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ROMANIA

FINANCIAL SECTOR ASSESSMENT PROGRAM

June 2018

TECHNICAL NOTE—SYSTEMIC RISK ANALYSIS AND STRESS TESTING THE FINANCIAL SECTOR

This Technical Note on Systemic Risk Analysis and Stress Testing the Financial Sector on Romania was prepared by a staff team of the International Monetary Fund. It is based on the information available at the time it was completed on May 18, 2018.

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TECHNICAL NOTE

SYSTEMIC RISK ANALYSIS AND STRESS TESTING THE FINANCIAL SECTOR

Prepared By
Monetary and Capital Markets Department

This Technical Note was prepared in the context of a joint IMF-World Bank Financial Sector Assessment Program (FSAP) mission to Romania during October 31–November 21, 2017, and January 11–23, 2018 led by Erlend Nier, IMF and Laurent Gonnet, World Bank, and overseen by the Monetary and Capital Markets Department, IMF, and the Finance, Competitiveness and Innovation Global Practice, World Bank. The note contains the technical analysis and detailed information underpinning the FSAP assessment's findings and recommendations. Further information on the FSAP program can be found at http://www.imf.org/external/np/fsap/fssa.aspx.

CONTENTS

TABLES

APPENDICES

Glossary

AFS	Available for sale
ASF	Available Stable Funding
BMA	Bayesian Model Averaging
BPS	Basis Points
CAR	Capital adequacy ratio
CCB	Capital Conservation Buffer
CET1	Core Equity Tier 1
CRE	Commercial real estate
DSTI	Debt service to income ratio
EAD	Exposure at default
EBA	European Banking Authority
EU	European Union
FSAP	Financial Sector Assessment Program
FSR	Financial Stability Report
FX	Foreign Exchange
GDP	Gross domestic product
GFC	Global Financial Crisis
HFT	Held for trading
HQLA	High-quality liquid assets
HTM	Held to maturity
IRB	Internal ratings-based (approach)
LCR	Liquidity coverage ratio
LGD	Loss given default
LTV	Loan-to-value (ratio)
NBR	National Bank of Romania
NBFL	Nonbank Financial Lender
NFC	Nonfinancial Corporate
NII	Net interest income
NIM	Net interest margin
NPL	Nonperforming loan
NSFR	Net-Stable Funding Ratio
OSII	Other Systemically Important Institution
PD	Probability of default
PiT	Point-in-time
QPM	Quarterly Projections Model
RAM	Risk Assessment Matrix
ROA	Return on assets

ROBOR	Romania Interbank Offered Rate
ROE	Return on equity
RON	Romanian leu
RSF	Required Stable Funding
RWA	Risk-weighted assets
SME	Small- and Medium-sized Enterprise
STeM	Stress test matrix (for FSAP stress tests)
TD	Top-down (stress test)
TTC	Through-the-cycle
WEO	World Economic Outlook
YoY	Year-on-year

EXECUTIVE SUMMARY[1]

The Financial Sector Assessment Program (FSAP) took place against a backdrop of improved resilience and recovery after the crisis. Romanian banks enjoy one of the highest capitalization ratios in Europe, significantly strengthened since the crisis. NPLs have declined to 6.4 percent as of December 2017 from their peak of 21.5 percent following the crisis. Banks' reliance on parent funding has also reduced significantly, and the share of foreign currency-denominated loans has declined. The banking sector's profitability is strong and liquidity appears ample.

Yet, new vulnerabilities are emerging. The banks' exposure to the government through large positions in domestic sovereign debt is rapidly increasing. Banks' exposure to the real estate market is also growing and becoming riskier as lending occurs at the margin to the more vulnerable households and at variable interest rates. The large stock of FX loans (although declining as a share) pose credit risk and has potential implications for liquidity needs in foreign currency. Finally, the rapid growth of credit extended by the nonbank financial lenders (NBFLs), combined with their relatively thin capital levels and riskier lending practices points to new vulnerabilities.

The FSAP stress tests examined overall resilience of the financial system, with a particular focus on the vulnerabilities highlighted above. The tests assessed the resilience of the banking system to solvency and liquidity shocks, and the risk of contagion: the interest rate risk and credit risk associated with the banks' exposure to government securities was assessed in a scenario where credit spreads widen and interest rates rise sharply; the vulnerabilities of households was tested in the scenario also, through the significant contraction of domestic output; the ability of banks to withstand funding shocks, in all major currencies, was assessed through a battery of liquidity stress tests. Finally, the threat to financial stability emanating from stresses in the NBFL sector was also examined.

While the Romanian banking sector has a strong initial capital position, banks are affected significantly by the realization of the shocks captured by the scenarios. The stress test results indicate that an extreme but plausible adverse scenario would have a significant negative impact on the capital ratios of the banking system. While the banking sector as a whole maintains capital ratios above the minimum regulatory requirements, several (smaller) banks prove vulnerable. The extreme adverse scenario reflects downside external risks—including a tightening in global financial conditions, leading to capital outflows and widening sovereign spreads, and a faster than anticipated pace of monetary policy normalization— as well as a domestic demand shock impacting private consumption and investment. These shocks result in a V-shaped recession characterized by a cumulative decline of GDP equal to two standard deviations relative to the baseline and a cumulative peak to trough GDP contraction of 8.1 percent.

[1] Prepared by Maral Shamloo and Armand Fouejieu, Monetary and Capital Markets Department, IMF.

Under the adverse scenario, the shocks have a significant negative impact on capital ratios and several banks fail to meet regulatory mimima. The CET1 ratio for the 12 banks considered declines from 17.1 percent at end-2016 to 8.2 percent at end-2020 in the adverse scenario, due to four main factors:

- Credit risk is a significant driver of overall losses, with a negative contribution of 750 bps in capital over the horizon.
- In addition, banks face significant trading losses on their sovereign securities portfolios, leading to a 300 bps drop in capital over the horizon.
- The exchange rate depreciation plays an important role in driving credit losses on FX loans.
- Finally, net interest income (NII) decreases by almost 40 percent throughout the test horizon.

Even under the baseline scenario, the assumed credit growth and the impact of an increase in interest rates imply a decline in the capitalization ratio of the banking system relative to the starting point. Under the baseline scenario, the banks are assumed to extend credit in line with nominal GDP growth, which is projected to grow strongly. In addition, there is a significant impact of rising rates on trading income as well as on banks' profitability given their positive interest rate risk: (NII) is on average lower by 20 percent throughout the horizon compared to 2016. These factors imply a drop in CET1 ratio for the 12 banks in scope from 17.1 percent at end-2016 to 14.1 percent at end-2020. The increase in risk-weighted assets (RWAs) contributes a 150 bps decrease in capitalization ratios whereas trading losses contribute a further 250 bps drop.

The sensitivity analysis assessed vulnerabilities of the banking system to concentration risk. The results show that most (though not all) banks can withstand the simultaneous default of five of their largest nonfinancial corporate exposures. While sovereign exposures are exempt from large exposure limits in the European regulatory framework, a test of resilience to a 50 percent drop in the value of government securities shows that a majority of banks fall under minimum regulatory capital requirements as a result. The test highlights one more time the extent of Romanian banks' exposure to the sovereign.

Liquidity stress tests reveal ample liquidity cushions at the aggregate level, but point to a need for currency differentiated liquidity requirements. The aggregate liquidity coverage ratio (LCR) is above 200 percent both in euro and leu, and remains significantly above 100 percent even under stress scenarios aimed to simulate a dry-up in retail and in wholesale funding respectively. Cash flow-based liquidity stress tests also revealed that, with the exception of one institution, all banks could confront persistent and sizable withdrawals of funding without resorting to central bank support. Although not a requirement, all Romanian banks meet the Net-Stable Funding Ratio (NSFR) ratios above 1. Nevertheless, a number of banks fail to meet the LCR (and NSFR) ratios on a currency-by-currency basis. Finally, an analysis of liquid assets (or counterbalancing capacity) of the banks indicates that liquidity ratios are flattered by the large stock of government securities. While

useful in the case of an idiosyncratic event, reliance on one type of liquid asset is less helpful in a systemic liquidity event.

The analysis of NBFLs highlighted certain vulnerabilities among these institutions, and in particular the leasing companies. The FSAP team conducted a number of sensitivity tests to assess NBFLs' resilience to withstand a depreciation, an increase in borrowing costs, and a deterioration in asset quality. Leasing companies are particularly vulnerable to a currency depreciation, due to their highly euroized lending portfolios and low starting capital levels.

The contagion analysis conducted by the FSAP team suggests that reputational risks to parent banks due to the failure of their affiliated NBFLs can be sizeable. The team assessed domestic and cross-border contagion risks. Romanian banks' exposure to banking systems abroad remains mainly through reliance on parent funding. On the other hand, there is limited scope for transmission of stresses among banks as domestic interbank exposures are small. An assessment of linkages between banks and nonbanks indicates that reputational losses from the failure of own-name affiliated NBFLs could be sizable. The FSAP team simulated a scenario in which the failure of an NBFL would lead to a retail deposit run on the parent bank as depositors fail to differentiate between the parent bank and the affiliated NBFL. Combined with the vulnerabilities of the NBFLs highlighted above, the results suggest the need for increased monitoring of the risks arising from this sector, despite their small size relative to the rest of the financial system. In addition, it is recommended to ensure that provisioning and other regulatory requirements are harmonized with the banks to mitigate opportunities for regulatory arbitrage.

Table 1. Romania FSAP: Recommendations from Stress Testing and Risk Assessment	
Recommendations	**Time**
Solvency	
Address the sovereign-bank nexus in order to mitigate interest and credit risk stemming from large bank exposures to the sovereign.	NT
Address household vulnerabilities by imposing a debt service to income ratio (DSTI) limit to mitigate risks of excessive credit growth and rise in defaults given households' vulnerability to a rise in interest rates or risk premia.	NT
Liquidity	
Enforce a currency-differentiated liquidity coverage ratio (LCR) for significant currencies.	NT
Monitor a currency-differentiated NSFR for significant currencies.	NT
Nonbank Financial Lenders	
Increase monitoring and ensure provisioning requirements tighten in line with the application of IFRS9 for the banks, so as to prevent regulatory arbitrage.	NT
Note: Time Frame: C = continuous; I (immediate) = within one year; NT (near term) = 1–3 years; MT (medium term) = 3–5 years.	

INTRODUCTION

1. The financial system in Romania is largely dominated by banks, although the nonbank financial sector is gaining importance. The 36 banks in Romania account for around 80 percent of financial sector total assets. The largest five banks concentrate 60 percent of total deposits in the system, and 57 percent of total loans. Nonbank financial lenders (NBFLs) represent a smaller but growing share of the financial sector (NBFLs assets represent about 11 percent of total banking sector assets as of end 2016). The rest of the nonbank financial sector (investment fund, private pension funds, insurance companies) remains underdeveloped. The Romanian capital market is small, relatively undiversified, and characterized by a relatively low market capitalization.

2. Intermediation remains low, with domestic credit to the private sector being among the lowest in the region. As of September 2017, bank assets were at just 52.7 percent of GDP, placing Romania's banking system last among EU countries in terms of financial intermediation. After negative growth rates in 2013 and 2014, credit to the private sector has rebounded since 2015. Banks' domestic loans are split roughly equally between households and nonfinancial corporates, with mortgage lending representing more than half of household loans. Although large companies do not seem to be credit constrained, small- and medium-sized enterprises have less access to financing from the banking sector, possibly due to their relatively high level of nonperforming loans (NPLs) in the past.

3. The 2018 FSAP took place in a context of improved resilience. NPLs increased substantially since the global financial crisis (reaching 21.5 percent in 2013), due to a sharp increase in foreign currency denominated loans extended during the 2004–08 loans.[2] The high number of NPLs has since declined to 6.4 percent in December 2017, as a result of an action plan implemented by the central bank and supported by the IMF, which saw about €4 billion in NPLs removed from the banks' balance sheets. Furthermore, foreign-owned banks' dependence on parent funding has significantly declined. Private sector deposits have increased from about 48 percent of banks' total liabilities in 2011 to about 64 percent in 2017, reducing the foreign-owned banks' reliance on parent funding. The share of foreign currency-denominated loans has also declined, albeit the associated vulnerabilities remain due to a large stock of foreign exchange (FX) denominated loans (43 percent for corporate loans and 38 percent for household loans in June 2017). As a result of the balance sheet clean-up, bank soundness indicators improved. The average banking sector return on assets has grown to 1.5 percent despite compressed interest margins, and the liquidity position strengthened (the loan-to-deposit ratio fell from 122 percent in 2008 to 75 percent in 2017). Romanian banks also enjoy a relatively high-risk weight density compared to European counterparts mainly due to an extensive use of the standardized approach to credit risk.

4. However, banks' exposure to the sovereign has increased substantially. The sovereign debt exposure of banks has increased from less than 5 percent in 2008 to about 22 percent of banks' total assets in 2016, putting Romania among the most exposed in the EU. In an environment of rising rates, the long duration of domestic sovereign debt held by many banks, relative to the duration of funding, makes them heavily exposed to interest rate risk.[3] Moreover, the government-backed mortgage loan program (Prima Casa) increases indirect banking sector exposure to the public sector.[4]

5. The increasing exposure to the real estate sector also represents a growing vulnerability. Housing loans increased from 21 percent of loans to households to more than 54 percent between 2008 and 2017. Furthermore, the effectiveness of the existing macroprudential tools on mortgages are undermined by the Prima Casa program, which allows for LTV ratios of up to 95 percent. Moreover, since the large majority of mortgage contracts are at variable rates, loan performance and default rates could deteriorate in an environment of rising interest rates.

6. FX exposures, while decreasing, continue to be a source of credit and liquidity risk. Loans in foreign currency continue to have a higher non-performing ratio than loans in lei

[2] Foreign currency denominated loans reached 63 percent of total loans in 2011, on the back of financing from foreign parent banks.

[3] The (exposure weighted) duration of sovereign debt in the available for sale (AFS) and held for trading (HFT) portfolios of the banks in scope are 3.3 and 2.8 years, respectively, which is very much in line with the average remaining maturity of domestically denominated debt. The weighted average remaining maturity of Romanian sovereign debt is 3.2 years for domestically issued debt and 8.4 years for Eurobonds, implying an overall remaining maturity of 5.4 years for sovereign bonds.

[4] Under the Prima Casa program, the State guarantees 50 percent of the mortgage, in addition to favorable loan terms (the down payment is 5 percent of the property, and the interest rate is relatively low, at ROBOR + a maximum spread of 2.5 percent).

(12.3 percent compared to 3.3 percent). Although the share of loans in foreign currency originated by local credit institutions has declined, the share in the stock was still 44 percent for corporate loans and 42 percent for household loans in December 2016. The share of FX in total new bank lending to the nonfinancial private sector was just below 20 percent in June 2017, with FX loans mainly extended to the corporate sector, while NBFL lending to the corporate sector is already predominantly in FX (84 percent). Going forward, FX lending may pick up again if domestic rates were to rise relative to euro area rates. While the currency mismatch on banks' balance sheets is limited, the indirect exposure via unhedged borrowers remains significant. Furthermore, meeting liquidity requirements in FX could become a concern if the share of FX denominated loans remains elevated.

7. Finally, the rapid growth of NBFLs could exacerbate household indebtedness and have reputational implications for the banks. Loans from NBFLs to households have increased by 63 percent between June 2016 and June 2017 (compared to 20 percent for banks). The rapid growth raises several concerns: First, they contribute to household indebtedness. Second, there are concerns regarding regulatory arbitrage, whereby banks may decide to book loans through their subsidiary NBFLs, who are subject to a lighter-touch supervision. Finally, there are concerns regarding contagion of risks from NBFLs to the banking system, through direct exposures but also via broader reputational risks.

8. Against this backdrop, the objective of the FSAP risk analysis is to assess the capacity of the banking system to withstand severe but plausible macroeconomic shocks. The tests are meant to explore potential weaknesses in the financial system and the channels through which adverse shocks could propagate. The FSAP stress tests can help to identify priorities for policy actions, such as those aiming at reducing specific exposures or building capital and liquidity buffers. The FSAP stress testing process can also help the authorities to identify informational and methodological gaps and assess their preparedness to deal with financial distress.

9. Although stress tests are useful to explore vulnerabilities in a financial system, results must be interpreted with caution. The implementation of stress tests is conceptually challenging. FSAP stress tests are macroprudential in nature and are aimed at assessing the resilience of the banking system to a set of macroeconomic and financial shocks. Unlike microprudential stress tests, the results may not be used to determine supervisory actions at the individual bank level. Caution is also advised in interpreting the likelihood that adverse scenarios materialize. Under these scenarios, the economy is assumed to be subject to a combination of external and domestic shocks that (ex-ante) are of low likelihood. Hence, by construction, the adverse scenarios should not be interpreted as macroeconomic "forecasts."

