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September 2015

TECHNICAL NOTE—STRESS TESTING THE BANKING SECTOR

This Technical Note on Stress Testing The Banking Sector for Norway was prepared by a staff team of the International Monetary Fund. It is based on the information available at the time it was completed in August 2015.

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August 17, 2015

TECHNICAL NOTE

STRESS TESTING THE BANKING SECTOR

Prepared by
Monetary and Capital Markets Department

This Technical Note was prepared by IMF staff in the context of the Financial Sector Assessment Program in Norway. It contains technical analysis and detailed information underpinning the FSAP's findings and recommendations. Further information on the FSAP can be found at: http://www.imf.org/external/np/fsap/fssa.aspx.

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Glossary

ADL	Autoregressive Distributed Lag (Model)
AFS	Available for Sale
BU	Bottom-up (Stress Test)
CCB	Countercyclical Buffer
CET-1 (Ratio)	Common Equity Tier 1 (Ratio)
CRD IV	Capital Requirements Directive IV (of the EU)
D-SIB	Domestic Systemically Important Bank
EBA	European Banking Authority
ECM	Error Correction Model
FSA	Finanstilsynet (Financial Supervisory Authority of Norway)
FSAP	Financial Sector Assessment Program
FSI	Financial Soundness Indicator
FX	Foreign Exchange
GAM	Generalized Additive Model
GDP	Gross Domestic Product
GPFG	Government Pension Fund Global
GRAM	Global Risk Assessment Matrix
HQLA	High-quality Liquid Asset
IMF	International Monetary Fund
IRB	Internal Ratings Based (Approach under Basel)
LCR	Liquidity Coverage Ratio
LGD	Loss Given Default
LTV	Loan-to-value Ratio
NB	Norges Bank
NPL	Nonperforming Loan
NOK	Norwegian Krone
NSFR	Net Stable Funding Ratio
PD	Probability of Default
P/L (Statement)	Profit and Loss (Statement)
RAM	Risk Assessment Matrix
ROA	Return on Assets
ROE	Return on Equity
RWA	Risk Weighted Assets
TD	Top-down (Stress Test)
TTC	Through-the-cycle (PDs)
WEO	World Economic Outlook

EXECUTIVE SUMMARY[1]

The Norwegian banking sector is generally well prepared to cope well with possible external shocks, but imbalances have built up in recent years and could pose challenges. Strong real mainland GDP growth, and high oil production and exports since the 2008 crisis have supported high credit quality and healthy bank profitability, despite a decline in interest margins.[2] Profit retention and equity issuance have accounted for the build-up of additional capital in the system. Banks' capitalizations were also propped up by risk-weight reductions for banks adopting the Basel II internal ratings-based (IRB) approach, even though the authorities have curbed excessive reductions via regulatory measures. The economic outlook under the baseline is expected to continue to support limited credit risks and strong profitability. However, the build-up of imbalances that began before the 2008 crisis—including the rise in household and corporate leverage—poses challenges. Banks' dependence on wholesale funding also remains high, even though banks have increased maturities—including of foreign borrowing—following funding pressures during the 2008 crisis.

The FSAP stress testing exercise included a comprehensive analysis of solvency and liquidity risks in the banking sector. The assessment was carried out in close collaboration with the authorities, and included three parallel top-down (TD) solvency stress tests by the Financial Supervisory Authority of Norway (FSA), Norges Bank (NB) and the FSAP team, using different methodologies but based on the same macroeconomic scenarios. These were complemented by bottom-up (BU) tests, carried out by individual banks on an unconsolidated and consolidated basis (the latter accounting for associated mortgage companies) and subject to the same scenarios. The liquidity stress tests were carried out by the FSAP team, and included assessments of banks' ability to withstand funding pressures in local and foreign currencies in the context of the Liquidity Coverage Ratio (LCR) under the Basel III and CRD IV liquidity frameworks.

The transmission of macroeconomic shocks in the solvency stress tests was captured via two versions of an adverse scenario and a baseline scenario of the projected path of the economy. The scenarios were constructed by the FSAP team in cooperation with NB. The adverse scenarios assume considerable negative deviations of economic activity from the baseline path over a five–year risk horizon, with hurdle rates based on the accelerated Basel III implementation schedule adopted by the Norwegian authorities. These scenarios reflect potential medium-term downside risks for banks related to a global slowdown, persistence of oil prices well below current WEO projections, and a sharp real house price correction. As a result of these shocks, banks experience pressures on their earning capacity, due to rising asset impairments and narrowing of interest margins in light of stronger competition for good credits. The first adverse scenario assumes no

[1] Prepared by Ms. Silvia Iorgova (MCM).

[2] Mainland GDP accounts for all domestic economic activity, except the extraction of oil and natural gas, services activities related to oil and gas, transport via pipelines and ocean transport.

policy response, while the second assumes monetary policy easing by the authorities. The baseline scenario is based on IMF staff projections as of December 2014, estimated in part via NB's macro model. The adverse scenarios are broadly in line, albeit of longer duration, with recent scenarios of the FSA and NB.

The stress test results show that while the banking sector is highly resilient, it could experience challenges in case of severe macroeconomic shocks, as assumed in the adverse scenarios. Banks' strong starting point, given sizable capital buffers, coupled with sound profitability and very low asset impairment levels, account for continued bank resilience under the projected baseline. In the baseline, the aggregate Common Equity Tier 1 (CET-1) capital ratio rises gradually to 14.0–16.7 percent by end–2019, from 12.5–13.3 percent at end–2014 (depending on methodology). However, a combination of severe shocks—including persistently low oil prices and a sharp contraction in house prices—under the adverse scenarios, could result in an aggregate capital shortfall of up to 4.6 percent of GDP over five years. BU stress tests produced considerably lower gaps, which could reflect underestimation of credit risks by individual banks. The authorities and the FSAP team viewed this as justifying the need for discretion, including through Pillar 2, to ensure the sufficiency of existing capital buffers.

The stress tests also illustrate that the banking system remains vulnerable to liquidity risks, due in part to scarce liquidity buffers in Norwegian krone. While covered bond issuance at longer maturities has increased funding stability (especially in foreign currencies) since the 2008 global financial crisis, banking groups face liquidity gaps in Norwegian krone (NOK) both under the baseline and in case of potential disruption of either secured or unsecured wholesale funding. Moreover, Norwegian banking groups are exposed to maturity mismatches and rollover risks, due to their reliance on currency swaps, which they use extensively to convert foreign currency (FX) wholesale funding (mostly of longer maturity) and finance NOK assets.

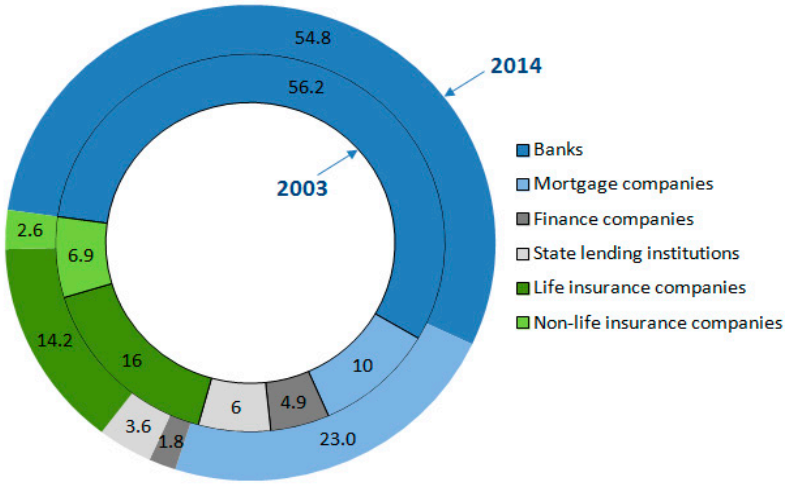
The authorities are encouraged to continue enhancing their stress testing frameworks and taking further steps to boost banks' resilience. Given the low sensitivities of household default measures to changes in macroeconomic conditions—and limited variability and short data spans of credit risk metrics—the authorities could consider supplementing their frameworks with models based on international experience. Moreover, the possible underestimation of risks in the BU stress tests warrants further cross-validation of results from the TD and the BU exercises. In this regard, continued use of supervisory discretion on the sufficiency of banks' capital buffers, especially the capital conservation buffer, would be important to ensure banks' resilience. Finally, while the supervisory liquidity stress testing framework has been applied effectively to monitor liquidity risks, the authorities could consider further steps, such as performing stress tests using the structure of cash flows at various maturities, or performing customized versions of the LCR more closely aligned with banks' funding profiles.

INTRODUCTION

A. Background

1. Banks play a dominant role in the Norwegian financial system, but the banking sector is smaller than in other Nordic countries (Figure 1). Banks, jointly with mortgage companies which they mostly own, accounted for 78 percent of total financial system assets at end–2014 (Figure 1). Mortgage companies have grown at a particularly fast pace, from 10 percent of total assets at end–2003 to 23 percent at end–2014, supported by considerable issuance of covered bonds through these entities after 2007.[3] The banking sector is also highly concentrated, with the largest bank—DNB Group ASA (DNB)—accounting for about 35 percent of aggregate banking sector assets, and the largest seven banks, comprising 75 percent of assets. Foreign (mostly Nordic) financial conglomerates have a sizable presence in Norway, both in the form of subsidiaries and as branches, accounting for more than 20 percent of aggregate assets. However, Norwegian banks remain mostly domestically oriented, with limited presence overseas. In addition, there are many small banks that operate under specific local economic environments.

Figure 1. Structure of the Financial System
(In percent of total assets)



Source: Statistics Norway.

[3] The rapid growth of mortgage companies was fostered by the adoption of covered bond market legislation in 2007, and the introduction of a government-led swap arrangement (allowing banks to swap covered bonds for Treasury bills) during the 2008 crisis. Mortgage companies issue covered bonds to fund the transfer of mortgage loans from parent banks.

2. Banks have been subject to limited credit risks in recent years underpinned by steady economic growth and limited output volatility. Favorable macroeconomic conditions, coupled with prudent and transparent monetary, fiscal and financial stability policies, have helped maintain financial stability. Norway's large sovereign wealth fund—the Government Pension Fund Global (GPFG)—and the link of the fiscal rule to the fund have provided considerable insulation against the impact of sharp downward shifts in oil prices. As a result, economic growth in Norway has been far less volatile relative to other countries and asset quality has been sound. In the aggregate, non-performing loans (NPLs) accounted for only 1.3 percent of total loans at end–2014, and have generally been persistently low (at 1.6 percent or less) in recent years (Table 1). However, banks' provisioning levels have been low, with the ratio of provisioning to NPLs at 20 percent at end–2014, down from 27 percent at end–2006 (Table 1).

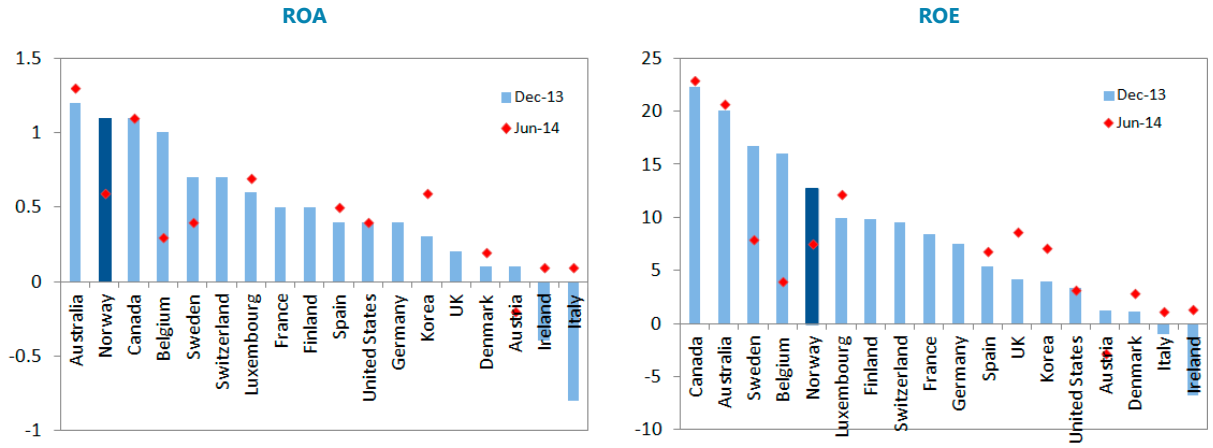
3. The low asset impairments and contraction in costs have contributed to healthy bank profitability. Norwegian banks were considerably less impacted by the global financial crisis than banking sectors in the rest of Europe. Banks maintained positive profitability during the crisis, and have posted solid results in the low-interest rate environment ever since. At end–2014, the aggregate return on equity (ROE) for the banking sector was 12.7 percent. Profitability (both in terms of return on assets (ROAs) and ROEs) has been among the highest in Europe (Figure 2 and Table 1). Banks' low provisioning levels have not inflated unduly profitability so far, given sound credit quality. However, adequate provisioning would be desirable, given potential downside risks.

4. Banks' adequate profitability has enabled them to build solid capital buffers. These buffers can shield banks from possible shocks and position them well to meet the requirements of Basel III / the Capital Requirements Directive IV (CRD IV). The banking sector's aggregate capital adequacy and Tier 1 ratios at end–2014 stood at 16.5 and 14.5 percent, respectively, up from 11.2 and 8.6 percent at end–2008 (Table 1). The average CET-1 ratio for the seven largest banks at end–2014 was 12.4 percent, above the 10 percent minimum requirement under the accelerated Basel III schedule in Norway. The phase-in of Basel III is not expected to exert a sizable downward pressure on banks' capital ratios, as banks have been subject to domestic regulatory rules that are generally at least as robust as Basel III requirements.[4] The authorities have also limited excessive reductions of risk-weighted assets (RWAs), associated with the adoption of the Basel II IRB approach (Box 1).

[4] For example, most CET-1 capital deductions under the Basel III capital quality rules are a part of current domestic regulations.

Figure 2. Banking Sector Profitability Across Select Countries

(In percent)



Source: IMF, *FSI Statistics*.

Table 1. Financial Soundness Indicators

(In percent)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Deposit-taking institutions 1/									
Regulatory capital to risk-weighted assets	11.2	11.7	11.2	13.0	14.2	13.6	14.5	15.5	16.5
Regulatory Tier 1 capital to risk-weighted assets	8.7	9.3	8.6	10.5	11.8	12.1	13.2	13.8	14.5
Nonperforming loans net of provisions to capital	4.4	3.8	5.7	9.4	10.9	10.9	10.2	8.5	7.1
Bank provisions to nonperforming loans									
Provisions to nonperforming loans	26.9	22.4	21.4	21.0	22.1	21.5	19.4	20.9	20.1
Nonperforming loans to total gross loans	0.6	0.5	0.7	1.3	1.6	1.6	1.6	1.4	1.3
Sectoral distribution of loans to total loans									
Deposit-takers	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.1	0.5
Nonfinancial corporations	26.8	27.0	29.1	30.5	32.5	33.6	34.7	32.9	29.8
Households (including individual firms)	63.9	55.7	47.6	47.3	43.9	41.7	38.6	38.4	37.2
Nonresidents (including financial sectors)	3.9	9.1	13.9	12.0	14.4	15.1	13.8	17.8	22.8
Return on assets (ROA) 2/	0.9	0.8	0.5	0.5	0.8	0.6	0.6	0.7	0.8
Return on equity (ROE) 2/	16.5	15.6	11.1	10.4	14.1	10.5	9.5	10.7	12.7
Interest margin to gross income	64.3	66.5	80.6	63.4	64.1	68.8	63.6	60.7	56.0
Noninterest expenses to gross income	51.2	49.9	55.2	49.0	46.1	51.4	46.8	47.6	41.8

Source: Norwegian authorities.

