100	100	80	80	80	80	80
Level 2B covered bonds (CQS1-6)	100	100	100	100	100	80	80	80	80	80
Level 2B: corporate bonds (CQ1-3)	100	100	100	100	100	80	80	80	80	80
Level 2B shares	100	100	100	100	100	80	80	80	80	80
Level 2B public sector (CQS 3-5)	100	100	100	100	100	80	80	80	80	80
Other tradable assets	100	100	100	100	100	80	80	80	80	80
Other assets	100	100	100	100	100	80	80	80	80	80
Monies due not reported in 2.1 resulting from loans and advances granted to:										
Retail customers	37	37	30	30	30	37	37	30	30	30
Non-financial corporates	37	37	30	30	30	37	37	30	30	30
Credit institutions	100	90	60	50	50	80	50	40	30	30
Other financial customers	100	90	60	50	50	80	50	40	30	30
Central banks	100	100	100	100	100	100	100	100	100	100
Other counterparties	30	30	30	30	30	0	0	0	0	0
FX-swaps maturing	50	50	50	50	50	15	15	15	15	15
Derivatives amount receivables other than those reported in 2.3	50	50	50	50	50	25	25	25	25	25
Paper in own portfolio maturing	100	100	100	100	100	80	80	80	80	80
Other inflows	100	100	100	100	100	80	80	80	80	80

Annex II. Table 6. Cashflow Analysis: Haircuts for Counterbalancing Capacity and Conversion Factors for Committed Facilities Received

(In percent)

Withdrawable central bank reserves	Mildly adverse	Severely adverse
Level 1 tradable assets		
Level 1 excluding covered bonds	3	10
Level 1 covered bonds (CQS1)	7	10
Level 2A tradable assets		
Level 2A corporate bonds (CQS1)	15	20
Level 2A covered bonds (CQS1, CQS2)	15	20
Level 2A public sector (CQS1, CQS2)	15	20
Level 2B tradable assets		
Level 2B ABS (CQS1)	25	40
Level 2B covered bonds (CQS1-6)	30	50
Level 2B: corporate bonds (CQ1-3)	50	75
Level 2B shares	50	75
Level 2B public sector (CQS 3-5)	20	30
Other tradable assets		
Central government (CQS1)	25	40
Central government (CQS 2 & 3)	35	50
Shares	50	80
Covered bonds	30	50
ABS	30	50
Other tradable assets	40	60
Non tradable assets eligible for central banks	50	80
Undrawn committed facilities received		
Level 1 facilities	80	90
Level 2B restricted use facilities	50	75
Level 2B IPS facilities	50	75
Other facilities		
Other facilities — From intragroup counterparties	100	100
Other facilities — From other counterparties	10	20

Annex III. Industry Classification Used for the Satellite Models of NPL Ratios in the Corporate Sector

A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply, sewerage, waste management and remediation activities
F	Construction
G	Wholesale and retail trade, repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defense; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities