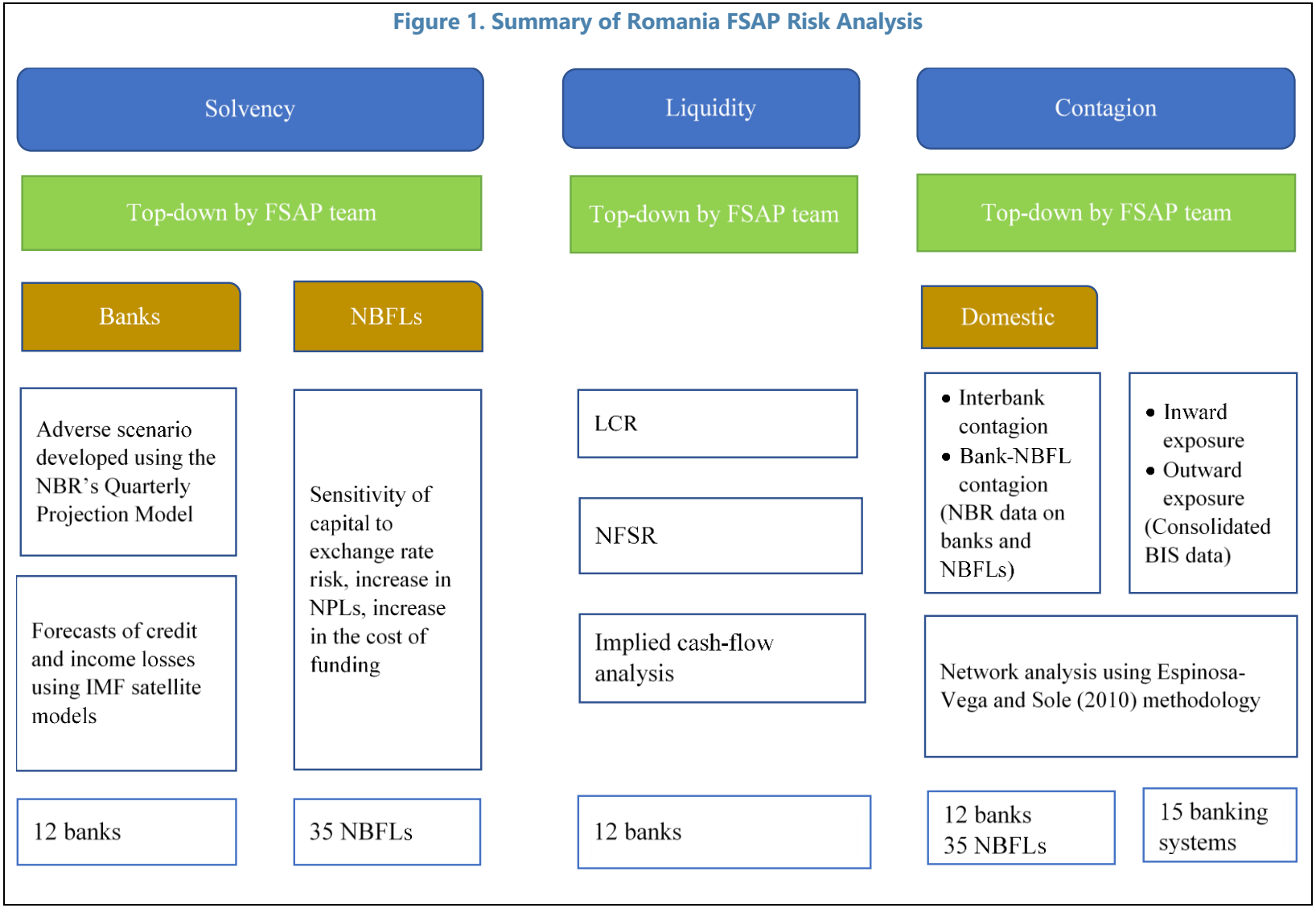
10. The risk analysis work stream of the Romania FSAP examined the resilience of the banking system to solvency, liquidity, and contagion risks (Figure 1). The solvency exercises entailed a Top-Down (TD) scenario-based stress test and single factor sensitivity analyses, all conducted by the FSAP team. The stress test assessed the impact of a combination of domestic and external shocks on the economy over a three-year horizon (2018–20), based on data available through December 2016. The effects of these shocks on individual bank profitability and

capitalization were assessed using satellite models and methodologies developed by IMF staff. Solvency tests based on sensitivity analysis assessed the banking sector's resilience to individual shocks. The TD liquidity stress tests assessed the capacity of banks to withstand large withdrawals of funding, using LCR, NSFR, and a cashflow based analysis, both at the aggregate level and by major currency. The contagion analysis covered cross-border exposures of the banking sector, domestic interbank exposures, and bank-NBFL cross-exposures.

11. In addition, a set of sensitivity tests were carried out to assess the resilience of NBFLs to various shocks. Given the large number of NBFLs and their simpler balance sheet structure, only single factor sensitivity tests were applied. These included sensitivities of capital to credit losses, exchange rate risk and an increase in funding costs.

12. The NBR conducted their own TD stress tests under the IMF macro scenario and arrived at results very comparable to those of the FSAP team. The NBR and the FSAP team estimated separate credit risk models, and had access to different levels of granularity in terms of loan and securities portfolios. The methodologies were also different for estimating trading losses. Nevertheless, the independently run stress test by the NBR staff arrived at very similar results to those highlighted by the FSAP team.

Figure 1. Summary of Romania FSAP Risk Analysis



BANKING SECTOR SOLVENCY STRESS TESTS

13. The FSAP solvency stress test covered Romania's 12 largest banks, accounting for 80 percent of banking sector assets. This set includes the nine institutions designated as Other Systemically Important Institutions (OSIIs).

A. Macroeconomic Scenarios

14. The solvency stress test for banks is based on a baseline and an adverse scenario, both three years in horizon. The baseline scenario features a strong output growth in 2018, and a gradual reversion to potential throughout the stress test horizon, consistent with both WEO and NBR's projections. The banking sector's resilience was assessed against an extreme but plausible adverse scenario, based on the risks highlighted in the Risk Assessment Matrix (RAM), (Appendix I).

15. The main features of the adverse scenario are a widening of sovereign credit spreads and a sharp rise in (domestic) policy rates (Figure 2 and Table 2 and 3). The increase in sovereign spreads coincides with capital outflows and a severe depreciation of the currency in the first year. Monetary policy reacts to the depreciation: a large hike in domestic policy rates aims to reduce pass-through of the weaker exchange rate to inflation. Finally, a slow-down in trading partners' economies reduces demand for Romania's exports. The monetary policy tightening, the slow-down abroad, and the additional domestic demand shock all contribute to a contraction in GDP that reaches its trough (8.1 percent relative to the reference date) in the second year of a three-year horizon (V-shaped profile). The severity of the scenario (defined as deviation of GDP growth from the baseline in terms of historical growth volatility) is 2.1 standard deviations. A drop in property prices is implicitly assumed in the scenario through the macroeconomic variables.[5]

16. The adverse scenario could be triggered by external or internal factors. An initial capital outflow may be triggered by risk-off reactions in financial markets to de-globalization initiatives driven by political developments in Europe and the United States. Alternatively, a faster than anticipated pace of policy rate normalization may induce Romania to follow suit and raise rates sharply. A larger than expected fiscal shock or adoption of expansionary fiscal policies could trigger a lack of confidence in the government's ability to repay, accompanied by capital outflows and a sharp rise in bond yields. Monetary policy would then respond by raising rates to counteract the capital outflow.

17. The adverse scenario was developed in conjunction with the Macroeconomic Modeling and Forecasting Department at the NBR. The narrative above was developed into a calibrated scenario using the NBR's Quarterly Projections Model (QPM). The use of this model was preferred as it was closely tailored to the Romanian economy and delivered realistic quarterly dynamics. The (exogenous) shocks were calibrated to deliver the desired dynamics and severity in terms of depreciation and GDP contraction. Specifically, the exogenous shocks consisted of the following:

[5] In addition, Loss Given Defaults (LGDs) are stressed under the adverse scenario, implying a drop in the value of collateral.

(i) a risk premium shock assumed for the private and the public sector; (ii) an external demand shock affecting Romania's main trading partners; and (iii) an additional internal demand shock.

Table 2. Romania: FSAP Stress Test Adverse Scenario
Deviation from the baseline (In percentage points; unless specified otherwise)

	Adverse Scenario		
	2018	2019	2020
Real GDP	-6.5	-14.6	-17.8
Policy interest rate	2.5	1.0	0.0
Short-term money market spread	0.5	0.0	0.0
Long-term government bond yield	4.2	4.0	3.6
Real Effective exchange rate appreciation(-)/depreciation(+)	14.7	7.3	7.5
Nominal exchange rate appreciation(-)/depreciation(+)	7.5	1.6	-0.8
Inflation rate (CPI)	1.3	-1.4	-4.1
Unemployment rate	1.2	1.6	1.7
Memo:			
Baseline Real GDP growth (in percent)	4.3	3.4	2.7
Real GDP growth (in percent)	-2.4	-5.2	-0.6
Cumulative real GDP growth (from 2017)	-2.4	-7.5	-8.1
Spread of short-term money market rate	-2.0	-1.0	0.0
"Severity"	**1.5**	**2.1**	**1.9**
(deviation of growth from baseline in terms of historical volatility)			

Source: IMF staff calculations.

Table 3. Romania: FSAP Stress Test Baseline and Adverse Scenarios
(In percent; unless specified otherwise)

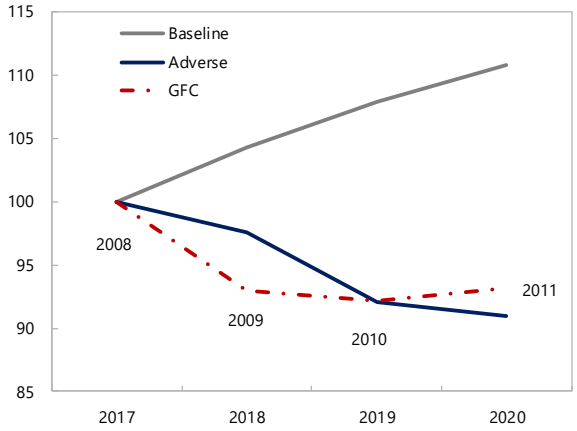
	Baseline			Adverse		
	2018	2019	2020	2018	2019	2020
Real GDP Growth	4.3	3.4	2.7	-2.5	-5.6	-1.2
Policy interest rate	2.3	3.3	4.4	4.8	4.3	4.4
Short-term money market spread	0.0	0.0	0.0	0.5	0.0	0.0
Long-term government bond yield	3.7	3.9	3.8	7.9	7.9	7.4
Nominal exchange rate app(-)/dep(+)	0.9	-0.1	-0.2	8.4	1.5	-1.0
Inflation rate (CPI)	3.5	3.2	2.8	4.8	1.8	-1.3
Unemployment rate	5.1	5.1	5.2	6.3	6.7	6.9

Source: IMF staff calculations

Figure 2. Romania: Macroeconomic Baseline and Stress Scenarios

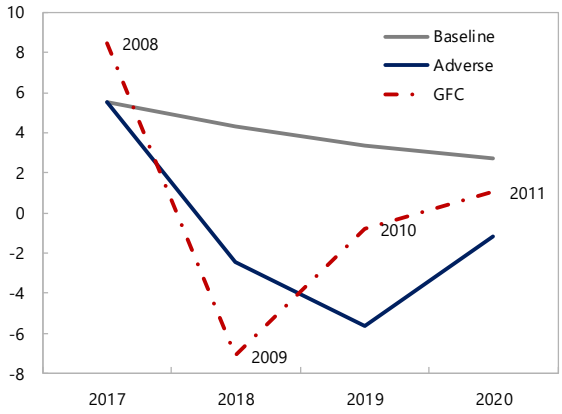
GDP in the adverse scenario is 18 percentage points lower than under the baseline…

Real GDP Under the Stress Scenario, 2017-20
(2017 = 100)



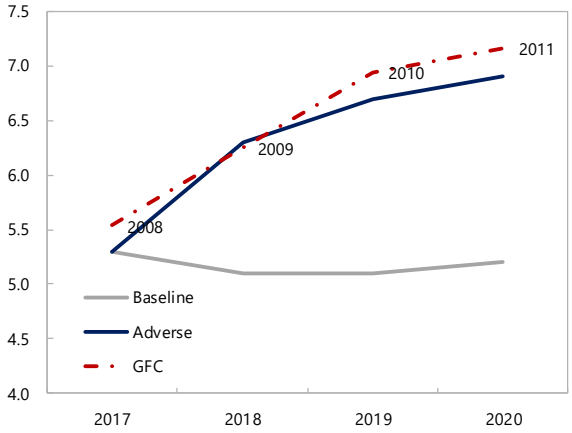
Growth shock comparable to the experience during the crisis

Real GDP Growth Under the Stress Scenario, 2017-20
(In percent)



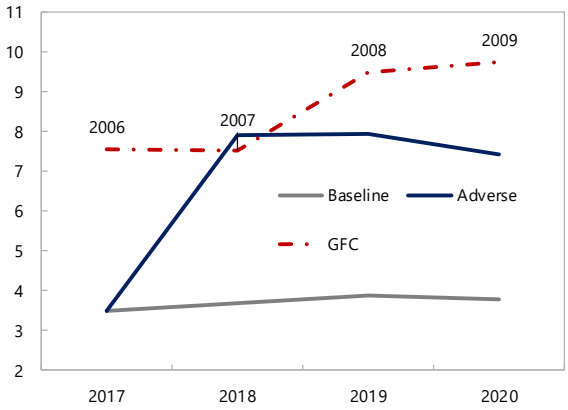
Unemployment in line with crisis levels…

Unemployment Rate Under the Stress Scenario, 2017-20
(In percent)



… while government bond yields rise significantly.

LT Government Bond Yields Under the Stress Scenario, 2017-20
(In percent)



Source: IMF staff calculations.

B. Top-Down Solvency Stress Test of Banks

Methodology[6]

18. The TD exercise for the banks is based on the IMF's internally developed solvency stress testing framework. This stress test includes a comprehensive set of risks. In particular, risks covered include: credit risk associated with all exposures, market risk (associated with mark to

[6] Also refer to the Stress Testing Matrix (STeM) in Appendix II.

market securities, exchange rate and other mark to market positions), and interest rate risk in the banking book. The main elements of the methodology implemented are as follows:

Balance Sheet and RWA Growth Projections

19. For the growth of the banks' balance sheets over the stress-test horizon a quasi-static approach is adopted. Asset allocation and the composition of funding are assumed to remain the same; whereas balance sheets grow in line with the nominal GDP path specified in the stress test scenario. However, to prevent the banks from deleveraging, the rate of change of the balance sheet is floored at zero percent. This constraint binds in the adverse scenario.[7]

20. In projecting RWAs we differentiate between standardized and internal ratings-based (IRB) portfolios. For the standardized portfolios, RWA assets change due to the change in the size of portfolio and the increase in risk weight for newly defaulted exposures, while maintaining the average risk weight for the rest of the portfolio. For the IRB portfolios, we use the projected through-the-cycle (TTC) probability of default (PDs) (calculated as one-eighth of point-in-time (PIT) PDs) for each asset class to calculate new average risk weights.

Modeling and Behavioral Assumptions

21. Interest income and interest expense. To project net interest income, we rely on maturity gap analysis. To do so, we keep track of the assets and liabilities that reprice in each period, assuming that a bank does not change its maturity profile over the stress testing period. The evolution of cost of funding depends on the policy rate plus the risk-premium assumed under the adverse scenario. Changes in lending rates in turn depend on changes in the policy rate. Since lending rates are tied to the Lombard rate by regulation, the banks are prevented from passing on the increases in cost of funding fully to their lending side. The overall interest income (interest expense) is also affected by the evolution of the size of interest earning assets (interest bearing liabilities).

22. Trading income and losses on securities. We use portfolio level information to assess gains or losses in the value of fixed income securities held in fair value accounting portfolios, due to changes in risk-free interest rates and credit spreads. To do so we apply the modified duration approach. The analysis covers the impact of the debt securities portfolio accounted in the trading book (held for trading or HFT) and available for sale book (AFS). While the impact of shocks to HFT securities impact regulatory capital through net profits, asset mark-downs from shocks to the AFS portfolio hit capital through other comprehensive income. Rebalancing of the portfolio was not allowed throughout the horizon. In the case of HTM securities, provisions are made according to changes in credit spreads.

[7] Under the baseline, we calibrate the growth of assets to half of nominal GDP growth, in line with recent relationship between financial asset growth and nominal GDP.

23. Other gains or losses associated with market risk. Gains or losses associated with other market positions (commodity and currency net open position) are impacted via the evolution of these variables under the relevant scenario.[8] Any remaining items on the income statement are projected to grow in line with the size of the balance sheet.

Capital Action Assumption

24. We assume that banks do not issue new shares or make repurchases during the stress test horizon. Dividends are assumed to be paid out of current period net income after taxes by banks that are profit making (i.e., only if net income is positive) and in compliance with supervisory capital requirements, at a rate of 10 percent.

Hurdle Rates

25. In assigning hurdle rates for banks, we differentiate between OSII and non-OSII banks, as well as baseline and adverse scenarios (Table 4). Hurdle rates under the baseline consist of Basel III regulatory minima on CET1 (4.5 percent), Capital Conservation Buffer (CCB) (2.5 percent) and include OSII buffer of 1 percent, where applicable. Under the adverse, we allow the banks to avail themselves of the CCB. The final capital level is calculated on a Fully Loaded basis. In addition to the CET1, we evaluate the banks' total capital adequacy ratio, which is set at CET1 requirements plus 3.5 percent, their Tier 1 capital ratio, set at CET1 requirement plus 1.5 percent, and the leverage ratio during the stress test horizon against the 3 percent Basel III minimum requirement. Banks that end the stress test horizon with a capital level or a leverage ratio below the relevant hurdle rates, are considered to have failed the test.

Table 4. Romania: Hurdle Rates for the Banking Sector Solvency Stress Tests

(In percent)

		Baseline		Adverse	
		OSII	N-OSII	OSII	N-OSII
Total Capital		11.5	10.5	9.0	8.0
Tier 1 Capital		9.5	8.5	7.0	6.0
CET1		8.0	7.0	5.5	4.5
	Basel III regulatory minimum	4.5	4.5	4.5	4.5
	Capital conservation buffer	2.5	2.5	0.0	0.0
	OSII buffer	1.0	0.0	1.0	0.0

Source: IMF staff calculations.

C. Credit Risk Estimation

26. Credit risk in the loan book, along with the market risk in securities portfolio, are key risk factors for the banking system (Figure 3). Loans represent more than half of total banking sector assets (57 percent). Debt securities (22 percent), more than three quarters of which are marked to market, come next. In terms of composition, mortgages form by far the largest segment

[8] Other market risks were negligible in the case of Romania.

of the loan book (51 percent), followed by small- and medium-sized enterprise (SME) loans backed by real estate (23 percent).[9] The composition of debt securities is even more concentrated, with domestic sovereign securities forming 97 percent of total securities holdings of the 12 banks.