1/ These may be grouped in different peer groups based on control, business lines, or group structure.

2/ Consolidated data for the seven main banking groups (IFRS).

Box 1. Regulatory Measures for Adequate Credit Risk Measurement at IRB Banks

The transition to Basel II led to a decline in RWAs and, hence, to inflated capital positions for Norwegian banks that adopted the IRB approach for capital requirements purposes. Banks' estimates of credit risk parameters were also subject to a downward bias, in view of the relatively benign conditions (and the lack of a full economic cycle) over which these were estimated. To ensure that banks capture risks effectively and do not inflate their capital adequacy levels (via excessively low risk weights), the Norwegian authorities introduced a number of measures:

- ***A "Basel I floor" transitional rule*** under which IRB banks are required to set RWAs to at least 80 percent of RWAs under Basel I. The floor has been set at 80 percent since 2009 and, per an announcement by the Ministry of Finance from October 2013, will continue to be applied in Norway in the foreseeable future.

- ***Tightened requirements on banks' IRB models for estimating residential mortgage risk.*** The FSA has set minimum standards for banks' estimations of probability of default (PD) and loss given default (LGD), and for the frequency of crises occurrences embedded in banks' IRB models. Banks are expected to assume that crises on average occur once every five years, with an average PD of about 3.5 percent in crisis years. Banks' LGD estimates are subject to a 20 percent floor, and model-based LGD calculations are also expected to be aligned with LGDs estimates from a reference model (that links LGDs and loan-to-value ratios (LTVs)), developed by the FSA. The FSA estimates that the new requirements on PD and LGD estimations in IRB models should increase the average risk weights on residential mortgages to about 20–25 percent, from 10–15 percent previously.[1]

The tightened regulatory requirements reflect the expectation that banks' IRB models should be calibrated to take into account losses in stressed environments, such as during Norway's banking crisis of the early 1990s. In the absence of regulatory adjustments, banks' limited credit risks previously translated into PD estimates that did not reflect adequately risks during economic downturns, in view of the persistently benign risks in recent years. The new regulatory measures should, thus, align more closely banks' capital requirements with actual risks. Moreover, to the extent that these measures may contribute to a contraction in the growth of credit to households, they may also lead to an additional reduction in systemic risk.

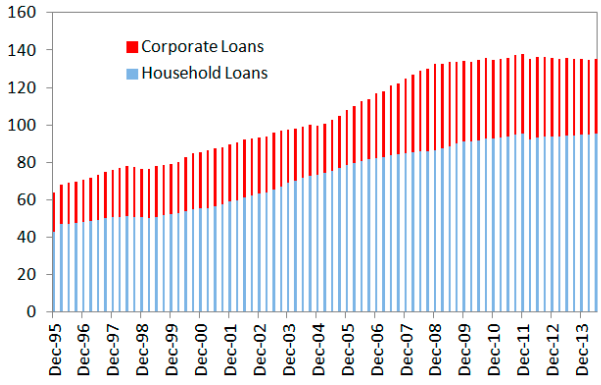
[1] However, the regulatory IRB risk weights may still underestimate potential risks, given the rapid growth of house prices and household debt in recent years.

5. Lending to the private sector has increased considerably in recent years, accompanied by a sharp rise in real estate prices. Private sector lending has increased considerably faster than income, with the ratio of credit to mainland GDP almost doubling since the mid–1990s (Figure 3). Household debt increased from about 150 percent of disposable income at end–2003 to about 220 percent at end–2014, and has been considerably above the OECD average. Corporate credit also rose rapidly, particularly in the years preceding the crisis, but has slowed down recently, as corporates have been raising more capital in the bond market and overseas. Importantly, the

commercial real estate sector—particularly in Oslo, where prices have increased rapidly in recent years—accounts for the largest share of corporate loans. In addition, residential mortgages (typically variable-rate) account for about 90 percent of household lending by banks and mortgage companies.

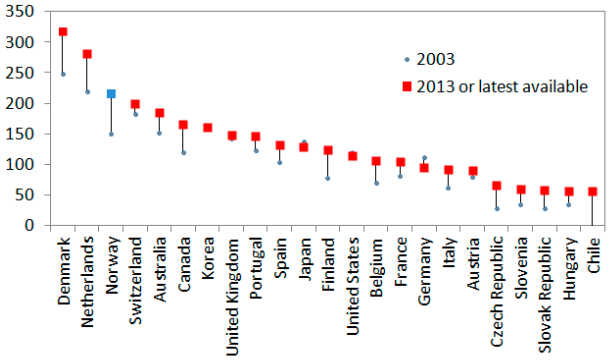
Figure 3. Lending to the Private Sector

Private Sector Lending, Norway
(In percent of Mainland GDP)



Sources: Norges Bank; and Statistics Norway.

Household Debt to Disposable Income, OECD Countries (In percent)

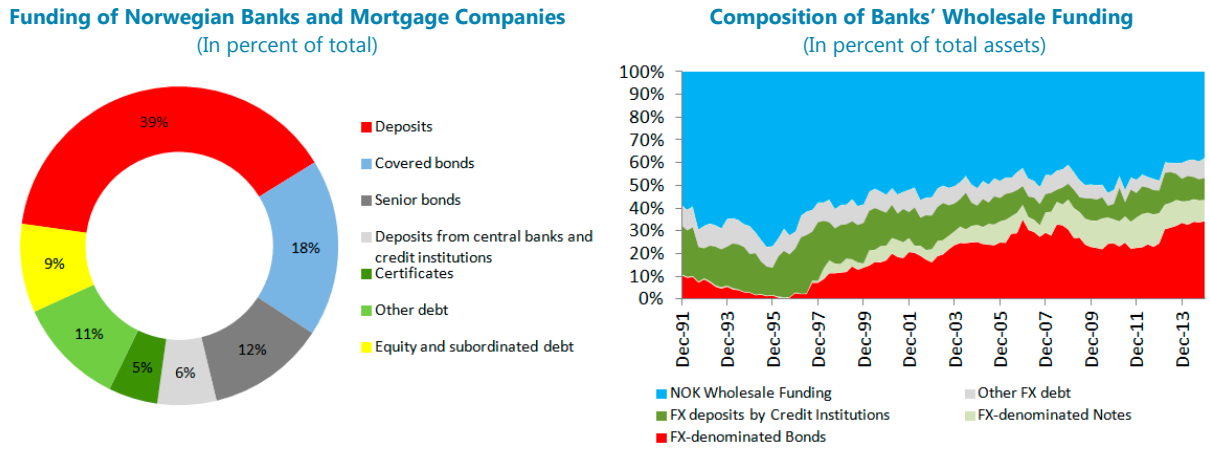


Note: Data for Czech Republic, Chile, Japan, Korea and Switzerland as of end-2012.

Source: OECD, *Financial Statistics.*

6. Norwegian banks rely heavily on wholesale funding to support domestic lending activity, although their funding structures have gradually shifted toward longer-maturity instruments. Wholesale funding accounts for about half of banks' liabilities, in part reflecting banks' reliance on non-deposit funding that has supported rapid growth of household and corporate lending in recent years (Figure 4). A large proportion of this funding (62 percent) is in foreign currencies, and is procured via international markets. Banks' high exposure to global wholesale funding markets was a source of vulnerability in the past, accounting for some funding pressures for Norwegian banks during the 2008 crisis. However, changes in banks' funding profiles since the crisis—particularly the shift to longer-term instruments in FX funding—have resulted in more stable wholesale funding structures. Thus, the share of covered and senior bonds in FX-denominated funding increased to 34 percent at end–2014 from less than 12 percent at end–2008, with a similar (albeit smaller) shift in domestic funding.

Figure 4. Funding Structure of Norwegian Banks



Source: Norges Bank.

B. Key Risks and Vulnerabilities

7. Banks are exposed to potentially high credit risks in case of considerable deterioration of macroeconomic conditions. These risks can be exacerbated further by the high private sector leverage and the likely significant overvaluation of real estate prices. The economy's high dependence on the oil sector makes potential persistence of low oil prices a possible trigger for these risks.

- **Banks' high exposures to the real estate sector make them vulnerable to a sharp increase in interest rates and sustained decline in income.** Higher interest rates increase the debt repayment burden and can trigger a decline in consumption and investment, as borrowers seek to meet debt payments.[5] Severe and sustained income deterioration would translate into higher unemployment which, if sustained over time, would put downward pressure on house prices and translate into losses on banks' household portfolios. However, in Norway, banks' losses are more likely to accumulate to the corporate (rather than household) portfolios, given that: (i) households have sound repayment buffers in view of their high financial asset holdings; (ii) the full recourse nature of mortgages has typically meant that households prioritize mortgage payments over other payments; and (iii) banks' loss absorption capacity is enhanced through LTV regulatory guidance.[6]

[5] While Norwegian banks have low direct exposures to interest rate risk since they both borrow and lend at floating rates, they are exposed to considerable indirect credit risks in the event of a sharp increase in interest rates, given that almost all household loans are variable-rate.

[6] The full-recourse nature of Norwegian mortgages and the ample social welfare system have accounted for limited credit risks on household loans, as households have incentives to or are enabled to make payments.

- **Persistently low global oil prices could lead to the accumulation of credit risks in the banking sector**. Banks' direct exposures to the oil sector are relatively limited, accounting for about 1.5 percent of outstanding corporate loans. However, analysis of cross-sectoral linkages suggests that the macrofinancial impact of lower oil prices could be considerably larger, with indirect bank exposures to the sector as high as 30 percent.[7] Despite Norway's well-recognized efforts to insulate the economy from global oil price developments, a large part of the mainland economy is now estimated to be indirectly tied to demand from the oil sector through the provision of services and inputs.[8] A persistence of low oil prices (below baseline projections) could, thus, trigger a generalized slowdown of the economy, which would translate into losses for the banking sector.

- **Risks to the banking sector are, in part, reduced by macroprudential measures.** For example, FSA-recommended upper limits on banks' LTV ratios and affordability checks on loan underwriting can curb potential bank losses.

8. Despite the shift to longer-term funding instruments, Norwegian banks are still exposed to potential liquidity risks.

- **The 2008 crisis showed that in the absence of sufficient liquid asset buffers, reliance on short-term and foreign currency wholesale funding can lead to substantial liquidity risks.** In Norway, banks' access to short-term foreign funding dried up, and some banks faced a considerable liquidity challenges when asset portfolios that had previously been deemed liquid became less or not sufficiently liquid.[9] Since the crisis, Norwegian banks have lengthened considerably their funding maturities. The share of covered and senior bonds has increased to 34 percent of wholesale funding at end–2014, up from 7.8 percent at end–2008. However, banks still face challenges in accumulating high-quality liquid assets in NOK to be able to build sufficient buffers to absorb potential liquid risks. The average LCR in NOK across Norwegian banks is low, below the 60 percent mark currently considered by NB.

- **With more than 60 percent of wholesale funding in foreign currency (mostly from foreign sources), banks are still vulnerable to distress in global funding markets.** The exposure to funding risks could be compounded by a potential inability of individual institutions to roll over currency swaps, used to convert FX funding into NOK. Norwegian banking groups rely on currency swap markets (FX or cross-currency swaps) to swap FX funding (covered bonds and senior bank bonds raised in global wholesale markets) and use the proceeds to finance NOK assets.[10] However, the maturities of currency swaps can be different from the foreign funding

[7] See Technical Note on Linkages and Interconnectedness in the Norwegian Financial System.

[8] See "Long-term Competitiveness in Norway" in International Monetary Fund, 2013, *Norway: Selected Issue Paper* (IMF Country Report No.), Washington: International Monetary Fund.

[9] This prompted the authorities to provide extensive NOK and FX liquidity and create a covered bond swap program.

[10] Currently, about one-third of foreign funding is used to finance domestic assets.

maturities, and banks thus can be exposed to maturity mismatches and rollover risks.[11] This is the case for unsecured bonds, while mortgage companies—which rely on covered bond funding—should not be exposed to this risk, as they are required to hedge FX risks at the same maturity as the bonds. Nonetheless, it is possible that this requirement is not met at the group level, as mortgage companies enter into hedging contracts with their own parent company, which may use shorter-term hedges.

9. Banks' high level of cross-ownership of covered bonds also exposes banks to risks. The share of banks' cross-holdings of covered bonds is high, accounting for more than half of domestically-issued covered bonds. Cross-holdings can exacerbate liquidity risks in the event of systemic liquidity pressures, as individual banks sell each other's covered bonds simultaneously to meet liquidity needs, affecting negatively covered bond market liquidity and the issuance of new covered bonds.

C. Stress Testing Practices of the Norwegian Authorities

10. The FSA and NB carry out periodic solvency stress tests as part of their surveillance activities. The results of the stress tests are published periodically in the FSA's Risk Outlook and NB's Financial Stability Report. The frameworks that they apply are different in terms of methodology, and the granularity and nature of the used data. The FSA solvency stress testing framework relies on supervisory unconsolidated data and includes a macro-financial model that links the PDs of individual corporates to corporate sector projections under stress (conditioned on the macroeconomic environment). Estimated PDs are then matched to each bank's exposure to the specific corporate client. The NB framework uses commercially-available consolidated institution-specific data and a macro-financial model that links the aggregate-level problem loan shares of corporate and household exposures to stressed macroeconomic projections. Both frameworks incorporate the largest six banks, accounting for 67 percent of the total assets of the Norwegian banking system on a consolidated basis (NB), and 75 percent on an unconsolidated basis (the FSA).

11. The FSA also carries out liquidity stress tests based on the Basel III / CRD IV LCR. The FSA stress testing framework relies on ongoing reporting of individual bank LCRs over a 30–day horizon, and monitoring of past cash inflows and outflows, and of maturing assets and liabilities.

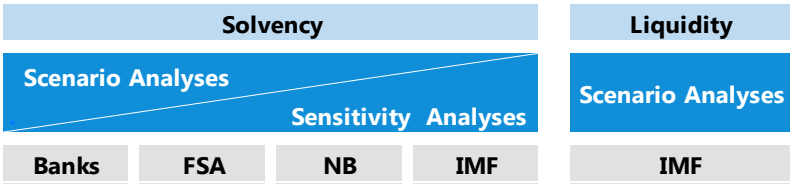
D. FSAP Stress Testing Framework

12. The FSAP stress tests evaluated the resilience of the banking sector to a wide range of macrofinancial shocks (Figure 5). The solvency stress tests were carried out in close collaboration with the Norwegian authorities, and also included "rule of thumb" estimations by the FSAP team, in

[11] Most currency swaps have maturities of 3 months or less and the maturity with the highest turnover is tomorrow next (TN) (Norges Bank, *Money Market Survey*). Cross-currencies basis swaps typically have longer maturities, and are used by mortgage companies to fully hedge risks.

parallel with analysis based on the existing frameworks of the FSA and NB.[12] The assessment also comprised solvency stress tests by the top six banks, and sensitivity analyses for exchange rate shifts and exposure concentrations, as well as liquidity stress tests by the FSAP team. An analysis of cross-sector and cross-border spillover effects was carried out separately from the stress testing exercise.[13]

Figure 5. Overview of the FSAP Stress Testing Framework



Source: IMF staff.

SOLVENCY STRESS TESTS

A. Framework

13. The stress testing exercises included both TD and BU approaches. The TD stress tests were carried out as three separate, but closely coordinated exercises, under different methodologies by the Norwegian authorities (FSA and NB) and the FSAP team (Figure 6). The BU tests were carried by individual banks, using banks' own internal data and analytical tools. This comprehensive approach was meant to take advantage of different methodological approaches and provide a range of results and insights, given limited financial sector risks in recent years and hence some modeling uncertainty.