Domain		Bottom-Up Stress Test by Banks	Top-Down Stress Tests by FSA and Norges Bank (NB)	Top-Down Stress Test by FSAP Team
Banking Sector: Solvency Risk				
1. Institutional Perimeter	Market Share of Institutions Included	• 3 banks in scope of account for 45 percent of the NO banking sector by assets (60 percent of total assets held by domestically incorporated banks): DNB Bank, SpareBank 1 SR-Bank, Sparebanken Vest.	• FSA: 20 banking groups included in ST account for about 77 percent of Norwegian banks' aggregate total assets at end-2018. Additional analysis on sample identical to FSAP (11 banks). • NB: One "macro bank" comprising nine large banks (about 60 percent of NO banking market by assets): DNB Bank, SpareBank 1 SR-Bank, Sparebanken Vest, SpareBank 1 SMN, Sparebanken Sor, SpareBank 1 Ostland, SpareBank 1 Nord-Norge, Sbanken and Sparebanken More.	• ST comprises 11 largest domestic banks which hold approximately 60.5 percent of domestic banking sector assets. The ST does not include branches of foreign banks operating in Norway.
	Data Source/ Baseline Date	• Internal audited data (where available) and other internal data. • Baseline date: June 30, 2019.	• Data from CRD IV reporting, reporting of banks' corporate client exposures, and other supervisory and public data sources. • Baseline date: June 30, 2019.	• Supervisory and publicly available data. • Baseline date: June 30, 2019.
2. Channels of Risk Propagation	Approach	• Balance sheet-based approach.	• FSA: Balance-sheet approach based on consolidated data (source: FINREP), covering 20 banking groups. • FSA: For distribution of loan losses: unconsolidated data (source: ORBOF) covering smaller banks. • NB: Balance sheet-based approach based on consolidated public accounts, delivered by SNL/S&P MI.	• Balance sheet-based approach.
	Satellite Models for Macro-Financial Linkages		• FSA: Total loan losses generated by proprietary macro model and assigned to individual banks according to risk in loan books. • NB: Satellite models for loan losses.	• Satellite models for PDs, LGDs, and NPL ratios for credit losses.
			• FSA: Satellite-proxy PD model for distribution of loan losses on loans to NFC. • FSA: Satellite model for market risk. • NB: Banks' loan losses in the stress scenario follow "rule of thumb" for total losses on corporate and household loans as a function of GDP developments.	• Market losses from holdings of debt instruments (sovereign and other) based on modified duration and shocks to rates as assumed under scenarios.
			• FSA: Non-interest income projections based on growth in total assets. • FSA: NII developments based on output from macro model and expert judgement.	• Non-interest income projections based on nominal GDP growth and expert judgment.
	Horizon	• 3 years (2020–2022).		

Annex IV. Banking Sector Stress Testing Matrix (STeM) (Continued)

Domain		Bottom-Up Stress Test by Banks	Top-Down Stress Tests by FSA and Norges Bank (NB)	Top-Down Stress Test by FSAP Team
Banking Sector: Solvency Risk				
3. Tail Shocks	Scenario Analysis	• Scenario-based tests, that assess the impacts on the entire portfolio including the loans and, if applicable, the trading book. The COVID scenarios have been used exclusively in the FSAP team exercise.		
		• The COVID central scenario is based on a preliminary version of the June 2020 WEO projections. The Market Shock and COVID downside scenarios are based on a given deviation of GDP from its long-term trend and COVID central, respectively. They all involve a series of domestic and global macroeconomic and financial variables.		
		• The Market Shock Scenario is simulated using the IMF's Flexible System of Global Models for the global variables and Norges Bank's NEMO model for Norwegian variables. For the COVID scenarios the paths of most variables are obtained as conditional forecasts in a Vector AutoRegression conditional on the June 2020 WEO projections for GDP, unemployment and inflation, plus the WEO forecast for the oil price. A few remaining variables (e.g., interest rates) are calibrated judgmentally.		
		• All scenarios are driven by a combination of external shocks and amplified by domestic characteristics. They include existing vulnerabilities and policy constraints.		
		• Under the Market Shock Scenario, the Norwegian economy goes through an L-shaped growth path, with annual GDP growth of -1.94 percent, -3.27 percent, and +0.51 percent during 2020, 2021, and 2022, respectively. This corresponds to a cumulative deviation of real GDP growth of close to -9 percentage points over the first two years compared to the long-term trend (almost 3 standard deviations). The COVID scenarios are based on a growth path with a different profile: in both scenarios GDP bottoms out in the second quarter of 2020, but at different depths and speed of subsequent rebound. In particular, under the COVID central GDP growth is -5.5, 3.8, and 3.3 percent in 2020, 2021, and 2022, respectively; under the COVID downside it is -7.1, 2.6, and 0.6 percent in the three years, respectively. The drop of GDP in the first year corresponds to a divergence from the long-term growth path of more than 4 and 5 standard deviations under the COVID central and downward scenarios, respectively.		
		• This economic slowdown is accompanied by an increase in the unemployment rate of close to 6 percentage points over the 3-year horizon under the Market Shock , and of approximately 1 and 1.6 percent under the COVID central and COVID downside scenarios, respectively (after peaking at 4.7 and 5.3 percentage points above 2019 in 2020, respectively). The cumulative house price decline reaches -35 percent over the risk horizon under the Market Shock scenario, while under the two COVID scenarios house prices record a cumulative growth of 16.2 (central) and 11.6 percent (downside).		
		• In all scenarios NOK depreciates by 8.7 percent in the first year, leading to a cumulative appreciation / depreciation of 10.7 percent at the end of the third year.		