27. The standardized approach is the dominant regulatory approach among banks in Romania. Ten out of 12 banks analyzed apply exclusively the standardized approach to credit risk. The two remaining banks apply the IRB approach partially (86 and 67 percent of their respective credit RWAs). Overall, more than 80 percent of credit RWA are under the standardized approach. This implies that Romanian banks have a relatively high average risk weight compared to their European peers (Figure 3).

28. Default rates were estimated separately for four different portfolios (Figures 4 and 5). Historical default rates were provided by the NBR for four portfolios: retail mortgages, SMEs backed by RE, non-RE backed SMEs, and consumer loans. Point-in-time PDs are projected using regression models with macro variables as independent variables. The FSAP team estimated the PDs using four panel regressions (one for each portfolio). Details of the estimations are included in Appendix III.

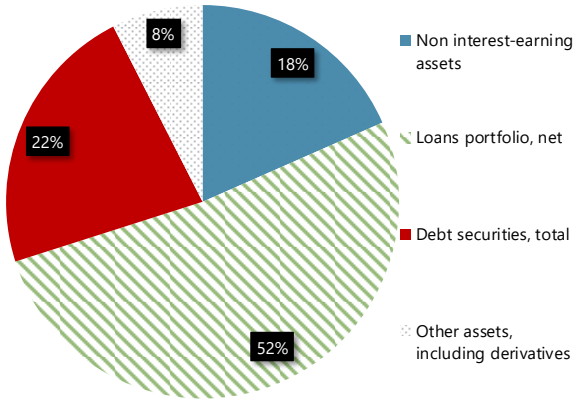
29. Default rates were estimated using a Bayesian Model Averaging (BMA) approach. Under this methodology, first, a subset of all possible models is chosen where all explanatory variables (macrofinancial variables and lags) are statistically significant in explaining changes in PDs. The coefficients were then obtained using a weighted average of default rate estimates across multiple models, with the weights corresponding to the posterior probability of each specification (see Appendix III).

30. PDs for large nonfinancial corporate exposures were set at historically stressed levels. Large nonfinancial corporate exposures are "low default portfolios" and thus macroeconomic variables have little explanatory power for the variations in these PDs. To overcome this problem, the 80th percentile default rate experienced in the historical data was used for each bank.

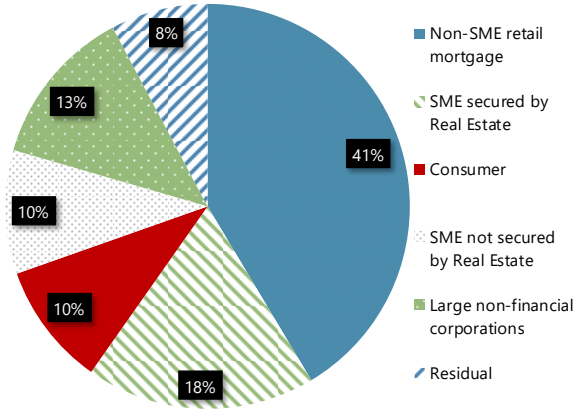
[9] New loans are predominantly granted at a variable interest rate: 88 percent of new loans in lei and 85 percent of new loans in euro have a variable interest rate, based on loan flows during January September 2017.

Figure 3. Romania: Balance Sheet Characteristics

Balance Sheet Composition

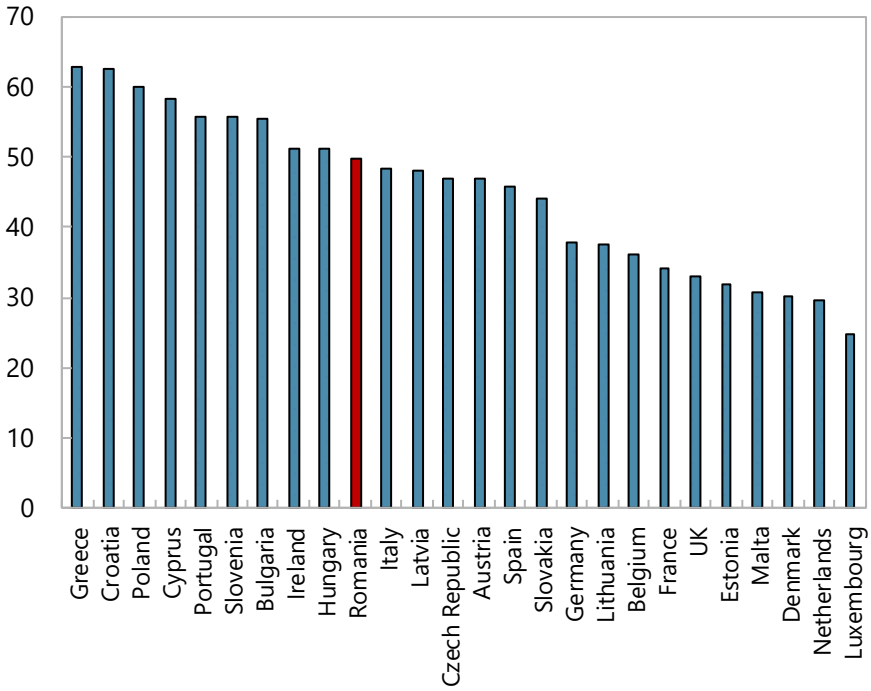


Loan Portfolio Composition



RWA to Total Assets

(In percent)



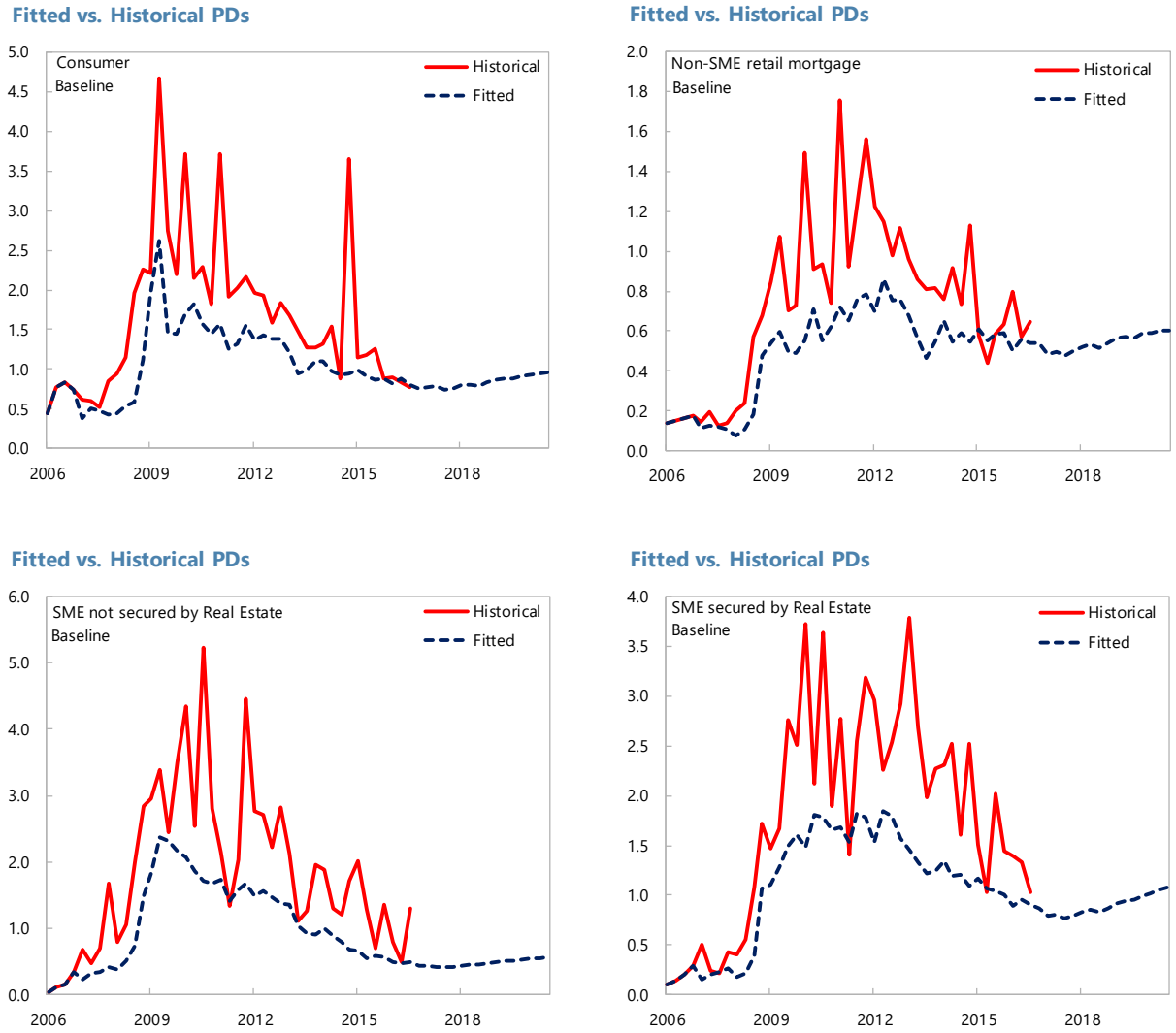
Source: IMF staff calculations.

Figure 4. Romania: Projected Default Rates Under the Baseline Scenario

(In percent)

Default rates rise modestly as growth slows down…

… and interest rates rise.

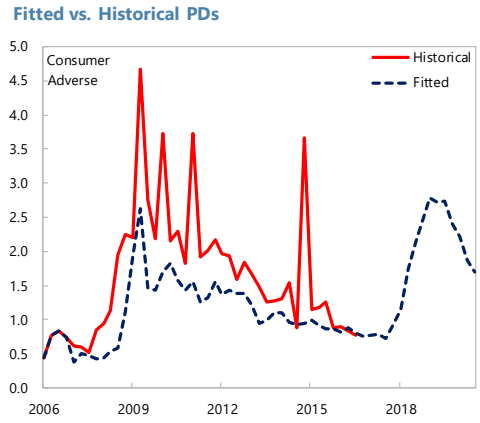


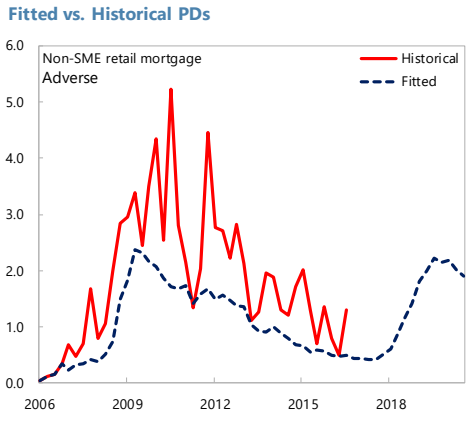
Source: IMF staff calculations.

Figure 5. Romania: Projected Default Rates Under the Adverse Scenario

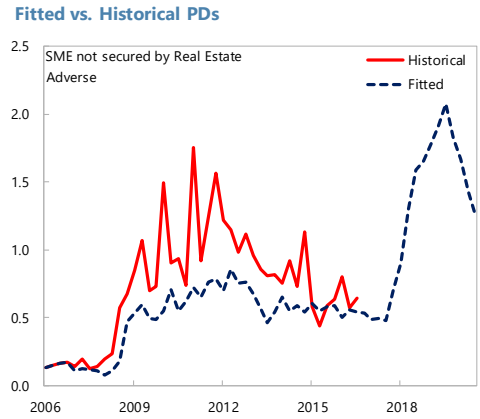
(In percent)

Default rates under the adverse scenario in line with levels during the crisis…

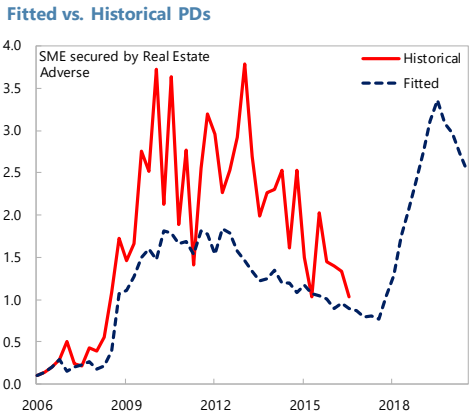




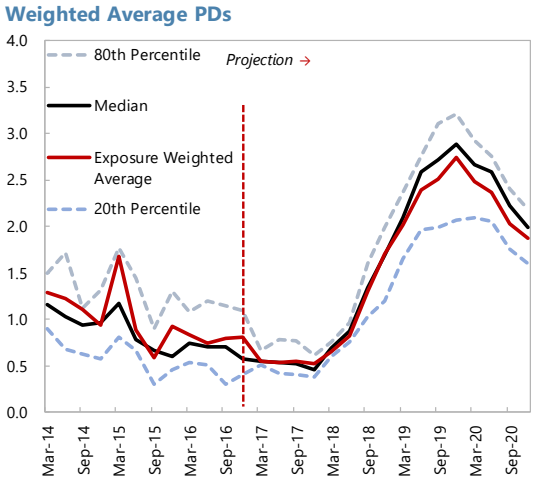
… or higher in the case of mortgages



… and real estate backed SME loans



Significant variation among banks, but most observe default rates comparable to the crisis episode…



Source: IMF staff calculations.

31. Exchange rate depreciation and an increase in government bond yields impact credit losses significantly (Figure 6). The satellite models show that corporate PDs are sensitive to real GDP and long-term government bond yields (which can be thought of as a measure of the prevailing risk-premia in the economy), while retail portfolios are sensitive to real GDP and exchange rate movements. In order to quantify the impact of these factor on credit losses, we constructed two hypothetical adverse scenarios which were identical to the adverse scenario used in the stress test in all aspects except the exchange rate and long-term government bond yields. In the first hypothetical adverse scenario we assumed that government bond yields remain at their end-2017 levels and in the second hypothetical scenario we assumed that the exchange rate will remain at its end-2017 level. We found that credit losses in SME portfolios are 45 percent larger in the presence of a rise in government bond yields (actual adverse scenario compared to the first hypothetical scenario) and mortgage and consumer losses are 20 and 16 percent higher due to depreciation, respectively (actual adverse scenario compared to the second hypothetical adverse scenario).

32. For modeling LGDs bank-by-bank provisioning rates were used. In the absence of time series data on LGDs, the provisioning rate on newly defaulted loans was used as the LGD for each bank under the baseline as a proxy for LGDs. A minimum 50 percent LGD floor on provisioning rate was imposed. For IRB portfolios the LGDs were stressed by 20 percent in the adverse scenarios.

D. Market Risk

33. The FSAP solvency stress test assessed the impact of market risk on regulatory capital from valuation losses in securities portfolios (Figure 7). The value of the debt securities portfolio among the 12 major banks amounts to around RON 71 billion or 22 percent of total assets; 97 percent of which are domestic bonds. Average duration of debt securities portfolio is 3.5 years; however, this varies significantly across banks, with some institutions having significantly longer average duration. Banks with longer average duration experienced higher valuation losses.

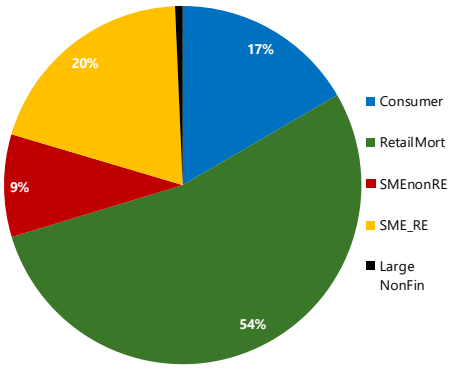
34. Market risk from shocks to other risk factors, such as equity and commodities and direct exchange rate positions are negligible. Romanian banks do not carry material open positions in equities or commodities. Therefore, market risk is mostly due to fair-valuation effects on the securities portfolio.

35. Repricing gap analysis (interest rate risk on the banking book) was also applied. The asset and liability repricing gap was applied. Romanian banks have significant positive interest rate risk on their balance sheet, which exposes them to losses in interest income as the (lending) yield curve flattens under the baseline and adverse scenarios. While under the adverse scenario long-term government yields and borrowing costs for the banks rise significantly, lending rates are constrained as banks' lending rates are tied to the Lombard rate.