14. The tests included the six largest banks and were based on data as of end–September 2014 and end–2014. The tests were carried out both at the unconsolidated level (FSA, IMF and BU approaches) and on a consolidated basis, accounting for bank-owned mortgage companies (NB and BU approaches). The six banks included in the stress tests accounted for 75 percent of the aggregate banking sector assets on an unconsolidated basis (excluding mortgage companies) and 67 percent of total assets on a consolidated basis (Appendix II). The tests did not cover Kommunalbanken, a specialized-lending entity fulfilling the policy function of providing funding to Norwegian municipalities.[14] The IMF and FSA stress tests used confidential supervisory data as of end–2014, while the NB relied on publicly-available data as of end–September 2014. Whenever the tests were

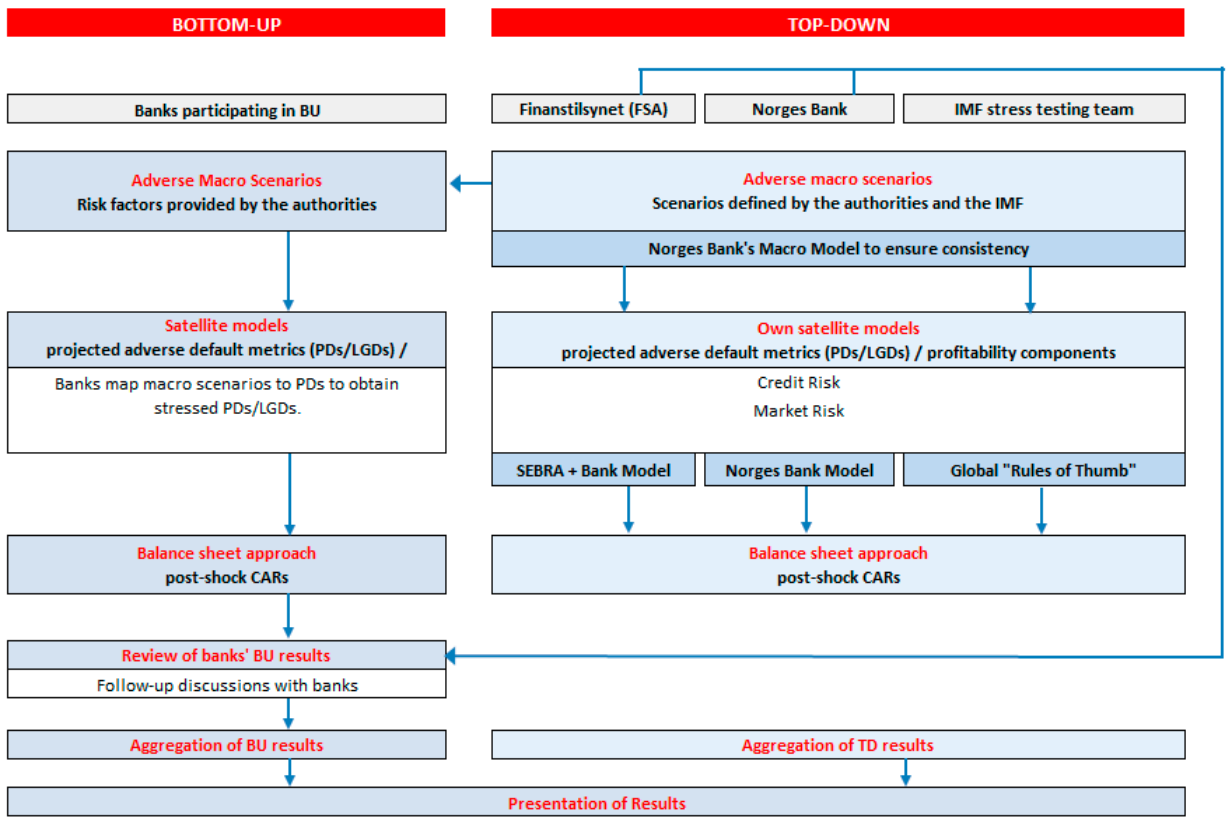
[12] The "rules of thumb" capture the link between bank losses and macroeconomic conditions at times of extreme distress, based on international experience. See Hardy, Daniel C. and Christian Schmieder, 2013, "Rules of Thumb for Bank Solvency Stress Testing," IMF Working Paper, WP/13/232.

[13] See Technical Note on Linkages and Interconnectedness in the Norwegian Financial System.

[14] The exclusion of entities with distinct public policy functions is in line with other FSAP stress tests (e.g., Kreditanstalt für Wiederaufbau in Germany, Cassa Depositi e Prestiti in Italy, and Japan Post Bank in Japan).

based on end–September information, banks' balance sheets and income statements were projected to end–year.

Figure 6. Structure of the Solvency Stress Tests



Source: IMF staff.

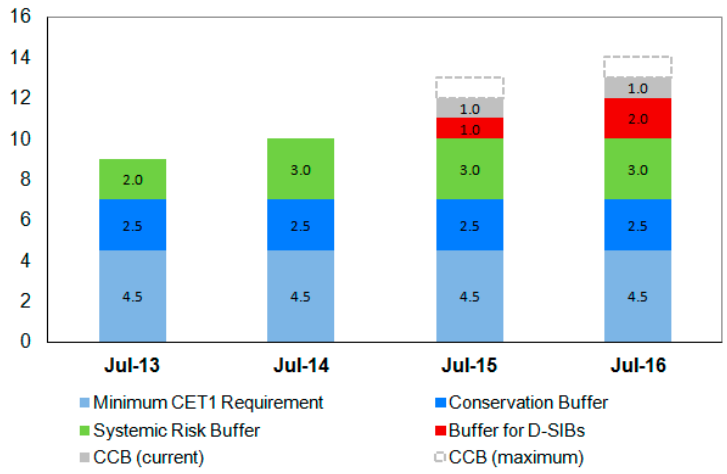
15. The solvency tests aimed at providing a robust evaluation of credit and market risks in the banking sector under severe common macro-financial scenarios. The scenario-based solvency analyses was carried out separately by the FSA, NB and the FSAP team (TD analyses), and by individual banks (BU analysis). Sensitivity tests on exposures to single risk factors were estimated on a BU basis.

16. The impact on banks' capital was assessed based on Basel III solvency benchmarks. Capital adequacy was evaluated based on the CET-1 capital ratio under the accelerated Basel III schedule followed by the Norwegian supervisors, including a conservation buffer, a systemic risk buffer, and a surcharge for domestic systemically important banks (D-SIB). Capital definition is based on Basel III, while risk-weighted assets are estimated under the IRB method of Basel III under the TD approach of the FSA and the FSAP team, and in line with problem loan shares in the NB approach.

17. The Norwegian authorities have adopted an accelerated schedule for the phase-in of the Basel III capital adequacy requirements, ahead of the Basel III and EU implementation

schedules. The underlying motivation was to accelerate capital accumulation as a countercyclical tool, with banks building solid capital buffers at a time of robust macroeconomic performance. In the beginning of July 2013, Norwegian banks adopted the requirements of the EU capital framework (CRR/CRD IV). The minimum required CET-1 ratio was set at 9 percent, including a minimum requirement of 4.5 percent, a (permanent) conservation buffer and a systemic risk buffer (Figure 7).[15]

Figure 7. CET-1 Requirements under Basel III Phase-In in Norway
(In percent)



Source: Norges Bank.

B. Scenarios

Macroeconomic scenarios

18. The solvency of the Norwegian banking system was evaluated under three macroeconomic scenarios. The three scenarios include a baseline that reflects the anticipated trajectory of the economy, and two versions of an adverse macroeconomic scenario, deemed to reflect severe risks for the Norwegian economy. The adverse scenarios are consistent with the IMF's views of global risks, and reflect severe but plausible events that would result in considerable negative deviations of economic activity from the baseline forecast path.[16] The design of the scenarios and the transmission of shocks through the Norwegian economy were determined jointly by the FSAP team and NB. The scenarios have a risk horizon of 5 years to end–2019. The baseline scenario reflects IMF staff projections as of December 2014, estimated in part via NB's macro model. The adverse scenarios include:

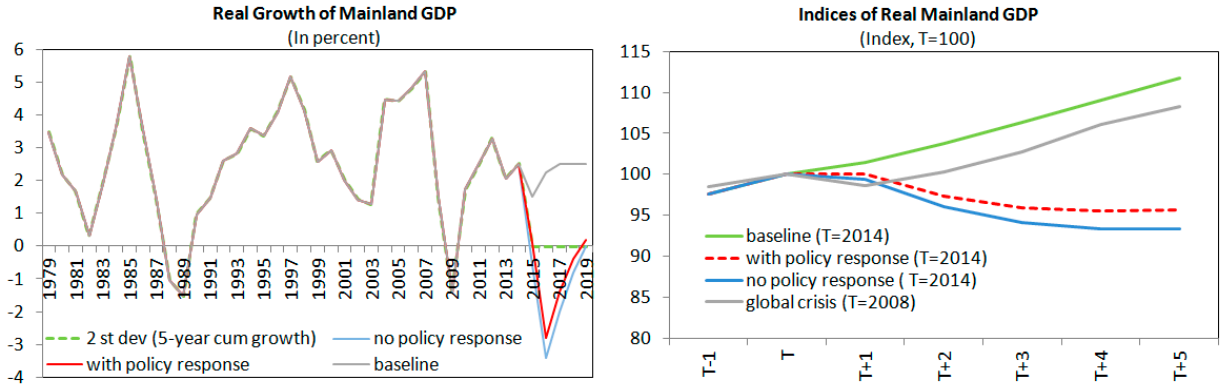
[15] After the conclusion of the stress testing exercise, the Ministry of Finance increased the countercyclical buffer (CCB) to 1.5 percent, starting June 30, 2016. This increase is not reflected in the results of the stress testing exercise.

[16] The transmission of shocks under both versions of the adverse scenario is consistent with the key global assumptions of the IMF's Global Risk Assessment Matrix (GRAM). The relatively long risk horizon is useful in capturing the protracted effects of macroeconomic shock transmission.

- **Adverse scenario with no monetary policy response**. This scenario assumes an upsurge in global financial market volatility, possibly on concerns about weakening fundamentals in emerging and advanced economies. Higher financing costs and strains on fiscal sustainability globally are assumed to push a number of countries into a tighter policy mix, with repercussions for global growth and rising financial stability risks. A slowdown of Norway's key trading partners leads, inter alia, to a prolonged period of significantly lower oil prices than currently forecasted, with a strong downward impact on domestic growth, higher unemployment and a sharp correction in real estate prices. Under these assumptions, real GDP growth declines cumulatively by 6.7 percent over 5 years (3.1 standard deviations from long-term trend), and the level of GDP declines 16.1 percent below the baseline by 2019 (Figure 8).

- **Adverse scenario with monetary policy response**. While the assumed external shocks are identical to the adverse scenario described above, this scenario presumes monetary easing (a 1½ percentage point cut in the policy rate in 2015-16; without fiscal measures) to offset the effects of the shock, in line with NB's assumptions. Under this scenario, real GDP growth declines cumulatively by 4.3 percent over 5 years on (a 2¾ standard deviation from long-term trend) and the level of GDP declines 13.9 percent below the baseline.

Figure 8. Real Growth of Mainland GDP under Various Scenarios



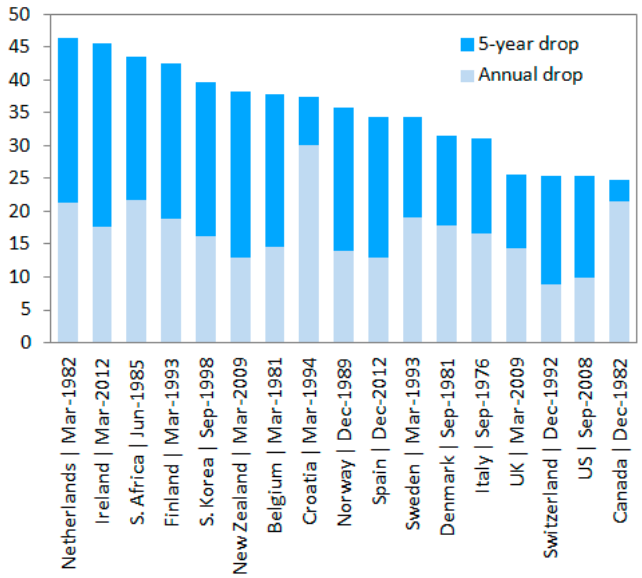
Sources: IMF staff; and Norges Bank.

19. Both versions of the adverse scenario result in a large contraction of GDP, in contrast to the persistent growth in the baseline. The adverse scenarios were calibrated to reflect a severe deterioration of key macroeconomic factors, including: (i) sustained lower nominal oil prices at US$40 per barrel over the entire stress testing horizon; (ii) an increase in money market rates by about 200 bps and wholesale funding spreads by an additional 150 bps (relative to baseline), starting in 2015, reflecting expert judgment on Norway's experience during the global financial crisis; and (iii) a 40 percent decline in real property prices over five years in line with international

boom-busts episodes (Table 2 and Figure 9).[17,18] These shocks translate into a decline of 2¾ to 3.1 standard deviations of five–year cumulative real GDP growth rate relative to the baseline, the worst five–year cumulative growth decline in Norway's recent history. Such stress is also considerably more severe compared to several other FSAPs, but broadly in line with the authorities' (NB's) own stress tests assumptions, and reflect the relative stability (and hence limited variability) of past economic growth in Norway. Moreover, the high structural dependence of the Norwegian economy on oil (and hence on global oil price fluctuations) and the build-up imbalances (e.g., high leverage and house prices) in the past 20 years, justify analyzing macrofinancial risks based on unprecedented shocks. The scenarios are broadly in line (albeit of longer duration) with scenarios in previous TD stress testing exercises by the FSA and NB.

20. The NB's macroeconomic model was used to map the evolution of various macrofinancial risk factors under each macroeconomic scenario. The macrofinancial risk factors include inflation, the unemployment rate, the policy interest rate, credit growth, house prices, deposit and lending rates, and exchange rates. The factors were estimated via the NB's macroeconomic model.

Figure 9. Largest Global Historical Declines in Real House Prices
(In percent)



Sources: Federal Reserve Bank of Dallas, *International House Price Database*; and IMF staff estimates.

[17] The assumed stressed oil prices are considerably below the IMF's own baseline projections of US$59 by 2015 and US$77 by 2019.

[18] The spike in funding costs is meant to capture the effect of dislocations in global funding and the FX swap markets, in view of the importance of the latter in Norwegian banks' funding models.