Annex IV. Banking Sector Stress Testing Matrix (STeM) (Continued)

Domain		Bottom-Up Stress Test by Banks	Top-Down Stress Tests by FSA and Norges Bank (NB)	Top-Down Stress Test by FSAP Team
Banking Sector: Solvency Risk				
3. Tail Shocks	Behavioral Adjustments	• Passive balance sheet assumption: - Balance sheets are assumed to be static, apart from credit growth, which is linked to nominal GDP growth. - Balance sheet composition remains constant throughout the stress test horizon. - The rate of increase of lending and funding is applied as of the end of the previous period, without taking into account the impact of defaulted exposures and the stock of outstanding loans during the current period. - Asset disposals and acquisitions are not permitted, except where in line with aggregate credit growth. - Banks' credit portfolio composition is assumed to remain unchanged.		
		• Capital increases are not permitted, unless these were approved prior to the cut-off date.		
		• Defaulted exposures do not generate interest income after they become impaired.		
		• Dividend payouts made according to the most recent payout experience in case of positive net income and no payouts in case of negative net income.	• Banks are assumed to make dividend payouts of 50 percent for periods with positive net income and no payouts in case of negative net income (no dividend payouts in the whole stress period in the NB exercise).	• Dividend payouts made according to the most recent payout experience in case of positive net income and no payouts in case of negative net income.
	Sensitivity Analysis	• Sensitivity analyses are conducted to supplement the scenario analysis. They evaluate impacts of single risk factors (one at a time) on the existing capital buffers: - FX shock - Interest Rate Risk in the Banking Book (IRRBB) - Credit concentration risk.		
				• Climate change transition risks

Annex IV. Banking Sector Stress Testing Matrix (STeM) (Continued)

Domain		Bottom-Up Stress Test by Banks	Top-Down Stress Tests by FSA and Norges Bank (NB)	Top-Down Stress Test by FSAP Team
Banking Sector: Solvency Risk				
4. Regulatory and Market- Based Standards and Parameters	Calibration of Risk Parameters			• Projected losses distributed across different asset classes.
				• Point in time credit risk proxies/parameters calibrated by FSAP team.
	Regulatory/ Accounting and Market-Based Standards		• FSA: National framework.	• National framework.
			• FSA: Hurdle rates: CET1, Tier 1, and total capital ratios, including SRB and D-SIB buffers and Pillar 2 requirements; leverage ratio, including 2 percent buffer and additional (1 percent) buffer for D-SIBs.	• Hurdle rates: CET1, Tier 1, and total capital ratios, including SRB and D-SIB buffers and Pillar 2 requirements; leverage ratio, including 2 percent buffer and additional (1 percent) buffer for D-SIBs.
5. Reporting Format for Results	Output presentation		• FSA: System-wide capital shortfall.	• System-wide capital shortfall.
			• FSA: Number of banks and percentage of banking system assets in the system that fall below the capital hurdle. Norges Bank: CET1 ratios for the 'macro' bank and for each of the 9 banks comprising the 'macro' bank are reported. •	• Number of banks and percentage of banking system assets in the system that fall below the capital hurdle.
			• FSA: Impact of different result drivers, including profit components, losses due to realization of different risk factors.	• Impact of different result drivers, including profit components, losses due to realization of different risk factors.

Annex IV. Banking Sector Stress Testing Matrix (STeM) (Continued)