Figure 6. Romania: Credit Losses Under the Adverse Scenario

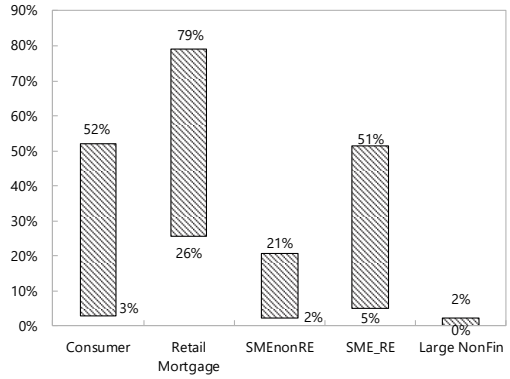
Credit losses in the mortgage and real estate backed portfolios form the majority of credit losses…

Composition of Credit Losses: Adverse Scenario



Contribution of Various Portfolios to Credit Losses*

(Share of total credit losses)

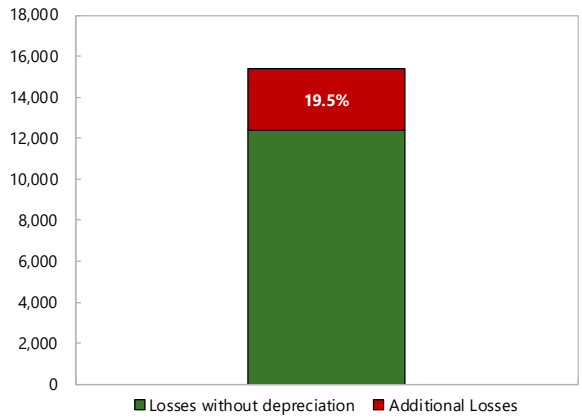


* The columns show the range of the values for each category across banks

Depreciation has a significant impact on credit losses in mortgage and consumer portfolios…

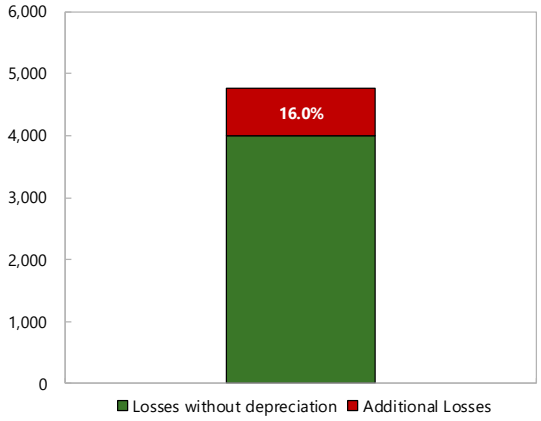
Mortgage Losses in Adverse Scenario

(Impact of depreciation, in millions of RON)



Consumer Losses in Adverse Scenario

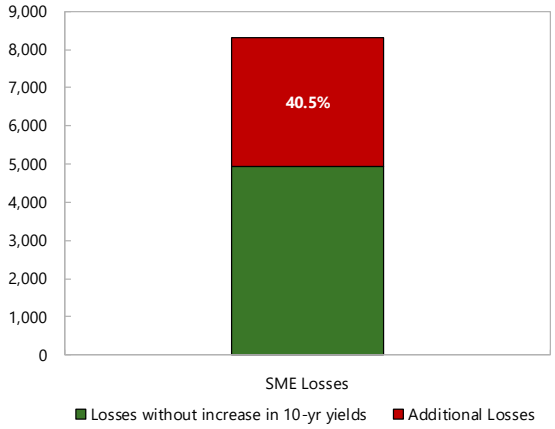
(Impact of depreciation, in millions of RON)



… whereas government bonds yields are a significant determinant of losses for the corporate portfolio.

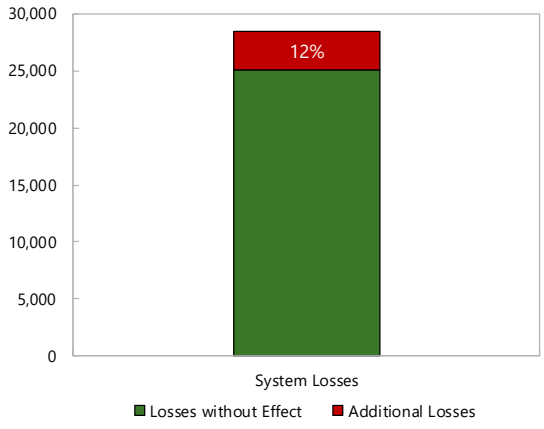
SME Losses in Adverse Scenario

(Impact of government bond yields, in millions of RON)



Losses in Adverse Scenario

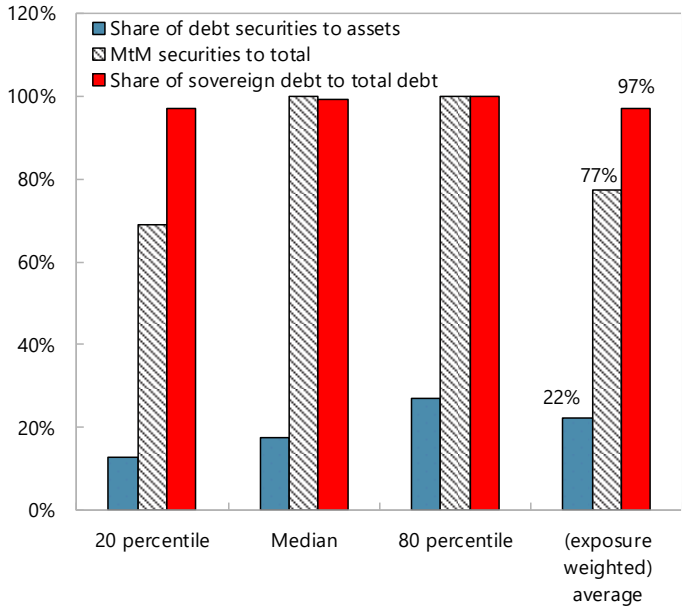
(Impact of government bond yields, in millions of RON)



Source: IMF staff calculations.

Figure 7. Romania: Composition of Securities Portfolios

Almost all securities are issued by the domestic sovereign … and more than three quarters are marked to market



Source: IMF staff calculations.

E. Solvency Stress Test Results

36. While the Romanian banking system as a whole appears fairly resilient, several banks show vulnerabilities in the face of risks considered in the adverse scenario (Figure 8 and Table 9). Solvency stress test suggests that banks are affected significantly by the realization of the shocks captured by the scenarios. Results in terms of the regulatory minima against the hurdle rates indicate that a number of banks fail to meet the minimum threshold for the CET1. The CET1 ratio for the 12 banks considered declines from 17.1 percent at end-2016 to 8.2 percent at end 2020 in the adverse scenario. The leverage ratio (T1 Capital to Total Assets) decreases from 9.3 to 4.8 percent during the stress test horizon.

37. The vulnerabilities highlighted above contribute to the reduction in capital ratios (Figure 8). More specifically, the stress tests results reveal that in the adverse scenario:

- *Banks face significant trading losses on their sovereign securities portfolios, with a total drop of 300 bps in capital over the three-year horizon*. Banks suffer from declining valuations in their trading book as sovereign yields rise significantly (due to an increase in the risk-free rate as well as risk premia). As a result, trading gains of 0.6 percent of RWA in 2017 turn to a market loss of 3.6 percent in 2018. The trading losses in the case of certain banks are comparable to loan loss provisions, which is unusual under an adverse scenario of such severity.

- *Credit risk is a significant driver of overall losses, with a total drop of 750 bps in CET1 during the three-year horizon.* Credit loss impairments increase from -2.2 percent of RWA in 2016 to

-3.5 percent of RWA in 2019, which is the peak in terms of provisioning.[10] In terms of composition, real estate mortgages account for the majority of credit losses (54 percent of total), followed by SME backed by real estate (20 percent of total).

- *Banks' net interest income decreases by almost 40 percent through the stress test horizon.* The contribution of NII to CET1 is, on average, 280 bps per year throughout the horizon, compared to 525 bps in 2017. Three factors contribute to this decline. First, the large NPL formation compresses interest income. Second, the net interest margin (NIM) is adversely affected due to a rise in funding costs, not matched by a rise in lending rates which are tied to the Lombard rate. Finally, the banks have a non-negligible positive interest risk, which exposes them to losses as ROBOR increases throughout the stress test horizon.

38. The banks capitalization ratios also decrease under the baseline scenario, due to the strong growth assumption and the impact of the increase in interest rates on NII (Figure 8 and Table 9). Under the baseline scenario the CET1 ratio for the 12 banks considered declines from 17.1 percent at end-2016 to 14.1 percent at end-2020. The leverage ratio (T1 Capital to Total Assets) decreases from 9.3 to 7.7 percent during the stress test horizon. The main contributors to the drop in capitalization ratios are:

- *Trading losses contribute a 250 bps drop in capital levels* as the cumulative increase in interest rates under the baseline is almost in line with that in the adverse, albeit the paths of interest rate increase (and thus distribution of trading losses) are significantly different under the two scenarios. Furthermore, the rise in interest rates under the baseline is due to an increase in the risk-free rate, whereas under the adverse scenario, yields rise primarily due to an increase in risk premia. While under the adverse scenario the trading losses are concentrated in the first year and reversed somewhat as risk premia decline, they are more evenly spread under the baseline scenario.

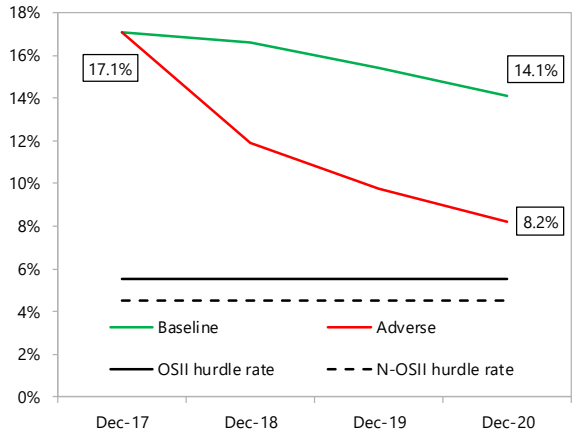
- *An increase in RWA contributes a 150 bps decrease in capitalization ratios.* Under the baseline, the banks' balance sheets are assumed to grow at half of the nominal GDP growth rate. This leads to an expansion of credit that is stronger compared to the post-crisis experience, and particularly in light of the strong nominal GDP growth under the baseline.

- *Banks NII is on average lower by 20 percent compared to 2016,* in light of a strong increase in short term rates and the positive interest rate risk in the banks' banking book.

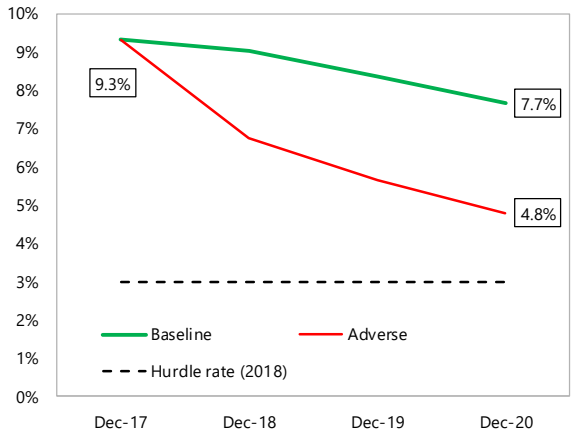
[10] It is important to note that provisioning and interest income reported by Romanian banks are inflated due to an accounting convention. Romanian banks book interest on NPLs and provision fully for this interest income, which leads to higher levels of both items compared to the IMF methodology, where no interest is accrued on NPLs. This difference in methodology partly masks the true increase in provisions due to formation of new NPLs in the stress test.

Figure 8. Romania: Stress Test Results

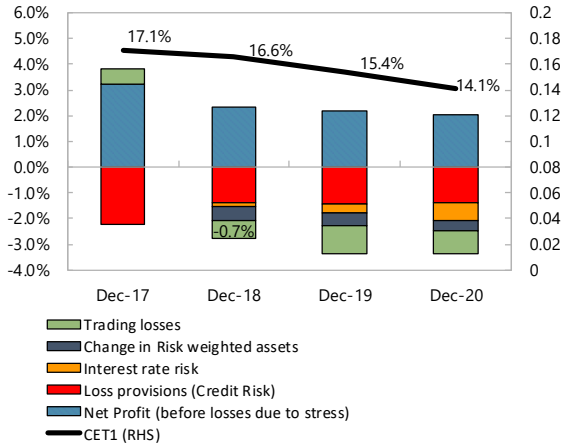
Common Equity Tier 1 Capital Ratio
(Fully-loaded, in percent)



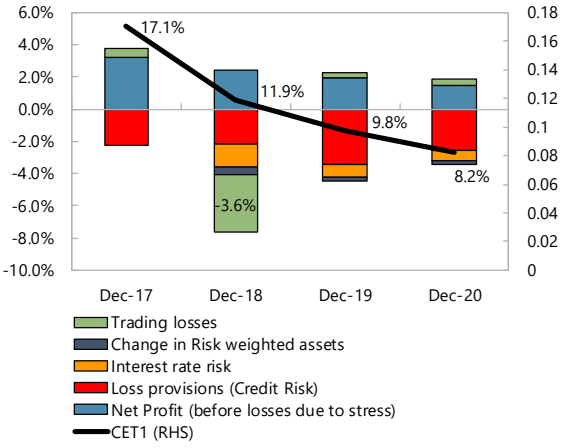
Leverage Ratio
(Fully-loaded Tier 1/Total assets, in percent)



Baseline Scenario: Contribution to Change of CET1 Ratio



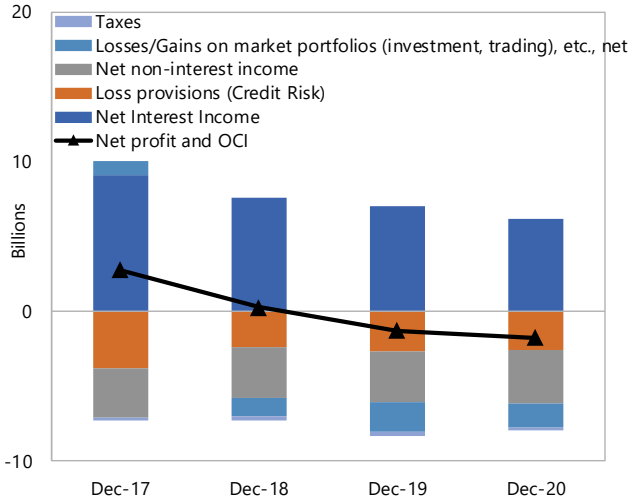
Adverse Scenario:Contribution to Change of CET1 Ratio



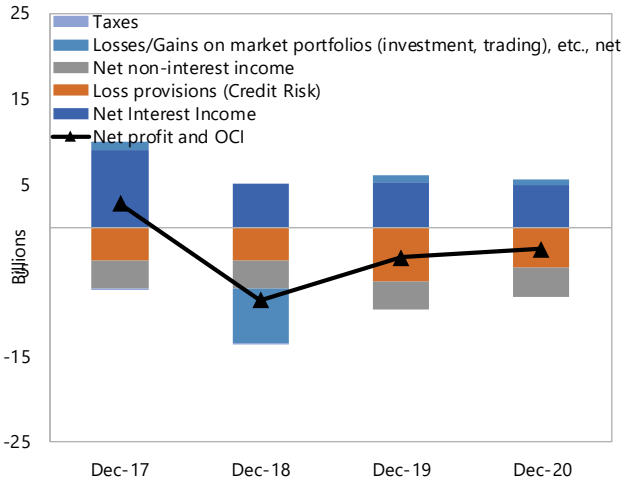
Source: IMF staff calculations.

Figure 8. Romania: Stress Test Results (concluded)

Baeline Scenario: Components of Comprehensive Income

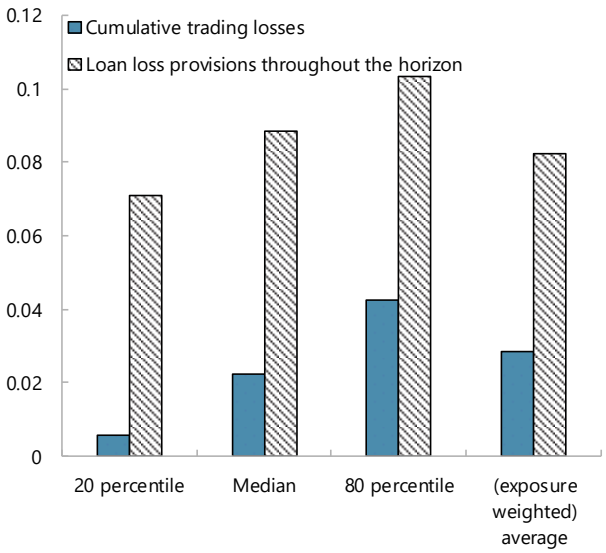


Adverse Scenario: Components of Comprehensive Income



Trading and Credit Losses Over the ST Horizon

(Share of RWA)



Source: IMF staff calculations.

Table 5. Banking Sector Solvency Stress Test Results
(In percent)

	Aggregate CET1 Ratio	Leverage Ratio	Asset Share Undercapitalized (CET1<Hurdle*)	Asset Share Undercapitalized (T1<Hurdle*)	Asset Share Undercapitalized (CAR<Hurdle*)	Asset Share Undercapitalized (leverage ratio<3%)	Maximum Capital Shortfall (% of GDP)
Before stress	17.1	9.3	0.0	0.0	0.0	0.0	0.0
Baseline scenario	14.1	7.7	0.0	13.1	13.1	0.0	0.1
Adverse scenario	8.2	4.8	30.3	30.3	28.3	30.3	0.3

Source: IMF staff calculations.

F. Solvency Tests Based on Sensitivity Analysis

39. Sensitivity tests assessed vulnerabilities of the banking system to sovereign, interest rate, and concentration risks (Figure 9).[11]

- *As emphasized in the scenario analysis, banks proved to be highly sensitive to a sovereign yield shock*. A 500 bps increase in sovereign yields reduces the system Tier I capital by 510 bps. The impact can be significantly larger for certain banks (up to 970 bps in capital).

- *Banks also show some sensitivity to interest rate risk, with a majority of them holding a positive interest rate risk exposure.* A 500 bps increase in interest rates reduces the system Tier 1 ratio by 120 bps, with the impact larger in certain banks.

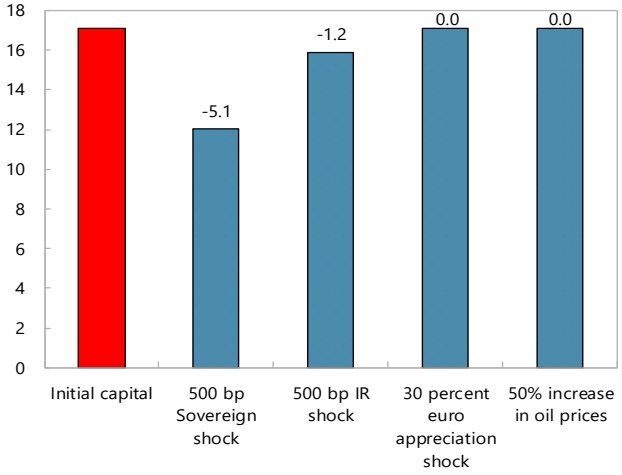
- *Concentration risk sensitivity test show that most, but not all, Romanian banks can withstand the simultaneous default of five of their largest Nonfinancial Corporate (NFC) exposures.* Collateral is mainly composed of cash or T-bills. Commercial Real Estate (CRE) collateral is not accepted as a credit risk mitigant in Romania for the purposes of large exposures.