Table 2. Macroeconomic Projections under Different Scenarios[1]

		Baseline Scenario					Adverse Scenario (with policy response)					Adverse Scenario (without policy response)				
	2014 (est)	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Economic activity and labor market																
GDP, mainland Norway (%)	2.5	1.5	2.0	2.3	2.5	2.5	0.1	-2.8	-1.4	-0.4	0.2	-0.6	-3.4	-2.0	-0.8	0.0
Private consumption (%)	1.8	2.0	2.3	2.8	2.8	2.8	1.3	-1.4	-1.9	-0.2	0.4	0.6	-2.3	-2.6	-0.7	0.2
Fixed investment, mainland Norway (%)	2.0	3.0	3.0	3.0	3.0	3.0	-6.4	-11.8	-11.5	-7.2	-3.6	-7.8	-13.6	-13.1	-8.7	-4.7
Petroleum investment[2] (%)	-0.3	-15.0	-5.0	-2.5	-2.5	-2.5	-15	-10	-10	-10	-10	-15	-10	-10	-10	-10
Mainland exports[3] (%)	3.8	4.5	2.3	3.5	3.5	3.5	-0.3	-4.6	4.2	4.5	4.1	-1.3	-4.6	4.1	4.7	4.2
CPI-ATE (%)	2.5	2.5	2.8	2.5	2.5	2.5	2.6	2.8	2.3	2.1	2.3	2.5	2.3	1.5	0.9	0.8
Registered unemployment rate (%)	2.8	3.0	3.3	3.0	3.0	3.0	3.6	5.0	6.0	6.6	7.0	3.8	5.4	6.6	7.3	7.9
Nominal import-weighted exchange rate (I-44) (level)[4]	93.5	96.3	93.3	92.0	92.0	92.0	100	100	100	100	100	99	98	98	98	99
Nominal household disposable income (%)	6.0	5.3	5.1	4.8	4.8	4.8	2.3	0.3	3.4	3.8	4.7	0.8	-0.7	2.6	3.3	3.6
Prices																
Oil price, USD per barrel (level)		59.3	67.5	71.8	75.1	77.0	40	40	40	40	40	40	40	40	40	40
Nominal house prices (%)	2.3	6.6	3.5	2.6	2.6	2.6	-3.0	-10.8	-9.6	-5.4	-3.9	-4.5	-11.6	-10.7	-6.6	-5.2
Nominal commercial real estate prices[5] (%)	9.8	6.6	3.5	2.6	2.6	2.6	-1.4	-10.8	-9.6	-5.4	-3.9	-2.9	-11.6	-10.7	-6.6	-5.2
Credit																
Credit (C2), households[6] (%)	6.6	7.3	7.9	7.2	7.2	7.2	2.7	0	0.8	1.7	2.5	1.8	0	0	0.1	0.7
Credit (C2), non-financial enterprises[6] (%)	2.9	2.5	2.5	2.5	2.5	2.5	2.7	0	0.8	1.7	2.5	1.8	0	0	0.1	0.7
Interest rates																
Key policy rate (%)	1.5	1.2	1.2	1.5	1.5	1.5	0.5	0	0	0	0	1.2	1.2	1.5	1.6	1.6
3-month NIBOR rate (%)	1.7	1.4	1.4	1.7	1.7	1.7	2.5	2	2	2	2	3.2	3.2	3.5	3.6	3.6
Average credit spread on wholesale funding[7]		0	0	0	0	0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Lending rates, households (%)[8]	4.3	3.8	3.8	4.0	4.0	4.0	5.1	4.6	4.6	4.6	4.6	5.8	5.8	6.1	6.2	6.2
Lending rates, non-financial enterprises (%)[8]	4.4	4.0	4.0	4.2	4.2	4.2	5.2	4.7	4.7	4.7	4.7	5.9	5.9	6.2	6.3	6.3
Deposit rates, households (%)	2.2	1.9	1.9	2.1	2.1	2.1	3.1	3.1	3.4	3.7	3.9	3.8	4.2	4.8	5.3	5.5
Deposit rates, non-financial enterprises (%)	1.8	1.6	1.6	1.8	1.8	1.8	2.7	2.7	3.0	3.3	3.5	3.4	3.8	4.4	4.9	5.1

Sources: Statistics Norway; NAV; Thomson Reuters; Eiendom Norge; FINN.no; Eiendomsverdi; Dagens Næringsliv; OPAK; Norges Bank; and IMF staff.

[1] Scenarios are constructed by the IMF and estimated via Norge Bank's macro model.

[2] Extraction and pipeline transport.

[3] Traditional goods, travel, petroleum services and exports of other services from mainland Norway.

[4] The weights are estimated on the basis of imports from 44 countries, which comprise 97 percent of total imports.

[5] Projections for commercial real estate prices are based on projected quarterly growth in house prices.

[6] Change in stock measured at year-end.

[7] Credit spread over NIBOR.

[8] Average interest rates on loans by banks and mortgage companies.

Market Risks

21. All market risk shocks were assumed to occur instantaneously and remain permanent, without price recovery over the stress testing horizon. Market risks were evaluated in terms of the potential valuation losses on various securities (i.e., sovereign bonds, covered bonds, corporate bonds and equities). In both the TD and BU stress tests, potential shocks were assumed to affect all securities in trading and available-for-sale (AFS) accounts. Market shocks in both versions of the adverse scenario were assumed to persist through the entire stress testing horizon. Shock magnitudes were determined based on the empirical or fitted distributions of the past price dynamics of each asset class. For equities, haircuts were determined based at the 80th percentile of the fitted distribution of the quarterly extrema of the daily year-on-year price changes of the MSCI Norway index between 1971 and 2014, accounting for a haircut of 26 percent. For debt securities, the yields were assumed to rise by 200 basis points; with yields on foreign sovereign bonds increasing based on an extreme value distribution fitted to past yield changes (as described next).

22. Losses on sovereign bond holdings were estimated, assuming a loss of "safe haven" status for Norway's debt, and higher market expectations of default risk in other countries.

- Norwegian sovereign bond yields under stress were assumed to increase by 200 bps across maturities in 2015, more than in other European countries, with a corresponding haircut of 10.4 percent (Table 3). Such an increase is unprecedented and is consistent with the extreme deterioration in the country's macroeconomic conditions, assumed in this stress testing exercise. Sovereign yields were also assumed to edge up in the baseline, in line with the forward rates over the stress testing horizon. Jointly, this accounts for a rise in sovereign yields to 4 percent by end–2019, a cumulative increase of about 270 basis points by end–2019.

- Yields on banks' holdings of other countries' sovereign debt are also assumed to increase in 2015 and remain at elevated levels over the stress testing horizon. Haircuts on such holdings are estimated from the historical distribution of daily year-on-year changes in 5–year government bond yields between 2006 and 2014 (Table 3).[19] Stressed sovereign yields under both adverse scenarios are determined through a simulation of daily year-on-year bond yield changes under a fitted extreme value distribution.

[19] The used yields are the Bloomberg generic 5-year government bond yields.

Table 3. Sovereign Bonds Yield Changes and Haircuts Under Stress
(In basis points)

	Change in yield (bps)	Stressed yields (in %)	Haircut (in %)
Norway	200.0	3.4	10.4
Sweden	147.4	1.8	7.6
Netherlands	137.4	1.6	7.1
Germany	137.5	1.5	7.1
Denmark	142.7	1.6	7.4
Finland	132.9	1.5	6.8
France	141.0	1.7	7.3
Belgium	230.9	2.5	12.1
Austria	142.0	1.6	7.3
Italy	211.4	3.3	11.0
Spain	193.7	3.0	10.1
Greece	1056.0	17.6	64.4
Ireland	142.8	2.0	7.4
Czech Republic	136.6	1.6	7.0
Hungary	328.6	6.6	17.4
Poland	183.1	3.9	9.4
UK	131.6	2.8	6.7
USA	151.1	3.1	7.8

Note: With the exception of Norway, 95th percentile of the distribution; 80th percentile for Italy, Spain, and Hungary; 80th percentile of the empirical distribution for Greece and Ireland, as the extreme value distribution not a good fit.

Sources: Bloomberg; and IMF staff estimates.

Sensitivity Tests

23. The sensitivity analyses evaluated Norwegian banks' resilience to FX shocks and credit concentration risks. In contrast to the scenario analyses, which assessed the impact of multiple macrofinancial shocks in an integrated and internally consistent framework, sensitivity tests estimated the effect on capital adequacy of one single factor at a time. These shocks were assumed to materialize instantaneously and have an immediate negative impact on capital. The tests were carried out on a BU basis. Banks were not permitted to resort to profits to counteract the shock or make any behavioral adjustments.

- **FX shock.** This test assessed the impact of an extreme NOK depreciation against major currencies on the net open positions. For each currency, the magnitude of the shock was set at two times the maximum shift of the annualized FX volatility from its long-term level (corresponding to the 2008–11 financial crisis). Banks estimated the impact on both the P&L and

the RWAs of the trading book in 2015 (at 100 percent of the calibrated shock) and 2016 (at 50 percent of the calibrated shock).

- **Credit concentration risk.** Banks estimated potential losses related to concentration risk, assuming defaults of their largest 1, 2, 5, and 10 exposures, per the definition of such exposures in the IMF's Financial Stability Indicators (FSIs). Banks estimated the direct impact on capital, assuming an LGD of 45 percent.

C. Credit Risk Models

Underlying Assumptions

24. The solvency tests in the TD and BU approaches were based on common assumptions. Some key assumptions include (for a full set of assumptions, see Appendix II):

- Banks' balance sheets are assumed to be static, apart from credit growth (which is largely in line with the path of nominal GDP growth). Banks' credit levels and corresponding liabilities, thus, evolve in line with the projected aggregate credit growth, without taking into account any contemporaneous asset impairments. Consequently, banks cannot deleverage over the stress testing horizon.[20]

- New problem loans are assumed to maintain default status, with banks provisioning fully any losses over the entire 5–year stress testing horizon.

- Banks' funding structure is assumed to be fixed, i.e. banks cannot shift from one funding source to another as a result of the change in the relative cost of funding, assumed in the macro-financial scenarios.

- Overall, the stress tests do not account for the impact of potential risk-mitigating managerial actions. For example, banks' credit portfolio composition is assumed to be fixed and banks are assumed not to be able to raise capital over the stress testing horizon.

- The modeling of shock transmission also does not account for the impact or new policy measures, except for the monetary policy response in the second adverse scenario. While potential stress is likely to trigger automatic fiscal stabilizers, for example, the stress testing framework does account for such policy effects.

25. The estimation of credit losses and their impact on banks' capitalization differed across TD approaches. The FSA estimates corporate credit losses via a multi-step approach of: (i) projecting key balance sheet risk factors of non-financial corporates based on stressed macro variables using an autoregressive distributed lag model (ADL); (ii) using a generalized additive model

[20] The FSA's stress testing framework is not fully static, but the effects are deemed to be relatively small and the results are largely comparable with those of a static balance sheet approach.

(GAM) form of logistic regression to calculate stressed PDs for individual non-financial corporates; and (iii) estimating banks' expected losses by matching the calculated PDs for each corporate to banks' corresponding exposures to the corporate in question. NB uses an Error Correction Model (ECM) that estimates aggregate problem loans under stress as a function of the projected macro variables. The FSAP team applies international "rules of thumb", corresponding to historical cross-country sensitivities of banks' credit losses to sizable deterioration in macroeconomic conditions.

The FSA's Methodology

26. The FSA solvency stress testing framework uses a multi-model approach to estimate the impact of credit risk on banks' capital adequacy. The set of models is constructed to calculate losses from banks' exposures to non-financial corporates.[21] The losses are estimated based on stressed corporate PDs, evaluated from an empirical logistical model that links the PDs of individual non-financial corporates (approximated by scaled bankruptcy probabilities) to corporate risk factors projected over the stress testing horizon (SEBRA model). The evolution of corporate risk factors is assumed to be related to shifts in macroeconomic conditions, with projections of corporate financial statements estimated via an empirical ADL model conditioned on macroeconomic factors. The projected PDs for individual corporates are then matched to the bank exposures to each specific corporate entity. A banking model then projects banks' financial statements based on the stress test assumptions (see Appendix II). Similarly to the FSAP team, the FSA used supervisory unconsolidated data for individual financial institutions.

27. The evolution of household PDs is proxied via the changes in corporate PDs estimated in the SEBRA model. Credit losses related to household exposures are endogenous to the FSA's internal macro model, which was not used in this exercise. To estimate the path of household losses over the stress testing horizon, the FSA estimated banks' household stressed PDs, using each bank's actual default rate at end–2014 as a starting point, then updating PD at the end of each year based on the estimated change in corporate PDs during that year.

28. LGDs are assumed to increase as loan quality declines. For exposures to non-financial corporates, LGDs are calculated in line with Moody's approach of linking LGDs to PDs, equivalent to 35 percent plus a factor that increases with each bank's debt-weighted PD. Depending on the scenario and the year of the shock, LGDs increase to between 35 and 53 percent under adverse conditions. For households, LGDs are assumed to increase from 25 percent in 2015 to 35 percent in 2017–19 in the adverse scenarios. In the baseline, the LGD is set at 20 percent for both corporate and household exposures.

[21] The SEBRA framework captures only partially the banks' corporate exposures (typically about 2/3 of bank exposures), given that it only covers Norwegian limited companies with sales revenues in their profit and loss (P/L) statements. To account for all corporate exposures (except for overseas exposures) in the stress test, loans to corporates without a SEBRA PD are assigned the average PD of each bank's corporate portfolio. The framework does not capture the impact of corporate group structures on the PDs, such as the possibility that group PDs may be higher or lower than those of individual corporates.

The NB's Methodology

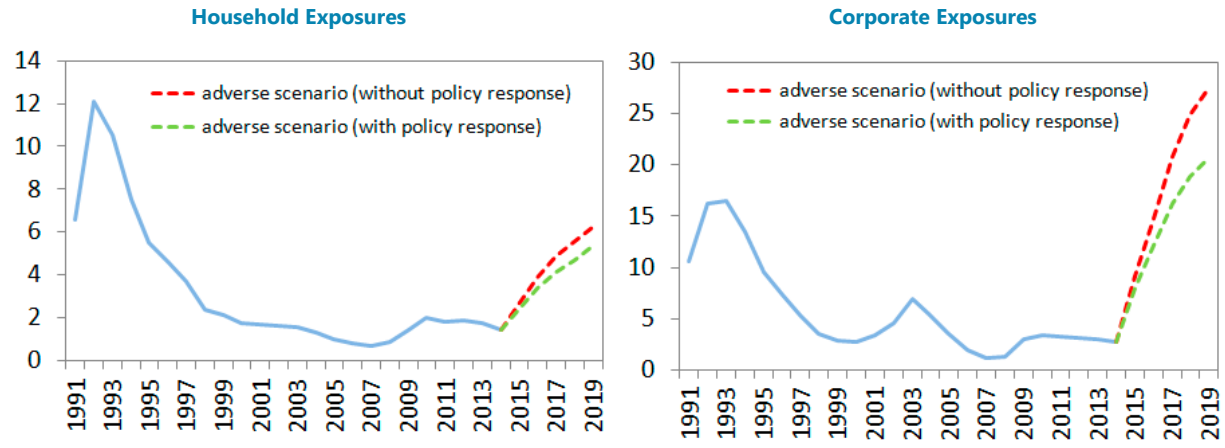
29. The NB credit risk modeling framework follows a two-step approach, accounting for the effect of systemic macroeconomic factors. The problem loan ratios for the (aggregate) banking system are modeled as a function of macroeconomic risk factors, separately for corporate and household exposures.[22,23] ECM models are applied to obtain projected problem loan ratios under stress. The one-period change in the estimated ratios are used as a proxy for banking sector stressed PDs. A (banking) balance sheet model is then applied to project banks' financial statements and estimate banks' capital adequacy under stress. In its normal set-up, banks are assumed to: (i) adjust lending rates to meet a target investor return; and (ii) adjust dividends and lending to meet target capital requirements. However, for the purposes of the FSAP stress tests, no targets were assumed. Lending (and funding) rates were, rather, assumed to be determined endogenously by the macro model, and banks were precluded from distributing dividends under stress. Loss given problem loans (a proxy for LGDs under stress) were determined based on expert judgment at 40 percent for corporate loans and 25 percent for household loans. The NB used commercially available quarterly consolidated institution-specific data, and credit risk data for the aggregate banking sector.