Domain		Bottom-up Stress Test by Banks	Top-down Stress Tests by FSA and Norges Bank (NB)	Top-down Stress Test by FSAP Team
Banking Sector: Liquidity Risk				
1. Institutional Perimeter.	Market Share of Institutions Included		• Stress test can be run on all Norwegian banks (unconsolidated). The model also includes links between banks and covered bond companies. • FSA and Norges Bank are collaborating on developing a liquidity stress testing framework for Norwegian banks and mortgage companies.	• ST comprises 11 largest domestic banks which hold approximately 60.5 percent of domestic banking sector assets. • Based on data availability, foreign branches could partially be involved into the exercise
2. Channels of Risk	Data Source and Baseline Date		• CRD IV— LCR and NSFR • Non-CRD IV reporting—Balance sheet data, "Refinancing under stress."	• Supervisory and publicly available data.
			• Baseline date: June 30, 2019.	
	Methodology		• Cash flow analysis of inflows and outflows from assets, liabilities and off-balance sheet items.	• Cash-flow based liquidity stress test using maturity buckets. • Basel III LCR and NSFRs. • Separate analysis for NOK, EUR and USD.
3. Risks and Buffers	Risks		• Model tests different scenarios: • Bank-specific stress, such as bank ratings downgrade. • Domestic/global market stress triggering house price decline and NOK depreciation.	• Shock to funding (stressed outflow and inflow factors) and available liquidity (haircuts).
	Buffers		• Banks' liquidity reserves with haircuts. • LCR buffer. • Extended liquidity reserve (includes non-LCR available securities and bank deposits). • Possible new issuances of covered bonds (where loans are readily available for transfer to the CB company and/or there are free cover pool assets within the CB company).	• Available and unencumbered liquid assets.

Annex IV. Banking Sector Stress Testing Matrix (STeM) (Continued)

Domain		Bottom-up Stress Test by Banks	Top-down Stress Tests by FSA and Norges Bank (NB)	Top-down Stress Test by FSAP Team
Banking Sector: Liquidity Risk				
4. Tail shocks	Size of Shock		• Projections are based on the expected behavior of banks, customers and depositors as well as other banks and market actors.	• Run-off rates calculated following historical events and based on IMF methodology (for cash flow analysis).
			• The stress factors are generally applied for a 30-day period. The model assumes declining stress. The same stress factors are applied for the next period (day 30 to 90) and reduced to zero after three months.	• Bank run and dry up of wholesale funding markets, taking into account haircuts to liquid assets.
5. Regulatory and Market-Based Standards and Parameters	Regulatory Standards		• National regulatory framework.	
			• LCR: 100 percent, consistent with Basel III LCR framework. • NOK LCR: 50 percent (only applies to seven largest banks).	
6. Reporting Format for Results	Output Presentation		• Survival horizon – time from initial event to net liquidity < 0. • Net liquidity equals the difference between financing gap and the bank's liquidity reserves.	• System-wide liquidity gaps.

Annex IV. Banking Sector Stress Testing Matrix (STeM) (Concluded)

Domain		Bottom-up Stress Test by Banks	Top-down Stress Test by Norges Bank (NB)	Top-down Stress Test by FSAP Team
Banking Sector: Interconnectedness				
1. Institutional Perimeter	Institutions Included		• 20 institutions for which there is data coverage (including 11 largest).	• Largest 11 banks which hold approximately 60.5 percent of the domestic banking sector assets.
	Data Source and Baseline Date		• Source: Supervisory data. • Baseline date: June 30, 2019.	• Source: Supervisory data. • Baseline date: June 30, 2019.
2. Channels of Risk Propagation	Methodology		• Combined direct and indirect contagion model based on Cont and Schaaning (2017) and Hueser et al. (2017).	• Balance sheet-based interbank model by Espinosa-Vega and Solé (2010). • Market price-based spillover model by Diebold and Yilmaz (2014). • Cross-border network model by Espinosa-Vega and Solé (2010).
3. Risks and Buffers	Risks		• Risk of indirect contagion due to price impact from fire sales of cross holdings, risk of direct contagion due to potential bail-in of MREL cross-holdings.	• Credit and funding losses related to interbank cross-exposures (and cross-border banking exposures).
	Buffers		• Banks' own capital buffers.	• Banks' own capital and liquidity buffers.
4. Tail Shock	Size of the Shock		• Initial shock results from top-down stress test and may trigger funding difficulties.	• Pure contagion: Assumed failure of institutions.
5. Reporting Format for Results	Output Presentation		• Contagion analysis: additional amplification (pp of CET1 ratio) of shock from solvency stress test.	• Network analyses with supervisory data. • System-wide capital shortfall. • Number of undercapitalized and failed institutions, and their shares of assets in the system. • Evolution and direction of spillovers.