- *Romanian banks are highly vulnerable if sovereign exposures were considered in the large exposures.* In a scenario with a 50 percent haircut on sovereign exposures, several banks fall below the 8.5 percent regulatory minimum on Tier 1 capital. While in Romania, as elsewhere in Europe, sovereign exposures are excluded from large exposure limits, this test demonstrates once more the extent of exposures to the sovereign for a majority of banks is very large.

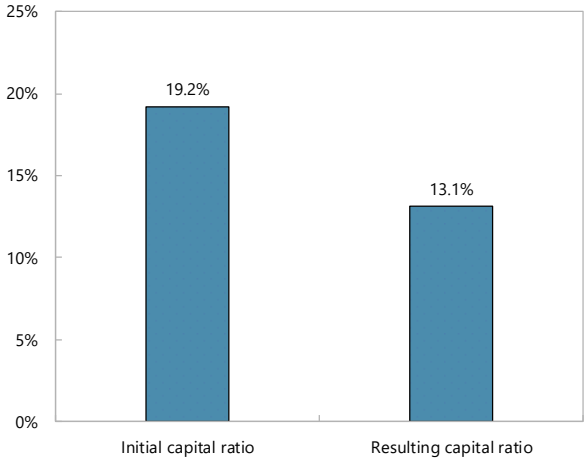
[11] Sensitivity analysis to an exchange rate shock and a commodity shock were also performed (see Figure 9). Since Romanian banks do not carry material open positions in equities or commodities, the impact of these shocks were negligible and are not discussed.

Figure 9. Romania: Single Factor Sensitivity Tests

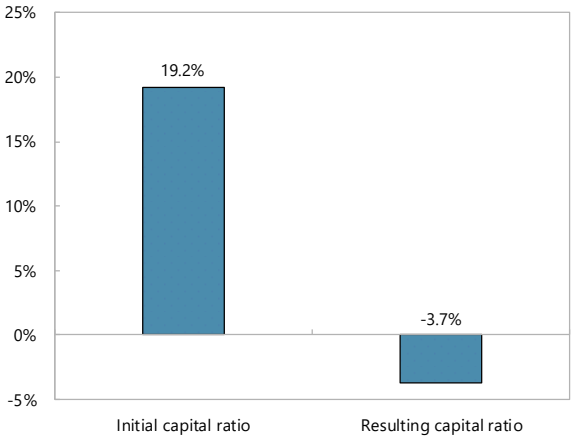
Impact of Shocks on System Tier 1 Capital



System Losses due to the Failure of Top Five NFCs



System Losses Arising From a 50 Percent Haircut on Sovereign Exposures



Source: IMF staff calculations.

LIQUIDITY STRESS TESTS

40. Three different liquidity stress tests were conducted to assess the resilience of the banking sector against funding and market liquidity shocks. The FSAP team conducted Liquidity Coverage Ratio (LCR), Net Stable Funding Ratio (NSFR) and cashflow based analyses for all the 12 banks in scope. The LCR and NSFR analyses were conducted separately in lei and euro. The third test pertains to implied cashflow analysis. This is similar to the LCR test, but the cashflow exercise considers different maturities of assets and funding sources. Specifically, it simulates an outflow of funding over maturity buckets from 1 day to 365 days, as opposed to the single 30-day window assumed by the LCR. The cashflow-based analysis used the supervisory data from local supervisory liquidity reporting templates, provided by the NBR.

A. Funding Structure

41. The structure of banks' funding appears relatively homogenous across the main currencies (Figure 10). At the aggregate level, the funding structure in the two main currencies (lei and euro) is very similar for the 12 largest Romanian banks in scope. Retail funding represents the largest source funding (52 percent), followed by non-operational deposits (23 percent) and other unsecured funding (18 percent). Secured funding is almost non-existent. The same structure is reflected in Available Stable Funding (ASF) composition, where 56 and 60 percent of lei and euro ASF are met by retail deposits, followed by funding from financial institutions.

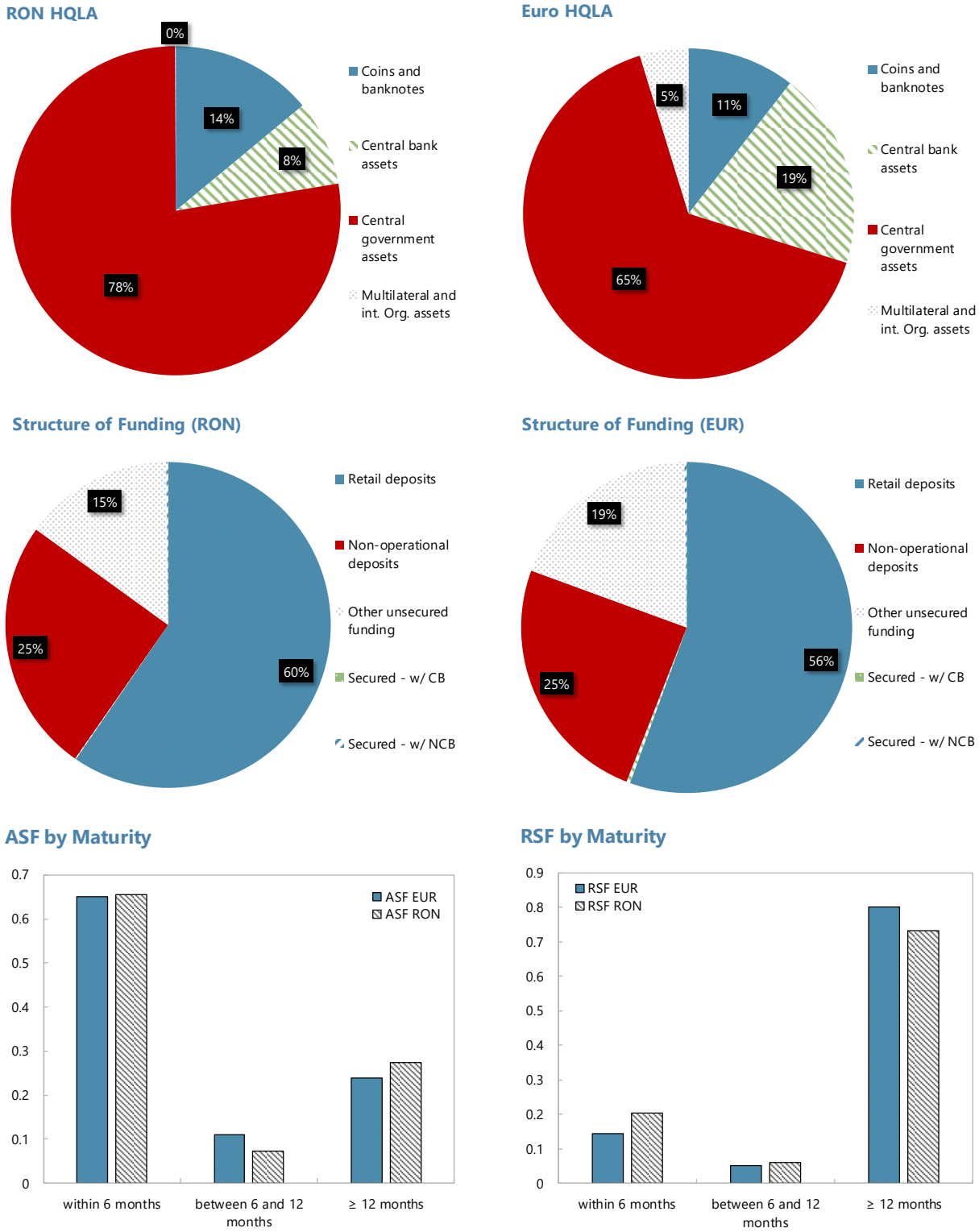
42. High quality liquid assets (HQLA) are dominated by government securities, in lei as well as euros (Figure 10). The HQLA needs of the banks are almost entirely met by exposures to the central government (78 percent in local currency and 65 percent in euro). Central bank assets (including excess reserves) form another 8 percent in local currency and 19 percent in euro.

43. The majority of available stable funding is of less than 6 months maturity (Figure 10). The majority of available funding (65 percent) has a maturity of less than six months, and only a quarter of funding is of maturity greater than 12 months. On the other hand, 80 percent of required funding is of maturity of greater than 12 months. This large mismatch in the maturity structure of funding is reflected in the large positive interest rate risk observed in the solvency stress test.

B. LCR-Based Liquidity Stress Test

44. While the aggregate liquidity level for Romanian banks is more than comfortable, the results suggest the need for currency differentiated liquidity requirements (Figure 11). Aggregate LCR is above 200 percent both in euro and lei, significantly above the 100 percent prescribed ratio under the Basel framework. However, a number of banks meet their aggregate LCR while missing the 100 percent benchmark on a currency-by-currency basis. Specifically, a number of banks fall short of the RON 100 percent requirement and some banks fall short in euro.

Figure 10. Romania: Structure of Funding and HQLA Composition



Source: IMF staff calculations.

45. In addition to the Basel III prescribed scenario, the FSAP implemented two additional tests to assess the short-term resilience of banks to an abrupt withdrawal of funding.

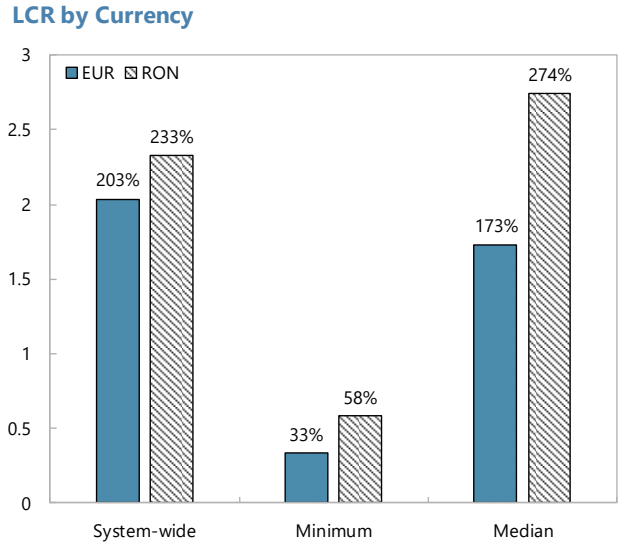
- *A retail stress scenario aimed at replicating a deposit run.* The key assumption raises run-off rates to 10 percent for stable and 15 percent for unstable retail deposits.
- *A wholesale funding stress scenario.* This scenario assumes a complete loss of wholesale funding on the interbank market. Key assumptions include: (i) run-off rates of 100 percent for wholesale funding from other legal entity customers; (ii) rates of 50 percent for operational deposits generated by clearing, custody, and cash management activities; and (iii) outflows by nonfinancial corporates, central banks and multilateral development banks up to 50 percent.

In addition, in both scenarios above, a 15 percent haircut is applied to government debt to simulate a fire sale, or illiquid market for these securities. A detailed table of all haircuts is included in Appendix IV.

46. In the face of the stress scenarios, the system-wide level of LCR remains high, yet a number of institutions fail to meet their LCR on a currency-by-currency basis (Table 6). Furthermore, the results are highly sensitive to the assumptions regarding haircut on government securities, as they form by far the largest portion of the stock of HQLA. Under the two stressed scenarios, a number of banks do not meet the 100 percent LCR ratio limit on a currency-by-currency basis. The average liquidity shortfall ranges from 1 to 3 percent of banks total assets.

Figure 11. Romania: LCR Ratio, December 2016

Average liquidity ample, but some banks fail to meet liquidity requirements in all significant currencies.



Sources: NBR, IMF staff calculations.

Table 6. Romania: Banking Sector LCR Stress Test Results						
	RON			EUR		
	LCR (Basel III)	Retail Scenario	Wholesale Scenario	Basel III	Retail Scenario	Wholesale Scenario
System-wide LCR	233%	184%	176%	203%	167%	159%
Liquidity shortfall 1/						
RON (mil)	785	1,925	2,384	362	613	816
Share of assets (average)	1%	2%	3%	2%	2%	2%

Sources: IMF staff calculations.
1/ Liquidity shortfall is the amount required for LCR in each bank to reach at least 100 percent.

C. NSFR-Based Liquidity Stress Test

47. The FSAP team analyzed the banks' longer-term liquidity position based on the NSFR framework. Romanian banks report their available and required funding according to the European Banking Authority's (EBA) NSFR templates; although the actual ratio is not calculated or monitored by the NBR, as there is still no formalized agreement on the implementation of a NSFR requirement at a European level. The team calculated NSFR ratios for each bank on a currency-by-currency basis using the Basel III weights.

48. Almost all banks meet an NSFR ratio of above one in euro and lei (Figure 12). Only one (small) bank fails to meet the NSFR on a euro basis. Consistent with the LCR results, NSFR ratios are flattered by the large presence of government securities, which have a low weight in terms of required funding. This fact is evident when comparing the average RSF factor for Romanian banks to that of a representative sample of European banks analyzed by the EBA (see text figure).[12]

ASF-RSF Factors for Select European Banks

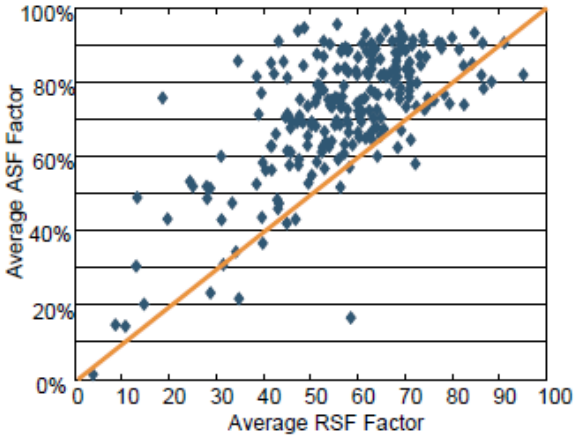
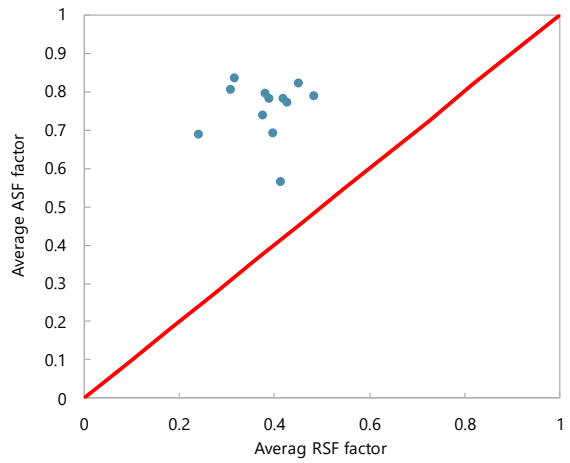
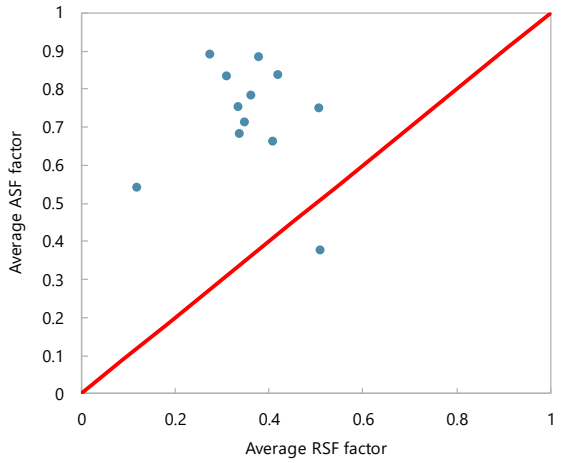


Figure 12. Romania: NSFR ASF and RSF Factors

RSF and ASF Factors RON



RSF and ASF Factors EUR

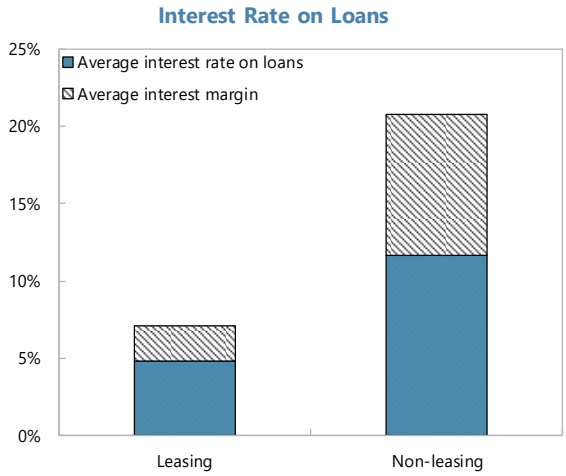


Sources: IMF staff calculations.

[12] See "EBA Report on Net Stable Funding Requirements under Article 510 of the CRR".

D. Cashflow-Based Liquidity Stress Test

49. A liquidity stress test based on maturity ladder analysis was undertaken to assess the capacity of banks to withstand severe funding pressures.[13] Cash-flow based liquidity stress tests were implemented through a TD approach, using supervisory information on the maturity structure of contractual cash flows generated by assets and liabilities. The tests assessed resilience to strong shocks characterized by run-off rates on funding sources calibrated by type, and liquidation of assets subject to valuation haircuts. Specifically, the exercise captured (i) a bank's liquidity needs derived from outflows; (ii) its available standby liquidity from inflows; and (iii) its buffers available to counterbalance liquidity gaps.



Sources: NBR and IMF staff calculations.

50. The results of the liquidity stress tests reveal that bank, by and large, could handle significant withdrawals of funding. Except for one small bank, all banks have sufficient counterbalancing capacity in the form of cash, excess central bank reserves or government bonds to meet their outflows. In line with haircuts applied to eligible assets for the provision of liquidity at the NBR's standing facility, all government securities are accepted at zero haircut. The assumption is that banks can convert their government securities to finance outflows through NBR's standing facilities.