30. The NB model points to a significant downside potential for corporate credit quality under stress, but the deterioration of household credit risks tends to be more muted than historical precedents. Corporate problem loans increase to close to 30 percent by end–2019 under the adverse scenario without policy response, well above the 18 percent peak after Norway's banking crisis of the early 1990s (Figure 10). However, the estimated rise in household problem loans, even under the most adverse stress scenario, remains limited. Household problem loans increase to only 6.3 percent by 2019 under the adverse scenario without policy response against a peak of historical losses at about 12 percent after the banking crisis. This appears to indicate limitations in the ability of statistical models to capture adequately household-related credit risks, given that the the deterioration of macroeconomic conditions and the loss of output under the FSAP scenarios are considerably more severe than past precedents.

[22] The use of problem loans as a credit risk metric in the model is motivated by the lack of sufficiently long historical series of household PDs.

[23] For household loans, the macroeconomic risk factors include: the real interest rate, real disposable income, real house prices, real lending to households and the unemployment rate. For corporate loans, the factors include the real interest rate, real lending to non-financial corporates, the unemployment rate, the real exchange rate, and global oil prices.

Figure 10. Norges Bank: Problem Loan Ratios Under Stress
(In percent)



Source: Norges Bank.

The FSAP Team's Credit Risk Methodology

31. The low sensitivity of household-related banks losses to changes in macroeconomic conditions prompted the FSAP team to apply international "rules of thumb". High household indebtedness and the persistent rise of house prices over more than 20 years may have exacerbated potential credit risks, which would not be captured sufficiently well via statistical models. The relatively benign household credit quality, and hence limited variability in credit risk metrics, since the late 1990s hampers the ability of models to capture a possible spike in credit risks in case of extreme deterioration of macroeconomic conditions. The use of global "rules of thumb", based on the experience of other countries under similar macroeconomic conditions, thus, provides a valuable additional metric in cases—such as Norway—where there has been an extended period of low credit risks, and a considerable structural change in the banking sector's operating environment since the banking crisis of the early 1990s.

32. The "rules of thumb" are determined based on a simple satellite model that links potential credit losses to the severity and duration of strain as measured by shocks to cumulative real GDP growth. The shocks are calibrated based on estimates of credit loss sensitivities under extreme severity, in line with a potential burst of a credit bubble. Specifically, the cumulative losses over the stress testing horizon are determined based on the deviation of the projected 5–year cumulative GDP growth rate from its long-term (20–year) trend, and applying a sensitivity coefficient of 0.4 for the adverse scenarios (corresponding to the evolution of credit losses at times of crises).[24] The evolution of credit losses for each year of the stress testing horizon is then mapped to correspond to the trajectory of GDP growth. As a result, bank losses are set to peak in

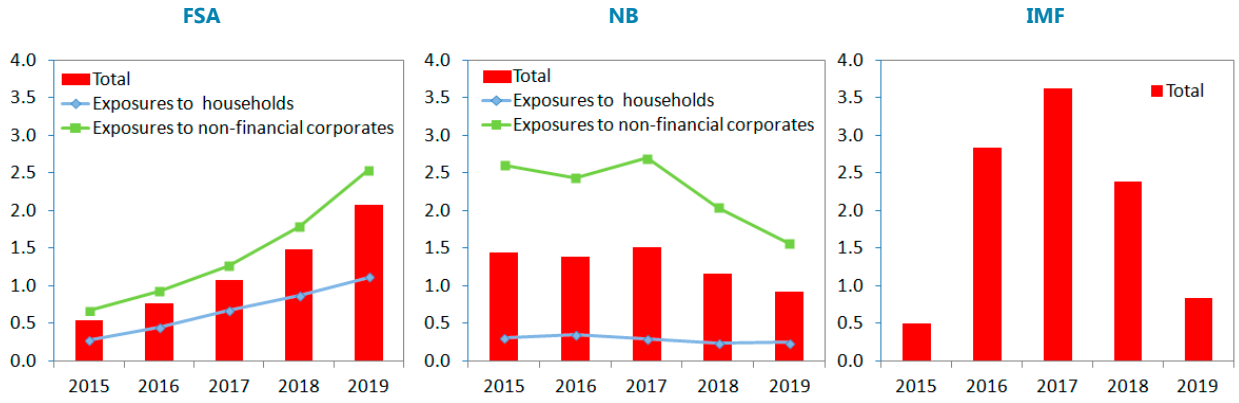
[24] The "rule of thumb" approach captures *aggregate* credit risk losses for banks at times of severe distress, but does not allow an analysis of the heterogeneity in loan performance across various types of exposures.

2017, the year when GDP growth reaches a trough. This assumption is in line with empirical evidence that shows that credit loss rates are symmetric in respect to the peak of a crisis. LGDs are determined based on the empirical relationship (1) shown below, and PDs for each year are then determined from the default rates and LGDs.

$$LGD = 3.38 \times Default\ Rate + 23.96 \qquad (1)$$

33. The estimated loss rates are more severe than in the FSA's and NB's models. In the most adverse scenario (without policy response), the "rule of thumb" approach accounts for a peak of the loss rate at 3.6 percent, relative to maximum loss rates of 1.5 and 2.1 percent under the FSA and NB approaches (Figure 11).[25] The difference partly reflects the higher loss rates on household exposures implicit in the "rule of thumb" approach.

Figure 11. Household and Corporate Loss Rates, Adverse Scenario without Policy Response
(In percent)



Sources: Finanstilsynet; Norges Bank; and IMF staff estimates.

D. Results

34. The results suggest that banks are well-positioned to withstand potential shocks in view of their relatively high capital buffers. Banks' capitalization is viewed as strong, and the regulatory minimum requirement (floor) on the level of their RWAs ensures that capitalization levels reflect more closely internal risks.[26] At the initial point of the stress testing horizon (end–2014), the capitalization of the banking sector was high, with aggregate CET-1 ratio at 12.9 percent on a consolidated basis and 12.4 percent on an unconsolidated basis. While there are differences across

[25] The loss rate is defined as PD x LGD. The coefficients (loss rates and LGDs) are based on international experiences of severe stress (for 9,372 banks in 32 advanced economies), as estimated by Hardy and Schmieder (2013).

[26] As discussed previously, Norwegian IRB banks have been subject to a 'Basel I' floor on RWAs—set at 80 percent of RWAs under Basel I—as a buffer against underestimation of risks in banks' internal models.

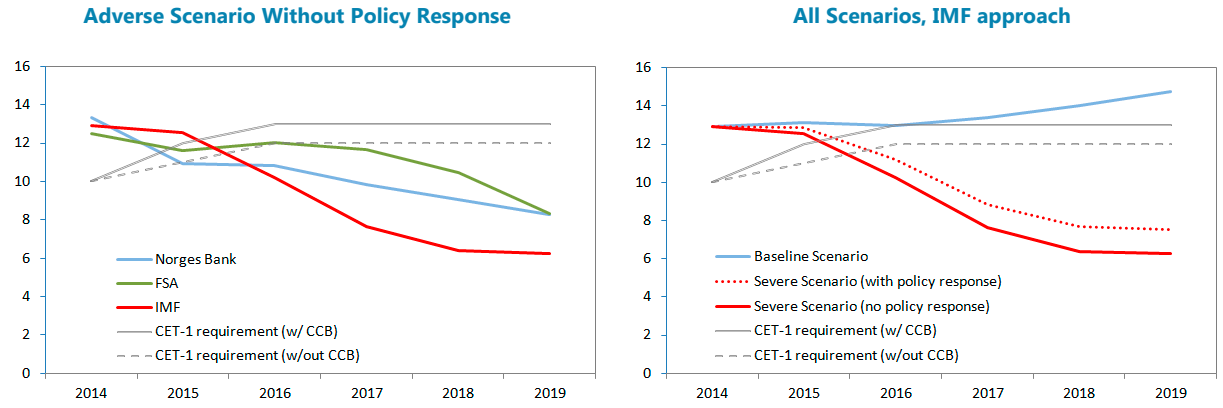
banks, in the aggregate, in the absence of any macroeconomic shocks (under the stress test's baseline scenario), banks are expected to be able to meet the new requirements.

35. However, in case of deterioration of macroeconomic conditions, as assumed in the adverse scenarios, banks could experience considerable losses and face recapitalization needs. The CET-1 ratio would fall by between 4.1 and 6.7 percentage points to the 6.3–8.3 percent range under the adverse scenario without policy response (depending on the specific approach; Figure 12). The three approaches, used by the FSA, NB and the IMF, are broadly consistent. However, the IMF's approach results in most significant losses and decline in capitalization (from 12.9 percent at end–2014 to 6.3 percent at end–2019 under the adverse scenario without policy response), given that it uses parameters based on global experience with severe crises. The Norwegian authorities use historical risk parameters on banks' credit exposures (PDs and problem loans respectively), which in view of Norway's long history of low credit risks—particularly for household exposures—results in more moderate results. Overall, the loss in capitalization is driven by: (i) the increase in loan losses (contributing by an average of 1.4 percent a year to the decline of the CET-1 ratio under the scenario with no policy response); (ii) the rise of RWAs (contributing by 0.8 percent); and (iii) higher funding costs (0.3 percent, Figure 17). The capital shortfall under the adverse scenario without policy response would amount to 2.7 percent to 4.6 percent of GDP by 2019, depending on the estimate (Figures 15 and 16).

36. Most credit losses stem from corporate exposures, while those from household exposures are small.[27] Under the FSA's and NB's TD approaches, which are calibrated on Norway's historical experience, loss rates on household exposures fall in the range of 0.2 to 1.1 percent per year, well below corporate losses of 0.7 to 2.7 percent (Figure 13). The low magnitude of household credit costs in part reflects the low anticipated impact of macroeconomic deterioration on domestic households, in view of the full recourse nature of mortgage loans and high welfare support. However, it also relates to the constraints of modeling the impact of severe stress in environments of limited past credit quality variability, as discussed previously. Potential corporate losses, on the other hand, are expected to be large, in line with Norway's experience during the crisis of the 1990s. Banks' direct losses from the oil sector are small, reflecting limited lending activity in the sector. Indirect credit losses from oil-related corporate exposures are likely significantly higher, but risk quantification is hampered by the need to establish a reliable way to identify such exposures.

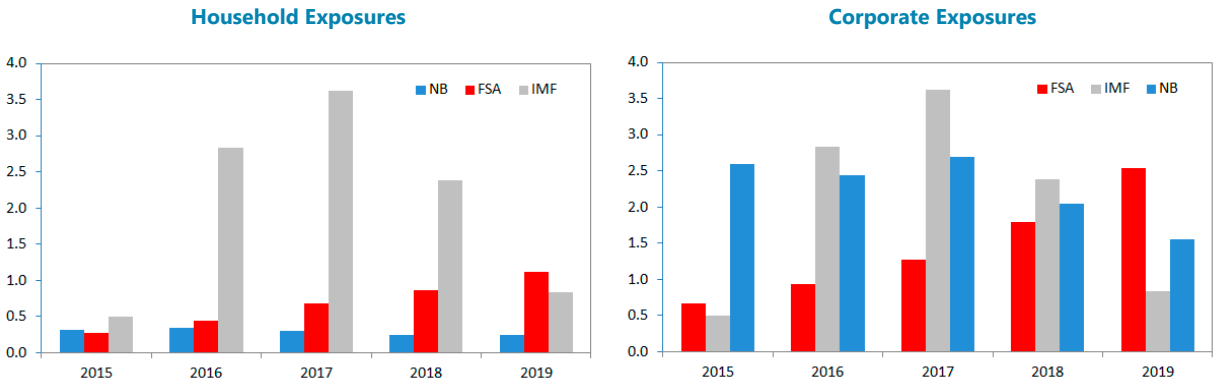
[27] Off-balance sheet exposures were not included in the analysis to ensure coverage comparability across TD approaches, given that the FSA's and NB's models do not account for these. However, the FSAP team conveyed the importance of incorporating these for ensuring comprehensiveness in measuring systemic risks.

Figure 12. CET-1 Ratios under Various TD Stress Testing Approaches
(In percent)



Sources: Norges Bank; FSA; and IMF staff estimates.

Figure 13. Household and Corporate Loss Rates, Adverse Scenario without Policy Response
(In percent)

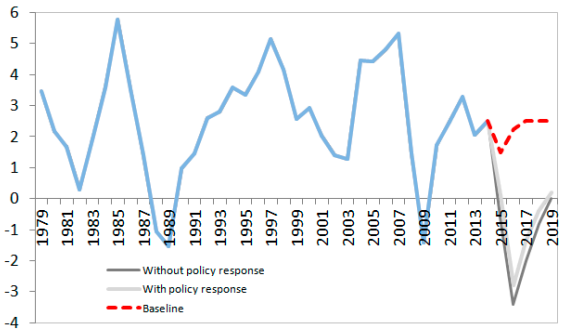


Sources: Norges Bank; FSA; and IMF staff estimates.

Note: The IMF approach assumes the same loss parameters for household and corporate loans, as these are calibrated on international experience with aggregate bank losses during periods of distress.

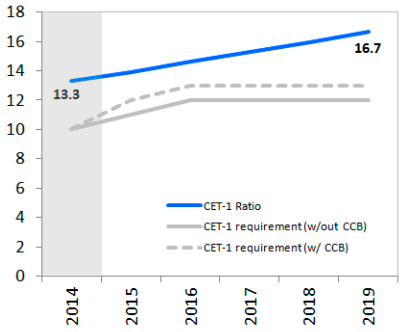
Figure 14. Solvency Stress Tests: Baseline Scenario

Growth of Real Mainland GDP
(In percent)

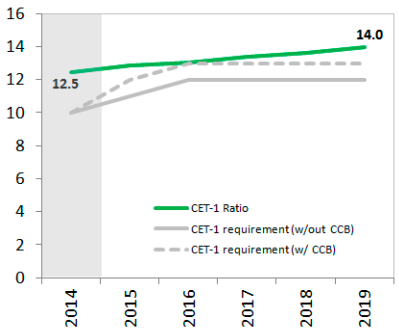


CET-1 Equity Ratios in Baseline
(In percent of RWA)

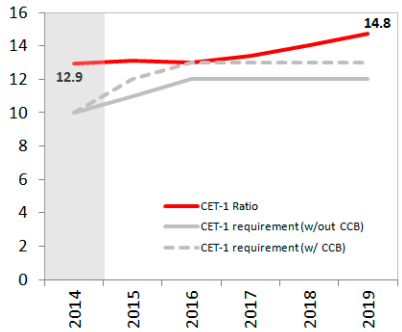
Norges Bank Calculations



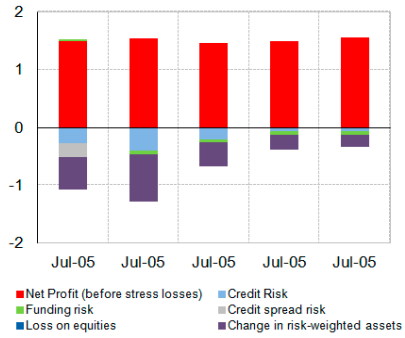
FSA Calculations



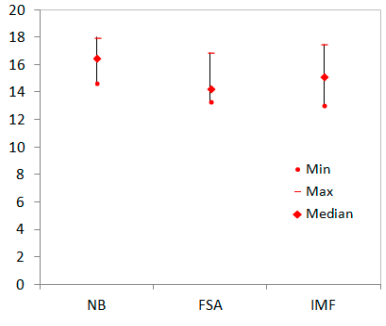
IMF Calculations



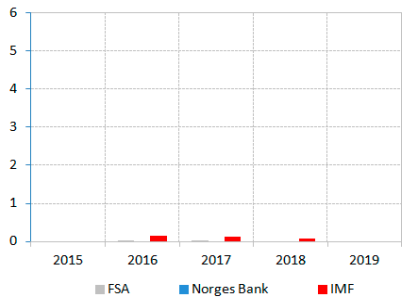
Drivers of CET-1 Ratio Changes, IMF
(In percentage points)



Distribution of CET-1 Ratios
(In percent; end–2019)



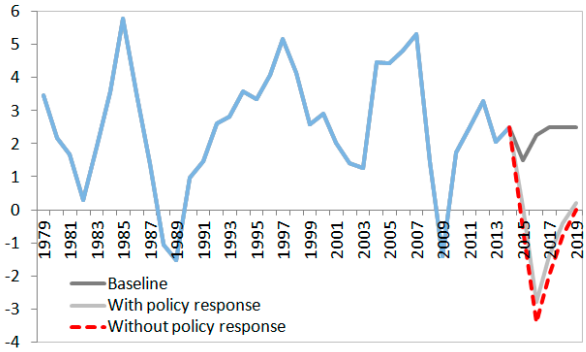
Expected Recapitalization Needs
(In percent of GDP)



Sources: Norges Bank; FSA; and IMF staff estimates.

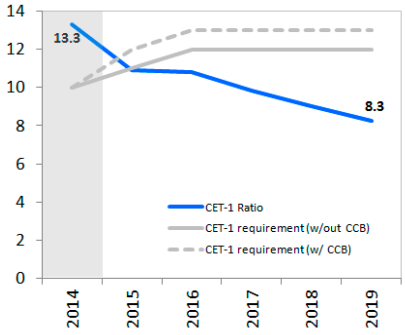
Figure 15. Solvency Stress Tests: Adverse Scenario, Without Policy Response

Growth of Real Mainland GDP
(In percent)

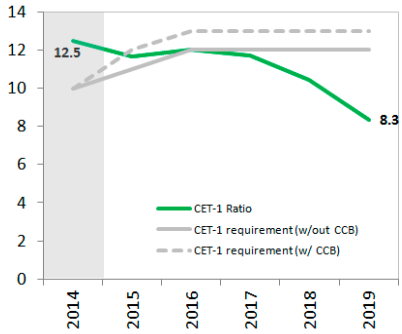


CET-1 Equity Ratios under Stress
(In percent of RWA)

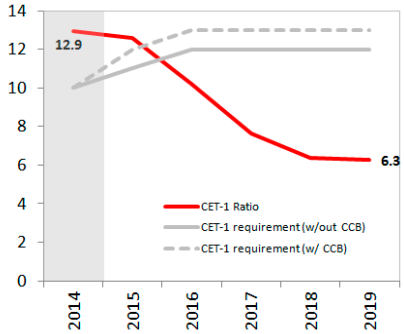
Norges Bank Calculations



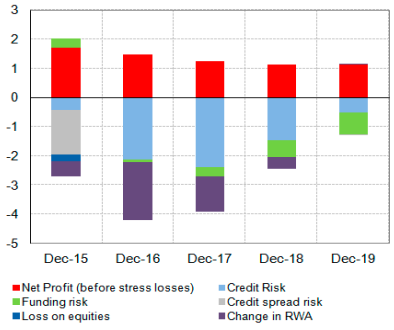
FSA Calculations



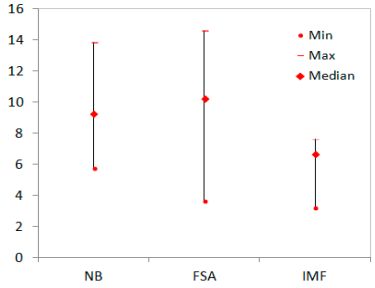
IMF Calculations



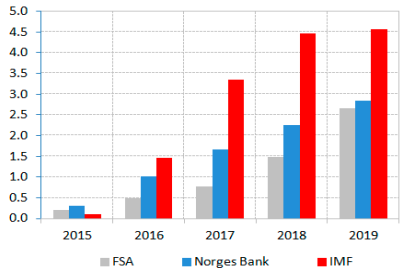
Drivers of CET-1 Ratio Changes, IMF
(In percentage points)



Distribution of CET-1 Ratios
(In percent; end–2019)

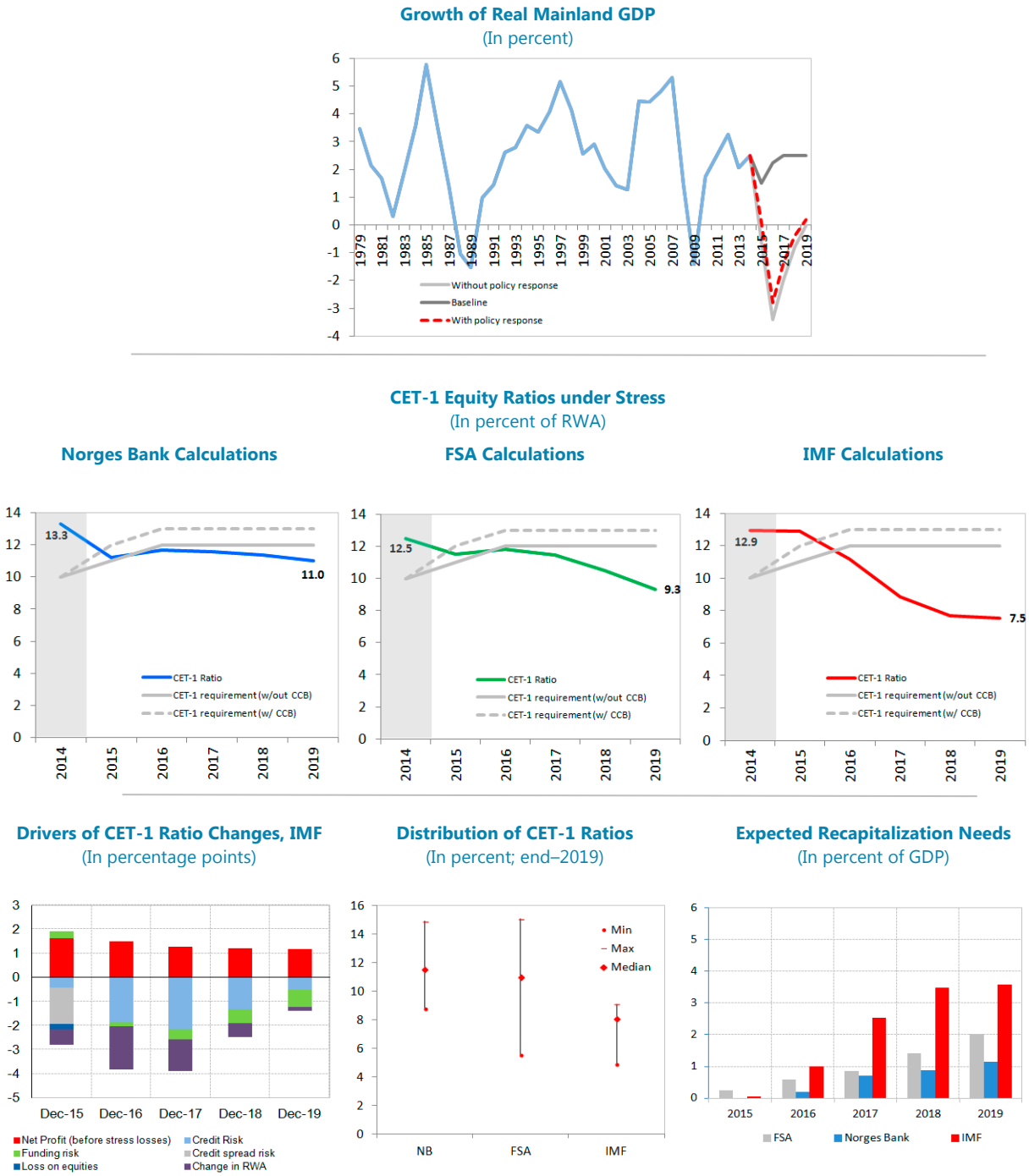


Expected Recapitalization Needs
(In percent of GDP)



Sources: Norges Bank; FSA; and IMF staff estimates.

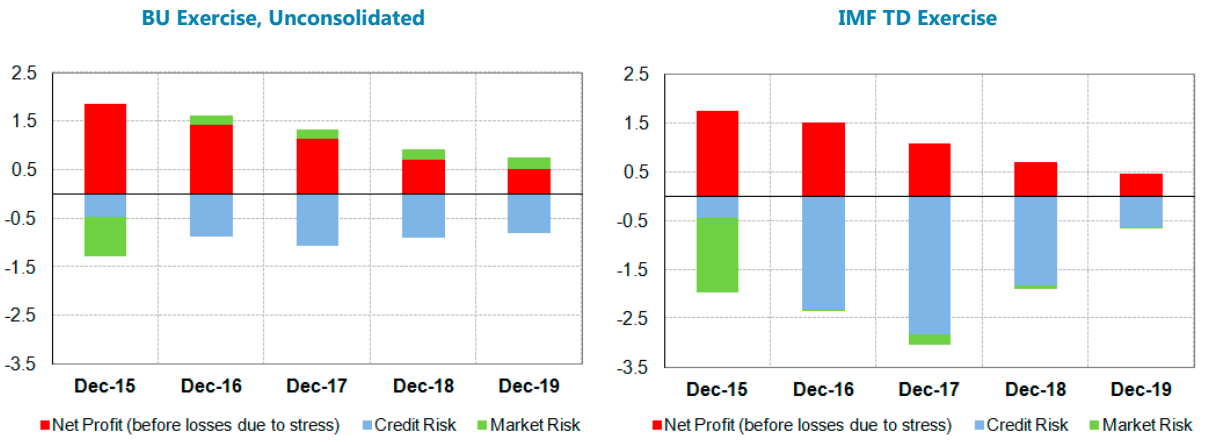
Figure 16. Solvency Stress Tests: Adverse Scenario, With Policy Response



Sources: Norges Bank; FSA; and IMF staff estimates.

37. The adverse effects on capitalization are significantly milder in the BU stress tests, suggesting that banks should consider introducing more conservative assumptions in their models. Under the BU approach, the CET-1 ratio for the banking sector declines by 0.6 percent (unconsolidated basis) and 1.4 percent (consolidated basis) over the stress testing horizon, far less than the 4.1—6.7 percentage point drop under the TD approaches. The discrepancy is, to a large extent, driven by lower assumed credit loss rates in the BU approach, which reach 1 percent a year during the peak of the stress, compared to 1.5 to 3.6 percent in the TD approaches (Figures 17 and 18).[28] This suggests that banks could be more conservative in the calibration of risk parameters. For example, some banks tend to depend on expert judgment in modeling losses on large corporate exposures, which could be slower-moving in stressed environments. Also, banks' estimates of household losses are subject to survivorship bias, given that present-day banks were not exposed to considerable losses during the banking crisis of the early 1990s.

Figure 17. Contributions to Changes of the CET-1 Ratio, Adverse Scenario without Policy Response
(In percent of risk-weighted assets)

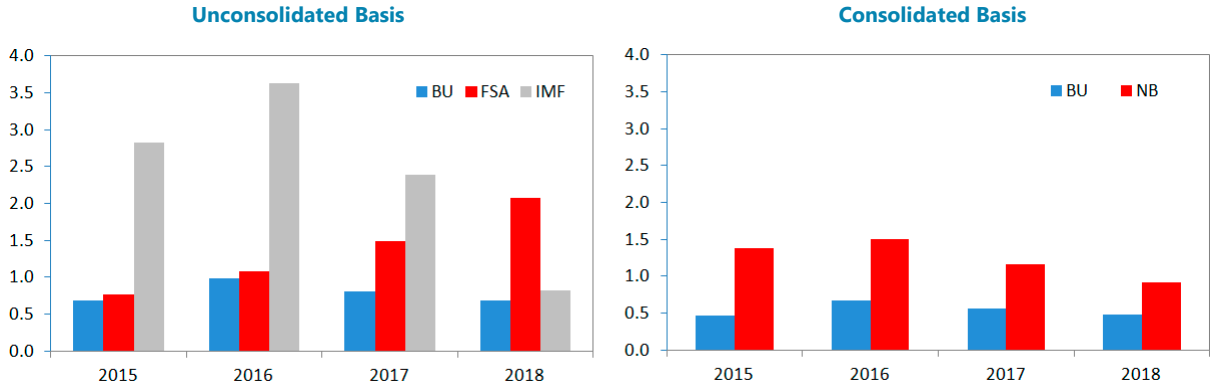


Sources: Participating banks; and IMF staff estimates.

Note: The results of the BU and TD stress testing results were compared on the assumption that the RWAs follow the same path as the RWAs in the BU approach to ensure comparability of the two sets of results.

[28] BU stress tests also reveal that banks' solvency risks tend to be lower on a consolidated basis, given that banks transfer their highest-quality household loans to the mortgage companies that they own.

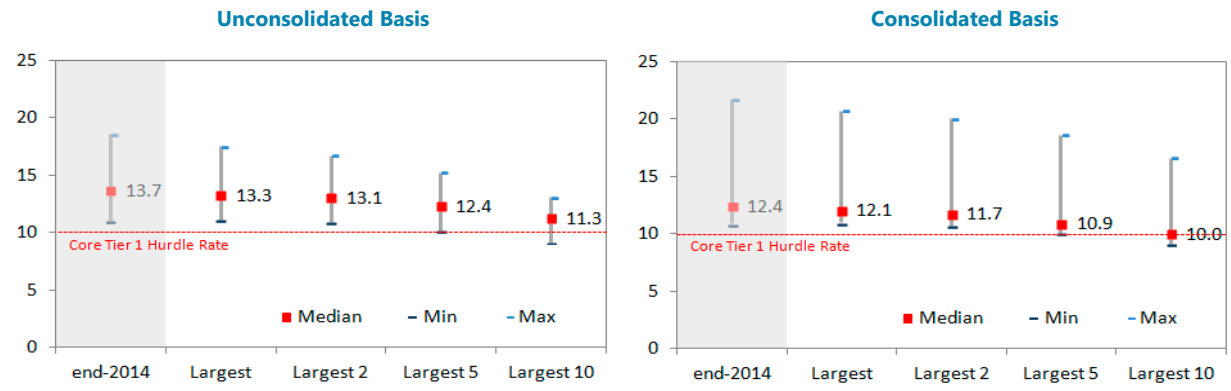
Figure 18. Aggregate Loss Rates, BU and TD Exercises, Adverse Scenario without Policy Response
(In percent of loan exposures)



Sources: Norges Bank; FSA; participating banks; and IMF staff estimates.

38. Sensitivity tests suggest that Norwegian banks' risks related to credit concentration and exchange rate risks are limited. Credit concentration risk was evaluated via BU simulations of defaults of banks' largest borrowers (up to the 10 largest borrowers). The shocks were applied to banks' end–2014 positions and were assumed to materialize immediately. Banks were found to be able to absorb defaults of their largest clients, with CET-1 ratios above the regulatory minimum even after the default of their 10 largest borrowers (with only one smaller bank in need for additional capital) (Figure 19). The impact of large foreign exchange shocks—set at two times the maximum shift of the annualized FX volatility from its long-term level—is found to be negligible, as banks' FX open positions are very small and well below position limits.

Figure 19. Sensitivity Analysis: Impact of Credit Concentration on Banks' Capitalization
(In percent; CET-1 ratios)



Sources: Participating banks; and IMF staff estimates.