STRESS TEST OF NONBANK FINANCIAL LENDERS

A. Introduction to the Sector

51. An assessment of the health of the NBFL sector is important for several reasons. First, the assets of NBFLs are almost 11 percent of the banking sector in total and rapidly expanding. Second, unlike the banking institutions the NBFLs do not undergo regular stress testing by the NBR. Third, their significant linkages with the banking sector (many are consolidated by local institutions and receive funding from their parents) could be an important source of contagion. Finally, it is likely that they have less sophisticated risk management systems and corporate governance structures.

52. Leasing companies account for the majority of NBFLs by assets size (text figure). The analysis of NBFLs in the FSAP was limited to the 35 firms in the special register. 22 of the 35 NBFLs in scope are leasing firms, representing about two-third of total assets in the sector. The rest are firms specializing mainly in consumer (uncollateralized) lending. There are significant differences in

[13] For methodological details, see IMF Guidance Note on Stress Testing, "Treatment of Liquidity Risks in Stress Tests," Number 11, November 2015.

terms of balance sheet composition between leasing and non-leasing companies, especially on the assets side. The collateralized nature of lending by the leasing companies as opposed to the consumer lending firms means that leasing companies' share of capital only accounts for one-third of the total capital of NBFLs in the Special Register,[14] despite their larger asset share.

53. Credit from the banking sector represents the main source of financing for leasing and non-leasing NBFLs (Figure 13). Loans from banks represent 76 percent and 87 percent of total liabilities for leasing and non-leasing companies, respectively. On the asset side however, the two types of firms differ: around two-thirds of leasing firms' assets is composed of fixed assets, reflecting leasing contracts related to their core activity; while non-leasing credit to customers only accounts for 22 percent of total assets. For non-leasing companies, credit to customers represents the largest share of assets (63 percent).

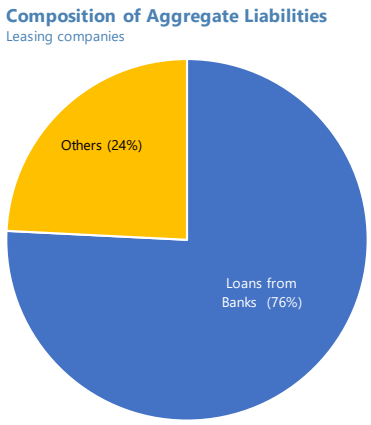
54. The composition of the credit portfolio and costs of lending also differ significantly across leasing and non-leasing firms (Figure 13 and text figure). 96 percent of credit to customers by leasing companies are granted to SMEs, of which close to 90 percent is in foreign currency. Only four percent of credit goes to the individuals. For non-leasing companies, credit to individuals accounts for the largest share of total credit to customers (67 percent), mostly denominated in domestic currency (95 percent). Credit to SMEs represents the remaining 33 percent of total credit to customers, split roughly equally in domestic and foreign currency. Both lending rates and interest rate margins are lower in the leasing activity, reflecting the collateralized nature of the lending. Leasing firms lend at an average interest rate of around five percent, with an average interest margin of two percent; compared to 12 percent and nine percent, respectively for other NBFLs.

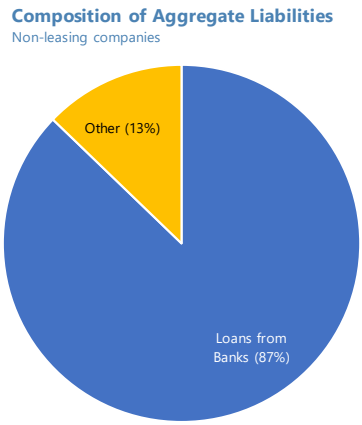
55. NBFLs show poorer asset quality indicators compared to the banks, and capital levels are particularly low for the leasing companies (Figure 14). NPLs stand at 13 percent and 22 percent for leasing and non-leasing companies, respectively (compared to six percent NPLs on consumer lending for banks). Coverage ratios are comfortable, however they are flattered by the fact that they include general provisions for performing loans. While capital levels are comfortably above the minimum requirement (7 percent of assets) for the non-leasing subsector (at 37 percent), there is significant variation among firms. Leasing companies' capital levels (at 11 percent) are much closer to the minimum requirements, partly explained by the secured nature of their lending activity; but this also leaves them more vulnerable to shocks.

[14] NBFLs with significant activity have to register in the Special Register, and less active NBFLs in the General Register. NBFLs in both registers must comply with certain prudential requirements, including simple minimum capital requirements among others. The NBR conducts onsite inspections for NBFLs in the Special Register, whereas General Register entities are monitored based on periodic reports.

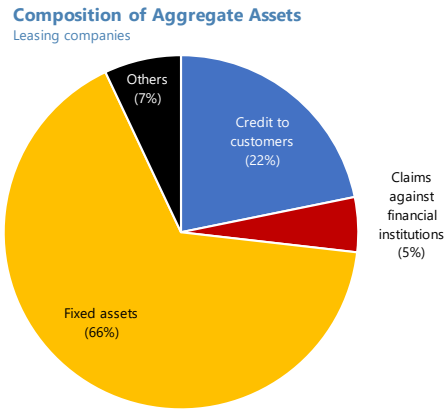
Figure 13. Romania: NBFLs—Composition of the Balance Sheet and Credit Portfolio

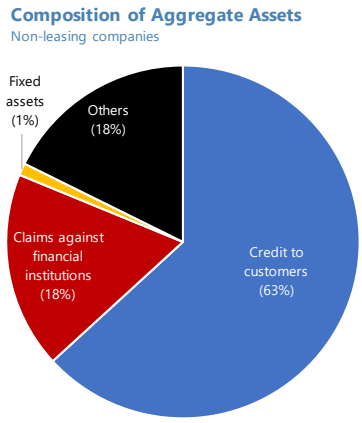
Composition of the balance sheet: liabilities



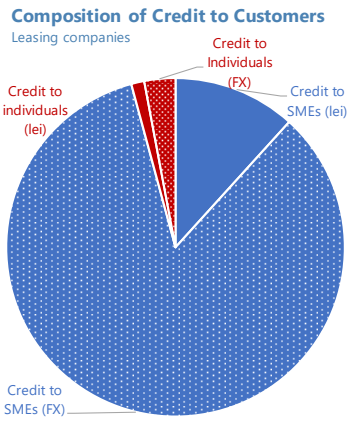


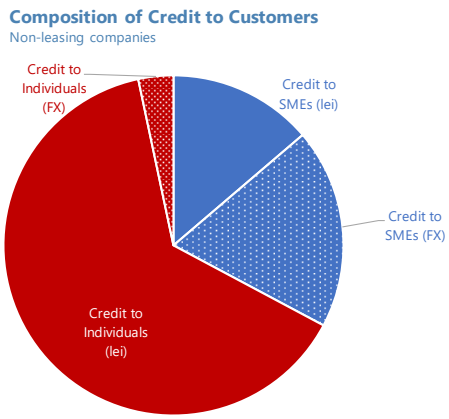
Composition of the balance sheet: assets





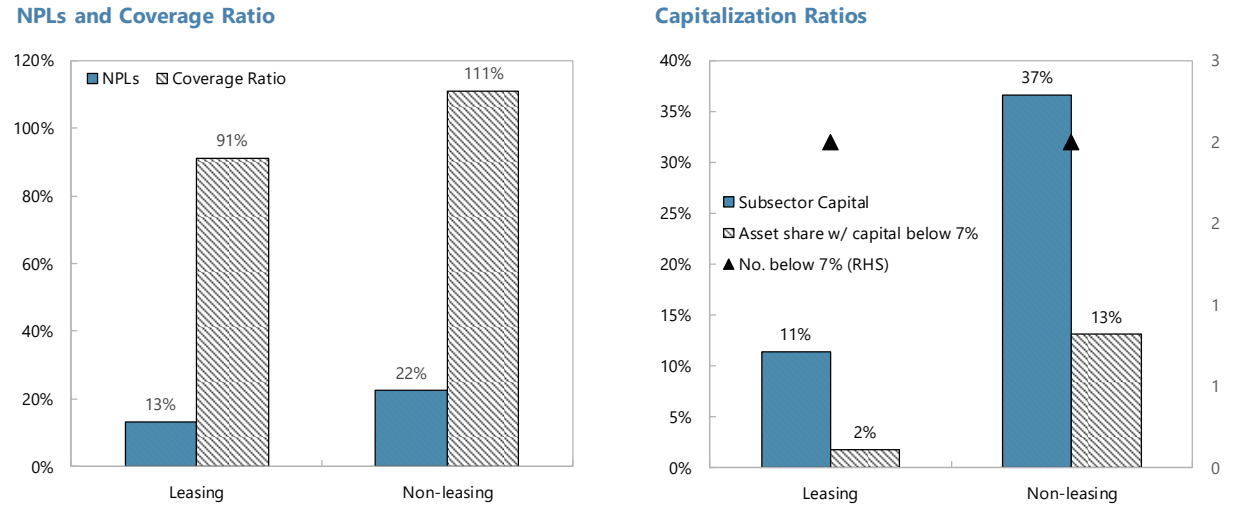
Composition of credit portfolio





Sources: NBR and IMF staff calculations.

Figure 14. Romania: NBFLs—NPLs, Coverage and Capital Ratios



Sources: NBR, IMF staff calculations.

56. The FSAP team conducted a number of sensitivity tests to assess NBFLs' resilience to withstand a depreciation, an increase in borrowing costs, and a deterioration in asset quality. Unlike for the banking sector, the team did not have access to time series data on default rates for the nonbank institutions and thus the solvency analysis for NBFLs was limited to a number of single factor sensitivity tests. Specifically, the team assessed the sensitivity of each of the 35 firms to:

- *A 10 percent depreciation of the domestic currency*. This captured both the direct impact of depreciation (through the net open position) as well as the indirect impact through FX-denominated loan losses. Since no time-series for defaults on the loans extended by the NBFLs were available, the team used the loss parameters estimated for the banks. Specifically, the coefficient on exchange rate movement in the PD estimation equation for SME loans extended by the banks was used to calibrate the losses faced by NBFLs in case of a 10 percent depreciation.

- *A five percent increase in NPLs*. The additional provisions associated with a 5 percent increase in NPLs were deducted from capital of each firm. A 100 percent coverage was assumed in line with existing observed coverage for NPLs.

- *A 300 basis points increase in the cost of funding*. The additional cost of borrowing was deducted from existing capital.

B. Results

57. Leasing companies are particularly vulnerable to a currency depreciation, due to the highly euroized lending portfolio (Figure 15). The leasing firms' low capital levels meant that their capacity to absorb losses were thin and a significant number of firms fell under the regulatory minimum capital levels in the face of shocks considered.

- *A 10 percent depreciation of the domestic currency:* Aggregate capital level for leasing companies decreases form 11.5 percent to -1.2 percent and several firms (accounting for 82 percent of the subsector's assets) fall under the 7 percent regulatory minimum capital.[15] Almost all the impact comes from the indirect impact of a depreciation via loan losses. The impact is much milder for non-leasing companies, mainly due to their mostly RON denominated loan book. For non-leasing firms the capital level decreases to 34 percent (from an initial 37 percent level) and only 1 firm falls below the regulatory minimum as a result.

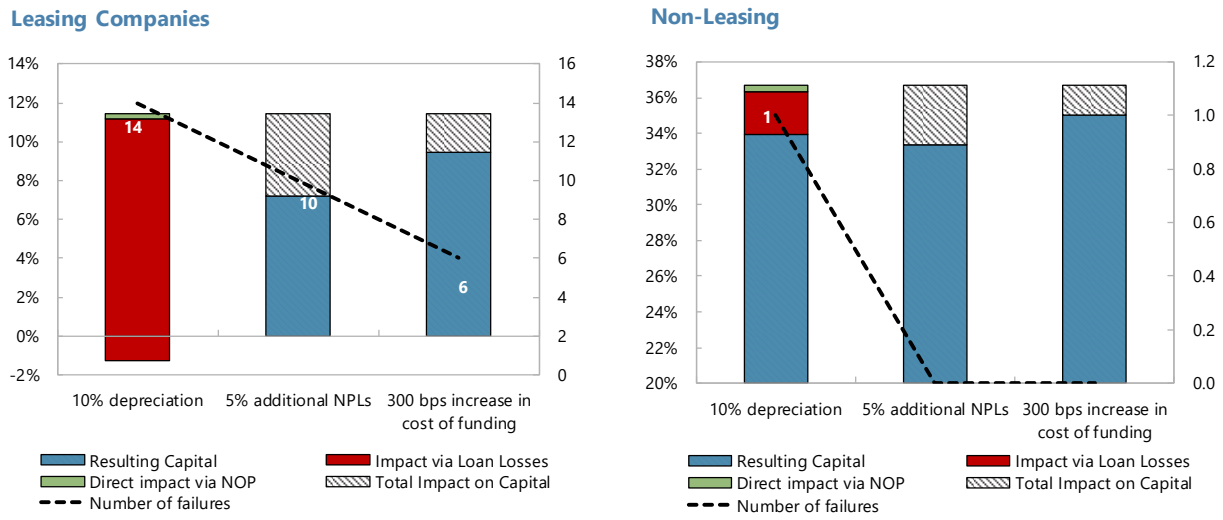
- *A five percent increase in NPLs*. The five percent increase in NPLs has the second largest impact on leasing companies' capital. Under this scenario, the capital ratio falls by 430 bps, to an aggregate of 7.2 percent. As a result, several firms (accounting for 72 percent of total assets of the sector) fall below the minimum capital requirement. The impact is significantly milder for non-leasing companies, where the impact is 330 bps, bringing the sectoral capital down to 33 percent. No firm falls below the regulatory minimum as a result.

- *A 300 bps increase in the cost of funding.* Finally, the increase in funding cost would reduce the capital to assets ratio by 200 bps for the leasing firms, with several institutions (representing around 50 percent of the sub-sector by asset share) falling below the minimum capital requirement. For the leasing firms the impact is of a similar magnitude (170 bps), however, as a result of higher initial capital levels, no firm finds itself below the regulatory minimum as a result.

58. Overall, the results reveal vulnerabilities related to the low capital levels of the leasing subsector and their highly euroized balance sheets. While a more tailor-made estimate of loan losses in the face of macroeconomic developments, similar to those conducted for the banks, is warranted, the sensitivity tests reveal the vulnerabilities of the sector, particularly to an exchange rate depreciation if borrowers are not to a large extent hedged naturally.

[15] The number of failures in these paragraphs are in addition to the two firms that are already undercapitalized.

Figure 15. Romania: NBFLs—Results of the Sensitivity Test



Sources: NBR, IMF staff calculations.

INTERCONNECTEDNESS ANALYSIS AND CONTAGION RISKS

59. The interconnectedness analysis explored the risk of contagion of stresses through balance sheet exposures to other institutions, domestically and abroad. Domestic interconnectedness analysis assessed interbank and bank-NBFL exposures, while the cross-border contagion analysis explored Romanian banking system's exposures to shocks from foreign banking sectors.

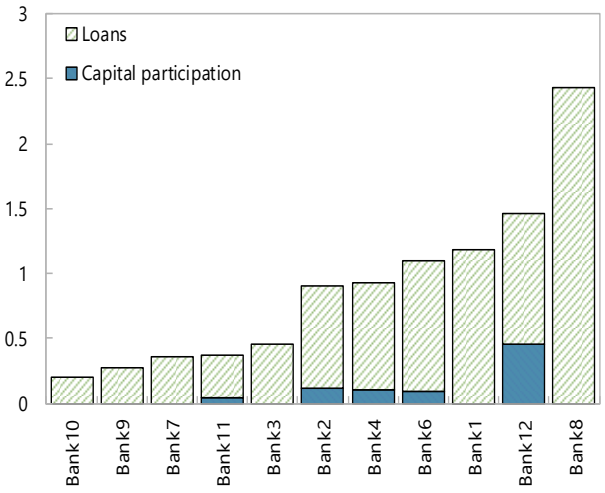
60. The interconnectedness and contagion analysis is complementary to the Balance Sheet Approach. In addition to the contagion analysis presented here, the Technical Note on Balance Sheet Analysis provides an assessment of exposures among subsectors of the financial system (i.e., between banks, investment funds, insurance companies, pension funds, etc.). The balance sheet analysis discusses how cross exposures at the level of these subsectors have changed over time. The contagion analysis, on the other hand, is focused on banks and non-bank financial lenders and uses institution-level data to examine the contagion impact of the failure of certain institutions on the rest of the network.

A. Domestic Contagion Analysis

61. The domestic interconnectedness analysis investigated channels of contagion between one or a group of institutions and the rest of the financial system. Given the relative concentration of the banking system in Romania, an adverse shock to the largest institutions could propagate to the rest of the banking system. In that context, domestic interbank contagion risks could prove to be important. An interbank contagion analysis, whereby the default of a single institution generates subsequent defaults among other banks, was implemented.

62. Furthermore, the interconnectedness analysis considers channels of contagion between banks and NBFLs. NBFLs are gaining importance in the Romanian financial system. Data from the NBR suggests that the stock of loans to the private sector granted by NBFLs has reached RON 26.6 billion in September 2017, representing around 10.3 percent of total loans to households and nonfinancial corporations. Furthermore, their significant linkages with the banking system (many NBFLs are consolidated by local institutions) could be an important source of risk. As a result, the extent to which a shock affecting NBFLs could generate losses in the rest of the financial system, and especially in the banking sector, was assessed.

Banks' Claims on NBFLs
(In percent of banks' assets)



Source: NBR.

63. The interconnectedness analysis relies on the network approach developed by Espinoza-Vega and Sole (2011). This methodology is based on a matrix of bilateral domestic bank-bank (for interbank contagion) or bank-NBFL (for bank-NBFL contagion) gross credit exposures of the 12 largest banks in scope and the 34 largest NBFLs in Romania's financial system. Interbank and bank-NBFL exposures were assessed on both the asset and liability sides of the financial institutions' balance sheet.

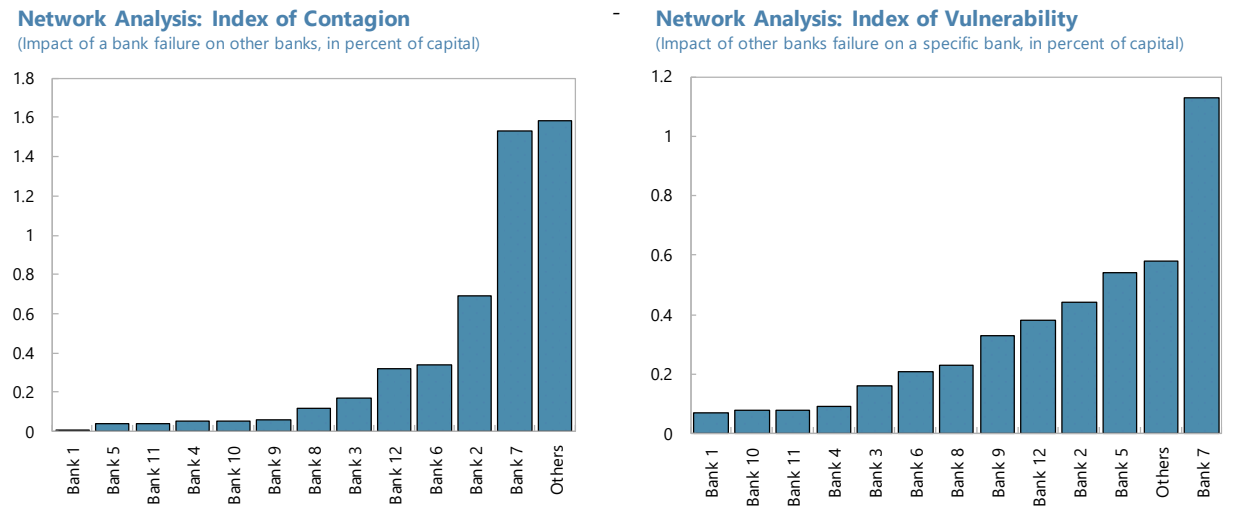
64. In addition to the direct exposure, the analysis simulated the impact of fire sales. The analysis explored pure contagion whereby the default of a bank on its obligations triggers direct credit losses for other banks in the system. We further assumed subsequent fire sales as a result of funding shocks and reflecting the fact that the default of an institution also leads to liquidity squeeze for those institutions funded by the defaulting bank. Banks affected by the default would need to replace a fraction of funding lost by selling other assets at a discount. The analysis thus explored potential for a "domino effect" whereby the initial default of a bank causes another bank to default, and so on. The exercise stops when there are no further failures.

65. The bank-NBFL contagion analysis also considered the impact of the failure of NBFLs as a group on the banking system as a whole. Given the size of individual NBFL compared to the banking system, the test not only considered the impact of the failure of a single NBFL (whose consequences for banks might be relatively limited), but also the extent to which a shock affecting the group of NBFLs as a whole, could have an impact on domestic banks. The analysis followed the same approach described above, i.e., a combination of credit shocks and the subsequent liquidity squeeze. In addition, we assessed direct exposures of parent banks (on a bank-by-bank basis) to the NBFLs they own, including via a reputational risk.

Results from the Interbank Contagion Analysis

66. The domestic interbank exposures provide limited scope for transmission of stresses among banks (Figure 16). The analysis was based on a network consisting of the top 12 banks by share of banking sector assets, and the remaining banking institutions were treated as a single entity. The data was as of end-2016. The stress test scenario which combines a credit and a funding shock assumed a 100 percent loss of claims in case of default, a 65 percent rollover of funding, and a 50 percent haircut on assets subject to liquidation. The results suggest that the index of contagion, which measures the average loss as a share of capital for other banks in the network due to the failure of one bank (outward measure), ranges from 0.01 to 1.6 percent. The index of vulnerability, which is a measure of losses as a share of capital for a bank due to the failure of the rest of the network (inward measure), ranges from 0.07 to 1.1 percent. The bank with the highest degree of outward contagion is also the most vulnerable to a distress in the rest of the system. Nevertheless, the low level of losses points to a limited risk of contagion through interbank exposures.

Figure 16. Romania: Domestic Interbank Exposure



Sources: BIS, IMF staff estimates.

Results from the Bank-NBFL Contagion Analysis

67. Results of the network analysis suggest that the systemic impact of NBFLs could be greater than that of the banks (Figure 17). The network consists of the 34 largest NBFLs and the 11 largest banks, with data as of end-2016.[16] We employ two scenarios. In the first scenario, we assess the vulnerabilities of the banking sector to the failure of each NBFL. Banks' exposures to NBFLs are mainly through loans granted to these financial institutions. This scenario therefore

[16] The 12th bank is excluded due to missing information. However, this specific bank only account for 1.6 percent of the bank sector total assets. Therefore, this should not materially affect the results of our analysis.

explores the impact of a credit shock, assuming a 100 percent loss in case of default of a counterparty. The results suggest that some NBFLs have a greater systemic impact on the network (higher contagion effect) than the failure of individual banks. This is because banks' exposures to NBFLs are at times larger, as a share of their capital, than their interbank exposures. The index of contagion (outward systemic impact) for banks is in line with the results obtained for interbank exposures, ranging from 0 to 0.2 for all but one bank. In line with larger exposures of banks to NBFLs compared to their interbank exposures, the index of contagion (outward systemic impact) of NBFLs are slightly higher (between 0.2 and 1.2).

68. NBFLs are mainly vulnerable to stresses in the banking sector on the liability (funding) side of their balance sheets (Figure 17). In the second scenario, the focus was on the vulnerabilities of NBFLs to stresses in the banking sector. Thus, in addition to the credit shock (with similar calibration as described in the previous paragraph), we considered a funding shock, assuming a 50 percent haircut on assets subject to liquidation, and a 65 percent rollover of funding. While the index of contagion (a measure of outward systemic impact) remains broadly similar for NBFLs, it is higher for banks compared to the first scenario, suggesting that the failure of banks have larger consequences for the NBFLs if a funding shock is also considered.

69. The network approach suggests the vulnerabilities of the two sectors to distress in the other can be significant (Figure 17). In this exercise we ask what happens to the banking sector if the entire NBFL sector fails and vice versa. In terms of the Espinosa-Vega and Sole (2011) model, we replicated the exercise described in the previous paragraph in a framework where the 11 banks and 34 NBFLs are treated as two single entities respectively. The analysis is based on the scenarios described above, with the same calibration for all parameters. The results of the first scenario (credit shock) show that the index of contagion (outward systemic impact) is estimated at 8.6 for NBFLs, suggesting that banks in the network will incur losses of 8.6 percent of their aggregate capital in case of a failure of all NBFLs. For banks, the index of contagion is 1.7, i.e., NBFLs' aggregate losses in case of failure of the banking system will amount to 1.7 percent of the NBFL sector's capital. In the second scenario (where credit and funding shocks are combined), the index of contagion is 50 for banks, which implies that in case of failure of the banking system, NBFLs will lose about 50 percent of their total capital. The contagion effect of NBFLs is similar to the first scenario. The results of the two scenarios confirm the higher exposure on the assets side for banks, and on the liability side for NBFLs.[17]

70. We also assessed the direct and indirect impact of failure of NBFLs on their (bank) parents. Six banks own fully or partially an "own-name" NBFL, i.e., an institution that bears the same name as the parent bank, with capital participations amounting from 50 to 100 percent of the NBFL's total capital. In this exercise, we investigate the impact of the failure of an NBFL on its parent bank. Parent banks are vulnerable in three ways:

[17] Note that in this specific case where there are only two entities in the network, the index of vulnerability is simply the mirror image of the index of contagion.

- Direct exposure losses: In case of the failure of an NBFL, the parent bank loses its capital participation in the subsidiary. We assume the entire capital participation is wiped out in case of NBFL default.

- Lending to the affiliated NBFL: Parent banks often lend to their affiliated NBFL.[18] We assume a 100 percent loss given default for any funding to the affiliate.

- Reputational losses: Finally, it is assumed that the parent bank will suffer a reputational risk following the default of the affiliated NBFL. This risk will be reflected through loss of retail deposits. The assumption is that depositors may not be able to differentiate between a bank and its affiliated NBFL which bears its name. We assume a runoff rate of 20 percent on retail deposits, of which 50 percent can be replaced with other sources funding for foreign banks. For domestic banks we assume only 30 percent of the lost deposits can be replaced with other sources of funding, as these banks do not have access to credit lines from the parents. To meet the remaining financing needs, it is assumed that banks have to sell part of their assets, with a 50 percent haircut.

The calibration of the LGDs are in line with those in the contagion analysis.[19] The run-off rates are in line with the liquidity stress test (the retail stress scenario). We quantify the impact of such a scenario on banks' capital and liquidity coverage ratios.

71. The analysis further suggests that reputational risks to parent banks due to the failure of their daughter NBFLs can be sizeable (Figure 18). Capital ratios decline by 3 to 9 percentage points for parent banks, while liquidity ratios drop by more than half for one bank. This analysis also demonstrates that reputational risks could be far more significant than direct exposures as a source of vulnerability for banks in case of distresses in the affiliated NBFLs. Nevertheless, given the very high level of initial capital and liquidity in the banking system, banks will remain resilient if they were to cope with such a shock.

B. Cross-Border Contagion Risks

72. The cross-border contagion analysis aimed at assessing Romanian banking systems' resilience to external shocks. With foreign banks representing the large majority of the Romanian banking system (27 out of the 37 banks), cross-border exposures could be significant, including via parent bank funding. Therefore, it is important to assess banks' resilience to external shocks,

[18] On the other hand, the parents' liability to affiliated NBFLs (often in the form of deposits) are very small.

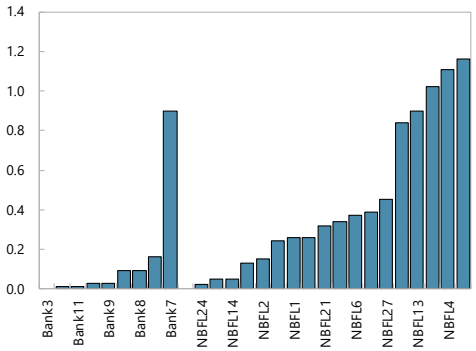
[19] The assumption that banks are unable to recover any of their loans when a credit shock materializes reflects the fact that it takes time to price recently defaulted exposures. The results of the simulations should be interpreted as the maximum possible short-term impact of a default. Espinosa-Vega and Sole (2011), and Wells (2004) argue that network analyses should consider higher loss-given-default estimates than typically assumed, as banks tend to face substantial uncertainty over recovery rates in the short run. A similar loss-given-default rate is assumed in the Spain 2017 FSAP, Germany 2016 FSAP, and the Italy 2013 FSAP.

including loss of access to this funding. On the other hand, stresses abroad could affect banks in Romania, through Romanian banks' claims on foreign entities (via deposits or other claims).

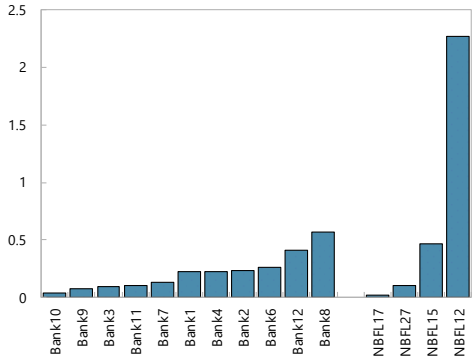
Figure 17. Romania: Bank-NBFL Exposures

Results of the contagion analysis: scenario 1

Network Analysis: Index of Contagion
(Impact of a bank or NBFL failure on the rest of the network, in percent of capital)

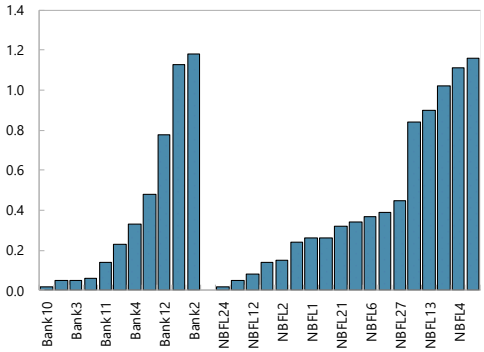


Network Analysis: Index of Vulnerability
(Impact on a bank or NBFL of failure of the rest of the network, in percent of capital)

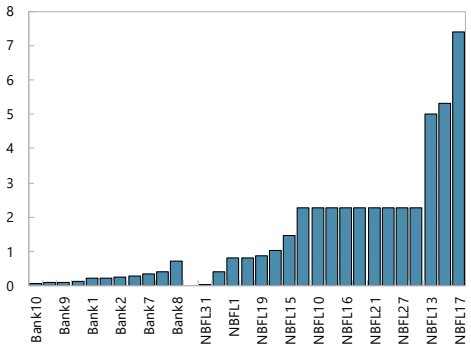


Results of the contagion analysis: scenario 2.

Network Analysis: Index of Contagion
(Impact of a bank or NBFL failure on the rest of the network, in percent of capital)

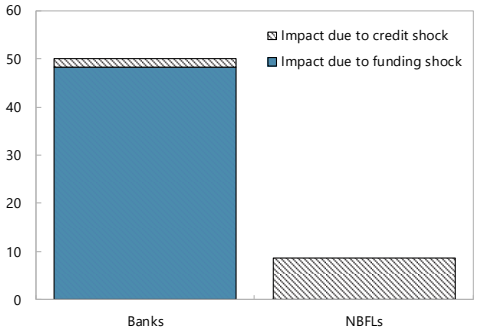


Network Analysis: Index of Vulnerability
(Impact on a bank or NBFL of failure of the rest of the network, in percent of capital)

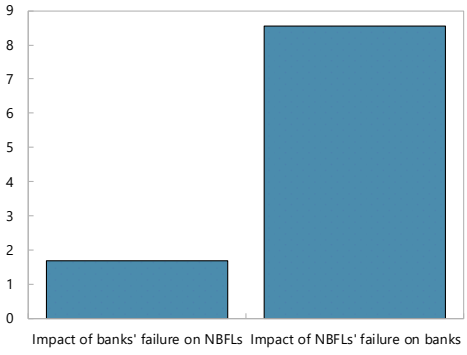


Results of the contagion analysis: aggregate exposures.

Network Analysis (Credit + Funding Shock): Index of Contagion
(Impact of failure of a group of institutions on the rest of the network, in percent of capital)



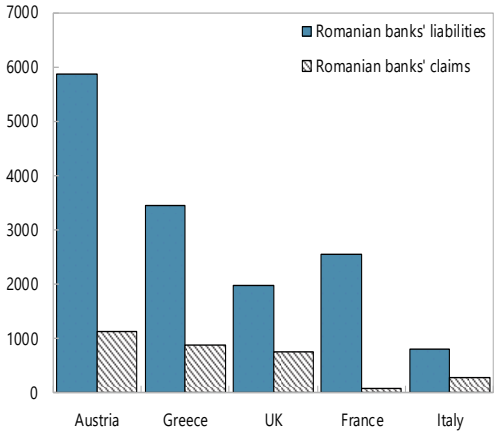
Network Analysis (Credit Shock): Index of Contagion
(Impact of failure of group of institutions on the rest of the network, in percent of capital)



Sources: NBR, IMF staff estimates.

73. Romanian banks are more exposed to foreign entities on the liabilities (funding) side (text figure). The analysis is based on the BIS consolidated international banking statistics, compiled on a locational basis (data as of July 2016).[20] Based on available information from BIS reporting countries, Romania's banking system claims against banks abroad account for about 4 percent of total Romanian banking sector assets, while liabilities to foreign banks represent about 15 percent of total assets. The Austrian banking sector appears to be the top foreign counterpart, both on claims and liabilities.

Romania's Banking System: Main Foreign Counterparts
(July 2016, millions of U.S. dollar)



Source: BIS.

74. The cross-border contagion analysis assessed the extent to which the Romanian banking sector is vulnerable to shocks from banking systems abroad. The exercise considers 15 banking sectors.[21] The analysis relies on two scenarios. (i) The first scenario considers only a funding shock, assuming a 30 percent roll-over of funding, and a 50 percent haircut on assets subject to liquidation. (ii) The second scenario applies a combination of credit and funding shocks, assuming a 100 percent loss on claims in case of the default of a counterparty, and a similar calibration of rollover and haircut parameters as in the first scenario. Thus, the first scenario only assesses risks on the funding side, whereas the second scenario also includes risks on the asset side.

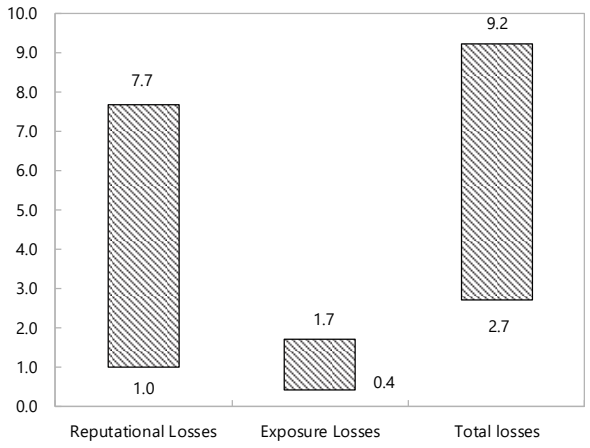
75. The results of the cross-border contagion analysis confirm that Romania's banking sector is more vulnerable to shocks from abroad on the funding side (Figure 19). Under the first scenario, the index of contagion (a measure of outward systemic impact) is about 0.01 percent. The index of vulnerability (a measure of inward systemic impact) is significantly higher at 10 percent. Under the second scenario, the index of contagion rises to 0.08 percent and the index of vulnerability to 15 percent. Overall, these results suggest that distress in Romania's banking sector will have, on average, very little impact on other banking sectors in the network. However, Romanian banking system appears to be more vulnerable to an external shock, especially through foreign funding.