LIQUIDITY STRESS TESTS

A. Framework

39. The liquidity stress tests assessed the resilience of Norwegian banks to sizable sudden funding outflows, and their access to stable funding, based on recalibrated Basel III metrics. The liquidity stress tests were completed on a TD basis, independently from the solvency risk analysis, based on data as of end–2014, and separately as of end–September 2014.[29] The impact of potential liquidity shocks was evaluated both with respect to banks' FX and local currency liquidity positions. The analyses were carried out on a consolidated basis (67 percent of aggregate banking sector assets), thus accounting for bank-owned mortgage companies. In line with other FSAPs, the tests were calibrated to reflect more extreme *system-wide* shocks than precedents in Norway. Accordingly, the estimated impact should be treated as indicative of liquidity conditions under very severe system-wide distress.

40. The quantitative standards under the Basel III liquidity framework provide a valuable basis for building liquidity stress tests that are comparable across countries.[30] For this reason, Basel III metrics are increasingly applied in FSAPs. In the case of Norway, their use was also motivated by the fact that the underlying LCR data, which banks are expected to report on an ongoing basis, is considerably more granular than other available information. The Basel III framework is meant to enhance banks' liquidity risk management practices, and as such captures important aspects of banks' liquidity, such as banks' counterbalancing capacity (i.e. availability of high-quality assets to meet funding needs in the event of stress), and the stability of their funding structure. The two metrics that underlie the evaluation of banks' liquidity positions include:

- **LCR.** This ratio is meant to ensure that banks maintain sufficient holdings of high-quality liquid assets (HQLAs) to withstand funding run-offs over a specified time period. Under the standard version, banks are expected to meet the LCR requirement under a 30–day stressed scenario (as specified by Basel and national supervisors). Banks' HQLA holdings (the numerator) should be sufficient to cover potential net cash outflows (subject to a 75 percent cap on cash inflows; the denominator), with an LCR of less than 100 percent indicating a funding shortfall. While the LCR is expected to be phased in Norway from October 1, 2015, Norwegian banks face a shortage of HQLAs in NOK.[31] To counteract systemic risks related to a potential sharp increase in cross-

[29] The end-2014 data are based on the HQLA definition (and related haircuts) of the EU LCR Delegated Act, adopted in October 2014. In contrast, the LCR data as of end-September 2014 are based on the original Basel III definition. The use of two alternative specifications here is motivated by the need to evaluate whether the broader definition of HQLA under the EU regulations (now including high-quality covered bonds of which Norwegian banks have large holdings) has had a positive impact on their liquidity positions.

[30] In the EU, the Basel III liquidity requirements (the LCR and the net stable funding ratio (NSFR)) are being introduced through the Capital Requirements Directive IV (CRD IV).

[31] Under EU regulations, banks can meet the LCR requirement via alternative mechanisms, such as use of other HQLAs in the same currency (subject to higher haircuts); HQLAs in other currencies; or a central bank credit facility.

holdings of covered bonds (due to high availability of covered bonds), NB has (on a preliminary basis) suggested a regulatory NOK LCR of 60 percent.

- **NSFR.** This ratio aims at ensuring that banks have sufficiently stable longer-term funding structure (over one year) to curb excessive maturity transformation and resulting liquidity mismatches. The final specification of the NSFR is still subject to deliberation, even though the Basel Committee has published a consultative paper and the ratio is expected to be introduced in the beginning of 2018.[32] Under the current proposal, banks would be expected to have sufficient stable funding (under a stress scenario) to cover longer-term lending and investment activities on an ongoing basis. In cases where stable funding (including customer deposits; wholesale funding with maturities of more than a year; and equity) is insufficient to cover longer-term assets, the NSFR (the ratio of the two) would be less than 100 percent, indicating a stable funding shortfall.

41. The system-wide ability of banks to withstand funding outflows was evaluated within the framework of the Basel III / CRD IV LCR. The tests simulated a sudden, sizable withdrawal of wholesale funding, and evaluated the ability of banks to maintain unencumbered HQLAs above expected liquidity needs under very severe stress scenarios over a 30–day horizon. In this set-up, cash flows were assumed to be affected via the following channels: (i) a sudden dry-up of or restricted access to funding markets ("funding liquidity risk"); (ii) cash inflows due to maturing assets and assets that are either repo-able or saleable at stressed market values ("market liquidity risk"); and (iii) scheduled cash outflows. Funding distress was assumed to affect all banks simultaneously, with systemic liquidity problems being associated with higher deposit run-off rates and fire-sale of assets than under idiosyncratic events.

B. Scenarios

42. The scenarios used were consistent with extremely severe market liquidity stress. The underlying assumptions applied to the LCR—including on potential amortization / renewal rates, decline in asset values, and callback rates on contingent claims and liabilities, among others—have a direct bearing on the severity of estimated net cash outflows and banks' counterbalancing capacity, and hence on the liquidity measures. The FSAP tests evaluated three scenarios: a baseline scenario and two adverse scenarios. The baseline scenario is identical to that in the standard LCR (Table 4). The two adverse scenarios assume: (i) *a complete dry-up of unsecured wholesale funding*, motivated by the experience of the 2008 crisis; and (ii) *a complete dry-up of secured wholesale funding, with a partial dry-up of unsecured wholesale funding* (including corporate deposits), and strong outflows of committed credit and liquidity facilities.[33,34] The adverse scenarios are motivated by the global

[32] See Basel Committee for Banking Supervision (BCBS), 2014, "Basel III: The Net Stable Funding Ratio," BCBS Publication No. 271, January (Basel: Bank for International Settlements), available at: http://www.bis.org/publ/bcbs271.pdf.

[33] The experience of the 2008 global financial crisis showed that unsecured lending can evaporate quickly. A systemic liquidity dry-up (as assumed in the first scenario) reflects high actual or perceived counterparty credit risks, with very high degree of asymmetric information accounting for loss of funding even for high-quality borrowers.

liquidity distress during the 2008 crisis and the IMF's analysis of past liquidity crises (with shocks of similar or more severe magnitude). Cash inflow rates and asset haircuts are assumed to be identical to those in the LCR.

Table 4. TD Liquidity Stress Scenarios: 30–day Cash Outflows
(In percent)

Cash Outflows (30-day)	Baseline	Dry-out of Unsecured Funding	Dry-out of Secured Funding
Deposits			
Retail deposits covered by deposit guarantees	5%	7%	7%
Retail deposits - other	10%	15%	15%
Unsecured wholesale funding			
Operational deposits	25%	100%	35%
Non-financial corporates, sovereigns, CBs and PSEs			
Fully covered by deposit insurance	20%	100%	25%
Not fully covered by deposit insurance	40%	100%	40%
Other legal entity customers	100%	100%	100%
Secured wholesale funding			
Backed by Central Bank or Level 1 assets	0%	0%	100%
Backed by Level 2 assets	15%	15%	100%
Backed by non-Level 1 or non-Level 2a asset	25%	25%	100%
(domestic sovereign, CB or PSEs as a counterparty).			
Backed by RMBS eligible as Level 2b assets	25%	25%	100%
Backed by other Level 2b assets	50%	50%	100%
Other transactions	100%	100%	100%
Undrawn but committed credit and liquidity facilities			
Retail and small business	5%	5%	25%
Non-financial corporates, sovereigns, CBs and PSEs			
Credit facilities	10%	10%	30%
Liquidity facilities	30%	30%	30%
Supervised banks	40%	40%	80%
Other financial institutions			
Credit facilities	40%	40%	80%
Liquidity facilities	100%	100%	100%
All others	100%	100%	100%

Source: IMF staff estimates.

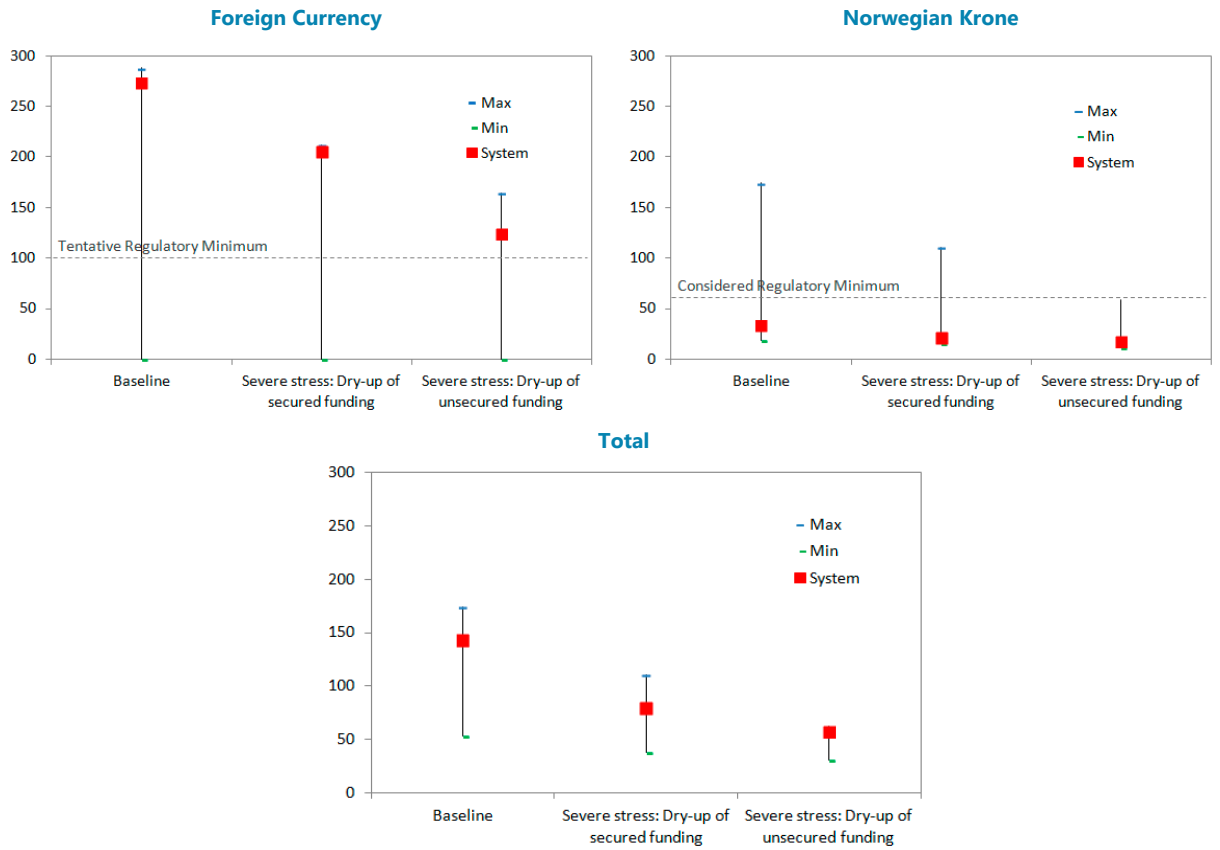
Note: All other haircuts are as specified by the regulatory LCR.

[34] Secured funding is generally more stable, reflecting the availability of pledged collateral. However, as seen during the 2008 crisis, previously highly liquid markets (e.g., parts of the repo market) can dry up as well, even though funding transactions secured against assets that continued to be perceived as safe (e.g., U.S. Treasuries or agency debentures) did not experience a complete liquidity dry-up. This scenario was, thus, carried out as a complement to the first scenario and reflects a possible loss of investor confidence in Norwegian covered bonds, perhaps due to the build-up of sizable credit risks in the system.

C. Results

43. The results show that, despite improvement, the Norwegian banking sector remains exposed to liquidity risks related to the limited availability of liquid NOK instruments. Even in the baseline, some banks fall short of the 60 percent minimum NOK LCR, currently proposed by NB. The aggregate LCR for the banking sector declines from 33 percent in the baseline to 18 percent under a dry-up of unsecured wholesale funding (Figure 20), with the corresponding NOK liquidity gap growing to NOK306 billion from NOK120 billion in the baseline. Under the (second) adverse scenario of a dry-up of secured wholesale funding, the gap is NOK232 billion. Banks' FX liquidity positions are generally better. Most banks are above the 100 percent LCR threshold under Basel III, with aggregate LCR at 124 percent in case of a complete dry-up of unsecured funding (the most adverse scenario). The FX funding gaps are generally small, and increase to NOK5.3 billion (in case of dry-up of unsecured wholesale funding) and NOK3.7 billion (in case of dry-up of secured wholesale funding) from NOK3 billion in the baseline.

Figure 20. LCR in Baseline and under Stress, end–2014
(In percent)

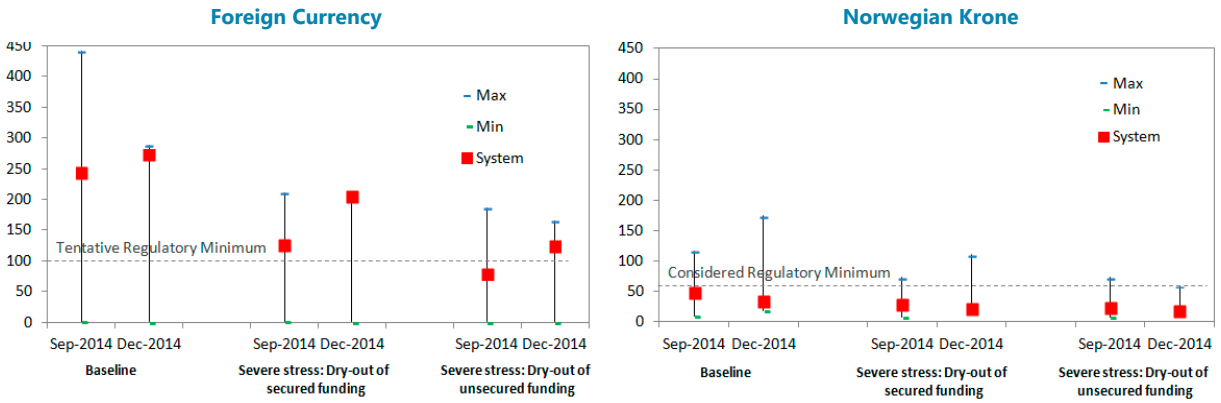


Source: IMF staff estimates based on data from the FSA.

Note: The secure wholesale market dry-up scenario also assumes higher deposit and contingency funding run-offs relative to the unstressed LCR.

44. Banks' ability to counteract potential liquidity shocks improves only partly under the broader recognition of covered bonds as HQLAs in the new EU LCR rules. Under the EU Delegated Act (adopted in October 2014), the set of permissible HQLAs was expanded to include high-quality covered bonds that meet certain criteria.[35] Norwegian banks' relatively large holdings of qualifiable covered bonds under the new rules—about 25 percent of HQLAs in NOK, and 21 percent in FX as of end–2014—were expected to boost banks' ability to withstand liquidity shocks (i.e. their counterbalancing capacity). A comparison of stress test results as of end–2014 (per EU rules) and end–September 2014 (per Basel III rules) shows that Norwegian banks' liquidity positions improved in FX terms. However, LCRs deteriorated further in NOK terms, with the aggregate NOK LCR for the banking system at 33 percent, down from 49 percent at end–September 2014 (Figure 21).[36] This reflects the rapidly changing nature of banks' liquidity profiles, and hence the need to monitor frequently the liquidity positions of domestic banks. In addition, banks' increased reliance on covered bonds as HQLAs raises concerns about a rise in liquidity risks due to the high cross-ownership of these instruments, as discussed previously.

Figure 21. LCR in the Baseline and under Stress, end–September 2014 and end–2014
(In percent)



Source: IMF staff estimates based on data from the FSA.

[35] Certain qualifying covered bonds can be categorized as Level 1 HQLAs (in a newly created Level 1B category), up to a ceiling of 70 percent and at a haircut of 7 percent. Covered bonds that don't qualify as Level 1B assets can also be part of Level 2A HQLAs (with haircuts in line with Basel rules), and as Level 2B assets (under the EU rules).

[36] Banks' counterbalancing capacity can be enhanced by the ready availability of liquid assets, other than HQLAs, that are eligible for access to NB's standing facilities. Norwegian banks do hold additional assets (mostly covered and corporate bonds, including own issuances) that do not meet the requirements of the European Banking Authority (EBA), but are legally and practically readily available at any time and are under the control of the liquidity management function. The FSAP team was unable to verify these instruments' eligibility for NB's standing facilities. However, even under lenient haircuts (in line with Level 2b assets of the LCR), banks' liquidity conditions remain broadly similar.

FURTHER CONSIDERATIONS

45. Stress tests should always be interpreted with caution, as they are subject to data, methodology and coverage constraints.

- **Data limitations.** The FSAP stress tests are based on market and supervisory data that are collected (and hence, reflect risks) at a specific point in time, and have not been subject to an independent data validation.

- **Data coverage constraints.** The FSAP stress tests were subject to certain data coverage limitations. For example, the tests do not include certain segments of the banking system (e.g., smaller commercial and savings banks, and foreign bank branches), as well as credit exposures to sectors other than corporates and households.

- **Ability to account for feedback loops.** Similarly to many other stress tests, the FSAP solvency tests do not capture nonlinear macrofinancial feedback channels. In Norway, the amplification of credit risks via some of these channels—for example, a downward spiral in housing prices—are mitigated by structural features of the Norwegian system, such as high household wealth, and ample and long-lasting unemployment benefits. However, in the absence of models able to capture such effects, it is not feasible to quantify the possible downward bias in credit risk estimates. Moreover, the tests, by design, do not account for the impact of banks' response to financial distress, such as a change in their business mix.

46. The authorities have built robust stress tests frameworks, but there are areas where these could be enhanced further.

- **Augmenting household credit risk measurement.** Given the low sensitivities of household default measures to changes in macroeconomic conditions, the Norwegian authorities may want to supplement existing measures of household credit risk with measures based on international experience. The limited variability and short data spans of household problem loans and PDs account for weak statistical relationships between household credit risk measures and macroeconomic conditions. Thus, even under very extreme macroeconomic scenarios—including an assumed 40 percent drop in real housing prices—credit risks related to household exposures are perhaps underestimated. The "rule of thumb" applied by the FSAP stress testing team is only one possible approach in this regard.

- **Incorporating market risks in solvency stress tests.** The authorities intend to expand their TD solvency modules to account for market risks, related to bond, equity and (possibly) derivatives holdings. This will enhance their stress tests framework.

- **Cross-validating BU and TD stress test results.** At present, Norwegian banks appear to be well-positioned to meet the regulatory capital requirements under the baseline projections. Moreover, even under severe shocks, the high potential losses in the FSAP stress tests appear manageable. However, the possible underestimation of risks in the BU stress tests warrants

further cross-validation of the TD and the BU exercises and justifies continued proactive steps to ensure that banks maintain sound capital buffers. The FSA's use of additional Pillar 2 buffers has been valuable in this regard.

- **Enhancing the liquidity stress testing framework.** The authorities monitor banking sector liquidity in several ways, including via ongoing onsite supervision, ad hoc requests from banks and use of reporting tools, including the LCR, the NSFR, past cash inflows and outflows, and tenor buckets of maturing assets and liabilities. In addition, banks' liquidity situation is followed more closely, via more frequent reporting, in cases where there are indications of higher funding market volatility. However, to further enhance their ability to monitor and reduce the potential risks related to banks' wholesale funding exposures, the authorities could consider further steps, such as performing liquidity stress tests using the structure of cash flows at various maturities; or performing customized versions of the LCR more closely aligned with banks' funding profiles.[37] The adoption of such approaches would require time, particularly in view of the changing nature of banks' reporting requirements, but it would facilitate a more anticipatory approach to identifying potential liquidity difficulties.

[37] For examples of TD supervisory liquidity stress testing frameworks, see: Basel Committee on Banking Supervision, 2013, "Liquidity stress testing: a survey of theory, empirics and current industry and supervisory practices", *Working Paper No. 24*. These include balance sheet approaches (e.g., Bank of Italy); simulation methods (e.g., Netherlands Bank); or more integrated approaches (e.g., Austrian National Bank).

Appendix I. Risk Assessment Matrix[38]

Source of Risk and Relative Likelihood (High, medium, or low)	Expected Impact if Threat is Realized (High, medium, or low)
High / Medium **Protracted period of slower growth in key advanced and emerging economies** • *Euro Area and Japan:* Weak demand and persistently low inflation from a failure to fully address crisis legacies and appropriately calibrate macro policies, leading a "new mediocre" rate of growth. • *Emerging markets:* Maturing of the cycle, misallocation of investment, and incomplete structural reforms leading to prolonged slower growth.	**High** • Protracted slower global growth would weaken non-oil exports and contribute further to lower oil prices. This would result in economic slowdown and higher unemployment, due to a fall in exports and less oil investments. • Lower asset prices would impact negatively GPFG's rate of return.
High **A surge in global financial volatility** • Prices of risky assets drop abruptly as investors reassess underlying risk and move to safe assets, associated with a rise in actual and expected volatility. Global growth would be impacted negatively as some countries face a tight policy mix, given higher financing costs and fiscal sustainability concerns, and constraints on accommodative monetary policies.	**Medium** • Renewed stress in global wholesale funding markets would lead to liquidity strains for Norwegian banks that rely on FX wholesale funding. The large presence of foreign-owned banks increases spillover risks. • Impaired global demand would lead to an economic slowdown, due to a fall in exports, less oil investments, and impaired consumer confidence.
Medium **Protracted low energy prices** • Persistently low energy prices are triggered by supply factors reversing only gradually, and weaker global demand.	**High/ Medium** • Persistently low oil prices would weaken growth directly via a reduction in the oil-related demand for mainland goods and services, and indirectly via a reduction in demand for housing due to confidence effects or a reversal of immigrant inflows.
Medium **A significant drop in house prices** • Norway has the highest house price-to-rent ratio relative to its historical average among OECD economies. Although this can be partly explained by fundamentals, there is a risk of significant overvaluation.	**High** • A fall in house prices would dampen private consumption and reduce residential investment. • The high household debt level may cause a sharp contraction in household consumption and retail sales, leading to a potential rise in default rates and higher solvency risks for banks.

[38] The Risk Assessment Matrix (RAM) shows events that could materially alter the baseline path (the scenario most likely to materialize in the view of IMF staff). The relative likelihood of risks listed is the staff's subjective assessment of the risks surrounding the baseline ("low" is meant to indicate a probability below 10 percent, "medium" a probability between 10 and 30 percent, and "high" a probability between 30 and 50 percent). The RAM reflects staff views on the source of risks and overall level of concern as of the time of discussions with the authorities. Non-mutually exclusive risks may interact and materialize jointly.

Appendix II. Stress Test Matrices

Table AII.1. Stress Test Matrix (STeM) for the Banking Sector: Solvency and Liquidity Risks

SOLVENCY				
Domain	**Assumptions**			
	Bottom-up by Banks	**Top-down by Finanstilsynet**	**Top-down by Norges Bank**	**Top-down by the IMF**
Institutions included	• Top 6 commercial and savings banks: DNB Bank, Nordea Bank Norge, SpareBank 1 SR-Bank, SpareBank 1 SMN, SpareBank 1 Nord-Norge, and Sparebanken Vest.	• Top 6 commercial and savings banks: DNB Bank, Nordea Bank Norge, SpareBank 1 SR-Bank, SpareBank 1 SMN, SpareBank 1 Nord-Norge, Sparebanken Vest.	• Top 6 commercial and savings banks: DNB Bank, Nordea Bank Norge, SpareBank 1 SR-Bank, SpareBank 1 SMN, SpareBank 1 Nord-Norge, Sparebanken Vest	• Top 6 commercial and savings banks: DNB Bank, Nordea Bank Norge, SpareBank 1 SR-Bank, SpareBank 1 SMN, SpareBank 1 Nord-Norge, Sparebanken Vest.
Market share	• 75 percent of banking sector assets (excluding mortgage companies; unconsolidated basis). • 67 percent of banking sector assets (including mortgage companies; consolidated basis).	• 75 percent of banking sector assets (excluding mortgage companies).	• 67 percent of banking sector assets (including mortgage companies).	• 75 percent of banking sector assets (excluding mortgage companies)
Data and baseline date	• Banks' internal data as of December 2014.	• Bank-by-bank supervisory data as of December 2014.	• Bank-by-bank commercial data and aggregate data as of September 2014.	• Bank-by-bank supervisory data and aggregate data as of December 2014.
Consolidation	• Consolidated and unconsolidated basis (2 tests).	• Unconsolidated basis.	• Consolidated basis (including mortgage finance companies).	• Unconsolidated basis.

SOLVENCY				
Domain	**Assumptions**			
	Bottom-up by Banks	**Top-down by Finanstilsynet**	**Top-down by Norges Bank**	**Top-down by the IMF**
Methodology	• Banks' internal risk management framework. • Guidance from FSAP team.	• Finanstilsynet models.	• Norges Bank's models	• Global "rule of thumb" approach and balance sheet solvency framework.
Stress test horizon	• 5 years.	• 5 years.	• 5 years.	• 5 years.
Exposure coverage	• Credit risks related to: (i) aggregate exposures; (ii) sectoral exposures (e.g., corporate, mortgages, other household lending; other financial institutions; FX loans); (v) exposures to industries; and (vi) exposures to up to 10 largest obligors.	• Credit risk-sensitive (corporate and household loans) and market risk-sensitive exposures (equity and debt)	• Credit risk-sensitive (corporate and household loans) and market risk-sensitive exposures (equity and debt)	• Credit risk-sensitive (corporate and household loans) and market risk-sensitive exposures (equity and debt)
Shocks	*Scenario analysis (scenarios generated by the Norges Bank macroeconomic model)* • **Baseline:** IMF staff macroeconomic projections as of December 2014, estimated via NB's macro model. • **Upsurge in global financial volatility and a considerable slowdown of global growth (w/out policy reaction):** A permanent rise in domestic and global spreads (money market spreads: up by about 200 basis points; wholesale funding spreads: up by additional 150 basis points (over stress testing horizon; relative to baseline)); a slowdown of the world economy; sustained drop of oil prices (to $40) over stress-testing horizon, starting in 2015; a real house price decline of 40 percent over 5 years; a cumulative 5–year decline of 6.7 percent in real Mainland GDP (16.1 ppt cumulative drop relative to baseline). • **Upsurge in global financial volatility and a considerable slowdown of global growth (w/ policy reaction):** Identical scenario, but allowing for monetary policy easing (policy rate down by 1½ ppts in 2015-16); a cumulative 5–year decline of 4.3 percent in real Mainland GDP (13.9 ppt cumulative drop relative to baseline).			

SOLVENCY				
Domain	**Assumptions**			
	Bottom-up by Banks	**Top-down by Finanstilsynet**	**Top-down by Norges Bank**	**Top-down by the IMF**
Shocks	*Sensitivity Analysis* • Exchange rate depreciation: Effect on the net open positions in the trading book. For each currency, the shock is set at two times the maximum shift of the annualized FX volatility from its long-term level. • Credit concentration risk: default of the largest one, three, five and ten exposures.	• N/A	• N/A	• N/A
Risks / factors assessed	• Market risk (incl. sovereign debt). • Funding cost risks.	• Market risk (incl. sovereign debt). • Funding cost risks.	• Market risk (incl. sovereign debt). • Funding cost risks.	• Market risk (incl. sovereign debt). • Funding cost risks.
Behavioral adjustments	• Balance sheets are assumed to be static, except for credit growth, based on macro model (no deleveraging allowed). Corresponding funding increases in line with projections from macro model. Credit growth does not take into account any contemporaneous asset impairments. • No changes in structural business models and in managerial decisions (e.g., strategic asset disposals; changes in funding structure; dynamic RWA management) allowed. • Dividend payout ratio assumed to be zero under stress. • Income composition assumed to remain constant. • Asset disposals not permitted (apart from credit growth projection). • No raising of new capital allowed.			
Behavioral	• Risk-weighted Assets (RWA)	• RWA assumed to follow the	• RWA for credit risk set to	• RWA for credit risk assumed

SOLVENCY				
Domain	**Assumptions**			
	Bottom-up by Banks	**Top-down by Finanstilsynet**	**Top-down by Norges Bank**	**Top-down by the IMF**
adjustments	assumed to be adjusted in line with PDs (IRB approach or standardized approach, depending on bank).	Basel IRB approach; through-the-cycle (TTC) PDs estimated as updated on long-term average PiT PDs.	increase in line with problem loan shares. For new lending, the marginal risk weight is assumed to be 40% for lending to households and 80% for lending to corporates. Norway's transitional rule of the Basel I floor is taken into account. • RWA for operational risk estimated at 15 percent of (Net interest income + Net commission income + (net) Other income) * 12.5. • RWA for market risk is set as a fixed share of the holdings of financial instruments (at fair value).	to follow the Basel IRB approach; TTC PDs estimated as updated on long-term average PiT PDs. • RWA for operational risk estimated at 15 percent of (Net interest income + Net commission income + (net) Other income) * 12.5. • RWA for market risk is set as a fixed share of the holdings of financial instruments (at fair value).
Regulatory standards	• RWA per Basel 2.5 and III. • Hurdle rates for regulatory capital (CET-1) based on Norway's schedule (accelerated Basel III schedule).			
Reporting format	• Post-shock solvency ratios and losses by type of exposure. • Distribution of capital ratios across the banking system; aggregated basis.			

LIQUIDITY	
Domain	**Assumptions**
	Top-down by the IMF
Institutions included	• Top 6 commercial and savings banks: DNB Bank, Nordea Bank Norge, SpareBank 1 SR-Bank, SpareBank 1 SMN, SpareBank 1 Nord-Norge, and Sparebanken Vest.
Market share	• 67 percent of banking sector assets (including mortgage companies; consolidated basis).
Baseline date	• September 2014 and December 2014.
Consolidation	• Consolidated basis.
Risks	• Systemic funding and market liquidity risks (withdrawal and market freeze; uniform shocks across banks; independent of solvency tests).
Buffers	• Counterbalancing capacity assessed via unencumbered assets at market values net of haircuts (by type of securities).
Test horizon	• 30 days.
Methodology	• LCR / NSFR. • Analysis assumes wholesale funding difficulties and deposit withdrawals (funding risk), and fire sales of assets (market liquidity risk) to meet liquidity constraints (market liquidity risk). Asset-specific haircuts are assumed.
Shocks	• The magnitude of the shocks is in line with the severe liquidity difficulties experienced by banks globally after the Lehman bankruptcy (first scenario) and IMF analysis of past liquidity episodes (second scenario). Both scenarios are more severe than the historical experience in Norway. • *Dry-up of unsecured wholesale funding:* Inability to rollover maturing unsecured wholesale funding. • *Dry-up of secured wholesale funding:* Inability to rollover maturing secured wholesale funding; deposit runs and withdrawal of contingent liabilities.
Regulatory standards	• LCR ratios; liquidity gaps; NSFR ratios.

LIQUIDITY	
Domain	**Assumptions**
	Top-down by the IMF
Reporting format	• Distribution of banks with LCR under 100 percent (FX liquidity) and 60 percent (domestic liquidity). • Liquidity shortfall (in absolute terms), both FX and LCR.