[20] BIS locational data for banking sectors are compiled based on residency principles of creditors and debtors.

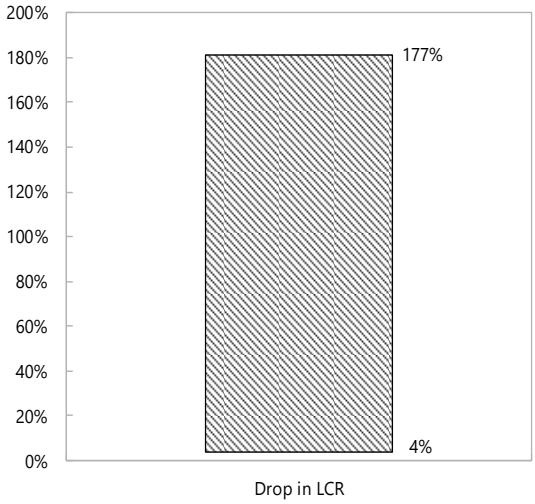
[21] Austria, Australia, Belgium, Canada, Cyprus, Denmark, Finland, France, Greece, Italy, Luxembourg, Romania, Switzerland, United Kingdom, and the United States.

Figure 18. Romania: Direct Exposures of Parent Banks to NBFLs

Range of (Direct and Indirect) Losses Due to Failure of NBFL*
(Share of RWA)



Range of Drop in LCR Due to NBFL Failure*
(Percentage points)



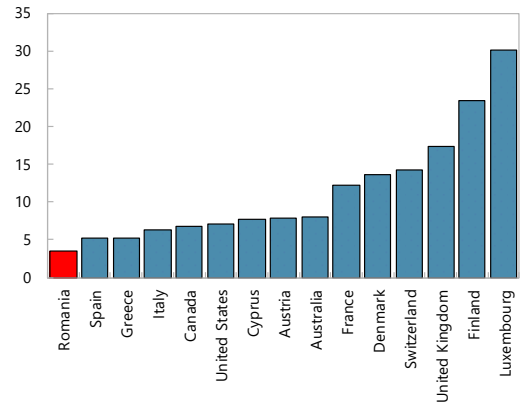
* Th e columns show the range of the values for each category across banks

Source: NBR, IMF staff estimates.

Figure 19. Romania: Cross-Border Exposure

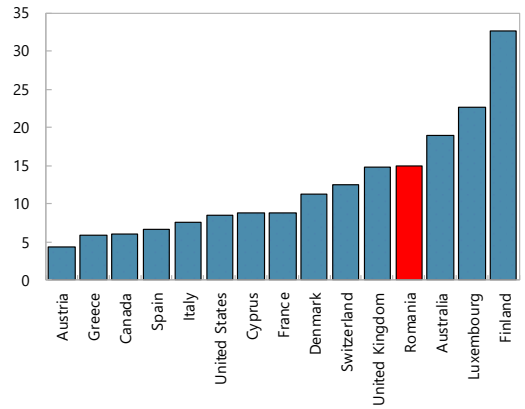
Banking sector claims on banks abroad are low,

Banking Sector Claims on Banks Abroad
(In percent of total bank assets)



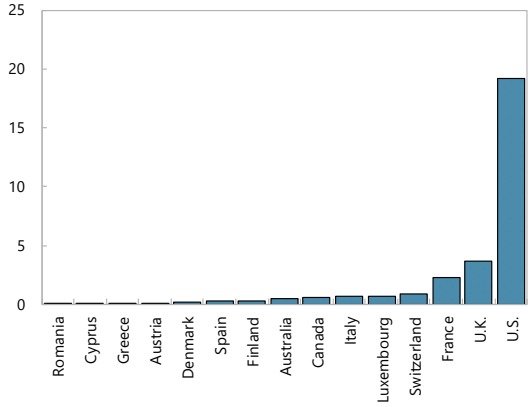
... while liabilities to banks abroad are higher.

Banking Sector Liabilities to Banks Abroad
(In percent of total assets)

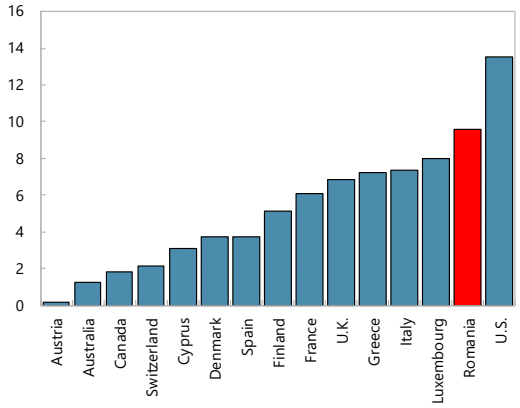


Results of the contagion analysis: scenario 1.

Network Analysis: Index of Contagion
(Impact of a banking system failure on conterparts)

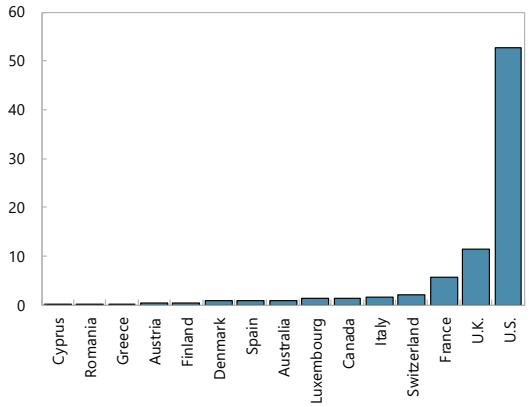


Network Analysis: Index of Vulnerability
(Impact on a banking system of failure of counterparts)

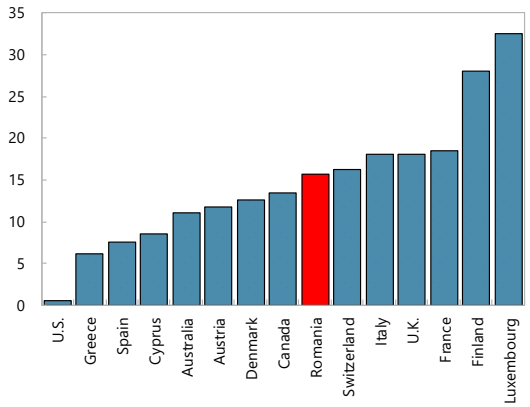


Results of the contagion analysis: scenario 2.

Network Analysis: Index of Contagion
(Impact of a banking system failure on conterparts, in percent of capital)



Network Analysis: Index of Vulnerability
(Impact on a banking system of failure of conterparts, in percent of capital)



Sources: BIS, IFS, FSI, IMF staff estimates.

CONCLUSION

76. The findings in the risk analysis workstream provide some of the analytical underpinnings for a number of the recommendations in the macroprudential workstream. Therefore, the results discussed in this note go hand in hand with the analysis presented in the Macroprudential Technical Note, and its policy recommendations, also highlighted below:

77. The team recommends addressing risks arising from the sovereign-bank nexus. The stress test shows that mark-to-market losses associated with securities portfolios account for a large share of the drop in capitalization ratios under the adverse scenario as credit spreads widen and domestic interest rates rise against depreciation pressures. Moreover, repricing of securities contributes negatively to the capitalization ratios even under the baseline scenario, as growth gains momentum and monetary policy normalizes. Thus, large exposures to the government pose risks, be it due to the potential for a re-emergence of sovereign risks, or due to interest rate risk as monetary policy normalizes.

78. The team also recommends a more nuanced approach to liquidity requirements and monitoring. While aggregate liquidity is ample, the authorities are encouraged to enforce LCR requirements on a currency-by-currency basis. Furthermore, the authorities were encouraged to start monitoring the NSFR. While there is no European-wide agreement on imposing an NSFR requirement, the monitoring will provide an accurate picture of the maturity mismatches in the banks' balance sheets.

79. Finally, a tightening of provisioning requirements for the NBFLs is advised. The analysis highlighted the vulnerabilities in the NBFL sector and the potential for stresses emanating from this sector to permeate to the banks. As such, the team advises closer monitoring of these institutions, despite the fact that they are not deposit taking. Furthermore, to prevent regulatory arbitrage the team recommends a harmonization, to the extent possible, between the provisioning requirements applied to the banks and to NBFLs for similar loans, in line with the application of IFRS9.

Appendix I. Risk Assessment Matrix

Nature/Source of Main Threats and Possible Triggers	Likelihood of Severe Realization of Threat Sometime in the Next Three Years	Expected impact on Financial Stability if Threat is Realized
1. A re-emergence of financial stress in European banks followed by risk aversion in global markets.	**Staff assessment: Medium** Financial stress may have knock-on effects on sovereign yields in Romania and negative spillovers from financial, trade and investment channels. Risk aversion in global markets may lead to a steepening of the yield curve.	**Staff assessment: High** A sudden rise in risk premia on Romanian government bonds exposes banks to losses on their domestic government bond positions. Adverse effect on economic activity and social tensions.
2. Policy uncertainty and divergence and a weakening of confidence in the Romanian economy.	**Staff assessment: High** Procyclical fiscal stance and growing macroeconomic imbalances may lead to a sharp recession, economic disruption, and adverse market sentiment, reflected in consumption and investment decisions.	**Staff assessment: High** Uncertainty increases borrowing costs, may impact Romania's credit rating, and may lead to sudden capital outflows and slower growth.
3. Surges in global financial market volatility, associated with the exit from unconventional monetary policies.	**Staff assessment: High** Financial market volatility could lead to a rapid and significant rise in interest rates, a steepening of the yield curve, and currency depreciation.	**Staff assessment: High** NPLs would likely rise further both in the case of increases in interest rates and in the case of lei depreciation, since both would weaken the repayment capacity of borrowers of lei and FX loans. Also, banks would face losses on their domestic government bond positions.
4. A protracted period of slower growth in advanced and emerging economies.	**Staff assessment: Medium** Weak growth in European trading partners could slow the Romanian economy through declines in trade and remittances.	**Staff assessment: Medium** Slower growth could increase NPLs and impact bank profitability.

Note: The RAM shows events that could materially alter the baseline path (the scenario most likely to materialize in the view of IMF staff). It reflects current staff views on the sources of risk surrounding the baseline, their relative likelihood, and the overall level of concern.

BANKING SECTOR: SOLVENCY RISK		
Domain	Assumption	
	Exercise	• Top-Down by FSAP team
	Institutions included	• The top 12 banks by share of assets.
	Market share	• 80 percent of total assets in the banking system.
	Data and baseline date	• Latest data: December 2016.[1] • Supervisory data: balance sheet information, Corep and Finrep, LCR and LE templates provided by the authorities. Also provided were further supervisory information on default rates, by portfolio and bank. • Scope of consolidation: banking activities of the consolidated banking group. • Coverage of sovereign and non-sovereign securities exposures: held to maturity, available for sale, and fair value accounts, valued at MTM or fair-value respectively at starting point.
2. Channels of Risk Propagation	Methodology	• Macroeconomic scenarios were quantified using the NBR's Quarterly Projections Model (QPM). • FSAP team satellite models and methodologies. • Balance-sheet regulatory approach.
	Satellite Models for Macrofinancial linkages	• FSAP team estimated models for credit losses on four portfolios: Consumer, Mortgages, SME backed by RE and SME not backed by RE. The PDs for the large corporates were calibrated to the 80th percentile. The estimates relied on time-series default rates for each portfolio, on a bank by bank basis. The estimates were obtained using panel regressions on a portfolio by portfolio basis, with bank-specific dummies. • Methodology to calculate losses from sovereign debt holdings: Haircuts are calculated based on a modified duration approach and historical distributions of changes in yield.
	Stress test horizon	• 2018–20

[1] While the data is as of December 2016, the stress test horizon covered 2018–20. The assumption was that the balance sheet of the banks remained exactly in their December 2016 position. This is supported by data available as of Q3 2017 (unaudited) which shows that CAR for the banking sector stood at 19 percent, and T1 capital ratio at 17.1 percent (see FSR, NBR, December 2017).

3. Tail Shocks	Scenario analysis	• Macroeconomic scenario analysis: agreed with the authorities. • Baseline scenario based on latest IMF staff projections, with inputs from the authorities' QPM model on variables for which projections were not available. • The (V-shaped) adverse scenario is based on a cumulative decline of GDP of two standard deviations over two years. The shocks to simulate the model were an external demand shock affecting Romania's main trading partners, a risk premium shock to generate the nominal depreciation of the exchange rate, and additional internal confidence shock due to increased risk aversion.
	Sensitivity analysis	• Sensitivity tests to various shocks: • Failure of the largest 1, 2, 5, and 10 corporate exposures; failure of largest non-corporate exposure. • Sensitivity tests to various risks (credit, interest, and market risks).
4. Risks and Buffers	Risks/factors assessed (How each element is derived, assumptions)	• Credit losses by exposure type and country. • Losses from debt instruments (sovereign and other issuers) in the banking and trading books. • Impact of funding cost shocks on net interest income. • Market risk, including foreign exchange risk.
	Behavioral adjustments	• Static balance sheet. • Dividends can only be paid out by banks that remain adequately capitalized and have positive profits. Payout rates consistent with past experience.
5. Regulatory and Market-Based Standards and Parameters	Calibration of risk parameters	• PDs and LGDs: point in time for credit losses and through the cycle for stressed RWA calculations. • Regulatory risk parameters for standardized banks.
	Regulatory/ Accounting and Market-Based Standards	• Hurdle rate: Pilar I requirements plus relevant systemic buffers. • Capital metrics: Fully loaded Basel III regulatory requirements. • CET1, T1, CAR, leverage ratio.
Reporting Form for Results	Output presentation	• Capital shortfall system wide, and share in whole system. • Dispersion of capital ratios: min., avg., max.: percentage of assets that fail.

BANKING SECTOR: LIQUIDITY RISK		
1. Institutional Perimeter	Institutions included	• The top 12 banks by share of assets.
	Market share	• 80 percent of total assets in the banking system.
	Debt and baseline date	• Latest data: December 2016. • Source: supervisory data. • Scope of consolidation: consolidated banking group.
2. Channels of Risk Propagation	Methodology	• Cashflow-based using data on the time structure of undiscounted cashflows for up to one year. • Variants of LCR ratios by currency. • NSFR.
3. Risks and Buffers	Risks	• Funding liquidity. • Market liquidity.
4. Scenarios		• Retail shock. • Wholesale shock.
5. Regulatory and Market-Based Standards and Parameters	Regulatory standards	• Liquidity gap, survival period. • Consistent with Basel III draft standards (LCR).
6. Reporting Format for Results	Output presentation	• Liquidity gap by bank. • Survival period in days by bank, number of banks that still can meet their obligations.

CONTAGION RISK			
		Domestic	**Cross-Border**
1. Perimeter	Institutions included	• For domestic network analysis of contagion, interbank exposure is conducted on the top 12 banks by share of banking sector assets, and the rest of the banks treated as a single institution. • The analysis of bank-NBFL contagion is based on the top 12 banks, and the 34 NBFLs in the special register.	• Romania and 14 BIS reporting countries.
	Market share	• The top 12 banks account for 80 percent of total assets in the banking system. • The top 34 NBFLs account for 90 percent of total NBFLs assets.	• N/A
	Data and Relevant date	• The top 12 banks account for 80 percent of total assets in the banking system. • The top 34 NBFLs account for 90 percent of total NBFLS assets.	• BIS Locational Statistics • July 2016.
2. Channels of Risk Propagation	Methodology	• Network analysis using interbank and bank-NBFLs exposures. (Espinosa-Sole approach).	• Network analysis using BIS data (Espinosa-Sole approach).
3. Tail Shock	Size of the shock	• 100 percent loss given default (LGD). • 65 percent roll-over of funding. • 50 percent haircut on asset fire sales.	• 100 percent loss given default (LGD) • 30 percent roll-over of funding • 50 percent haircut on asset fire sales.
4. Reporting Format for Results	Output presentation	• Capital shortfall, by institution. • Capital shortfall, system wide. • Failure of individual institutions. • Interconnectedness measures.	• Failure of banking systems • Interconnectedness measures.

NBFLs: Solvency Sensitivity Tests		
1. Institutional Perimeter	Institutions included	The 34 NBFLs in the special register.
	Market share	90 percent of total assets in the NBFLs.
	Debt and baseline date	Latest data: December 2016 Source: supervisory data.
2. Tests	Sensitivity analysis	Sensitivity tests to credit risk and funding risk.
3. Regulatory standard	Regulatory standards	NBR regulation governing capital requirements.
4. Reporting Format for Results	Output presentation	Losses system-wide and as a share of sectoral assets.

Appendix III. PD Estimation Models

1. Probabilities of Default (PDs) for credit risk estimation were projected for each individual bank using historical default rate series for 4 portfolios: retail mortgages, SME backed by RE, non-RE backed SME and consumer loans. Point-in-time PDs are projected using regression models with macro variables as independent variables. The data provided by NBR on a quarterly and bank by bank basis, from Q12006 to Q42016. The satellite models for PDs as a dependent variable were constructed as follows:

- To ensure that the models only produce PD predictions between 0 and 1 (or, equivalently, between 0 and 100 percent) and to capture nonlinearities in the relationship between the dependent and explanatory variables, the following logit transformation was applied to the original PD:

$$Y_{it} = ln\left(\frac{PD_{it}}{1 - PD_{it}}\right)$$

- To estimate impact of shocks of macrofinancial variables on PDs, the logit-transformed PDs were modeled as a linear function of different exogenous macroeconomic and financial factors (regressors). Therefore, the estimated model for the PDs can be expressed as:

$$Y_{it} = \alpha + \boldsymbol{\beta} Y_{i,t-k} + \boldsymbol{\delta} \boldsymbol{X}_{i,t-s} + \varepsilon_{i,t}$$

  where $Y_{i,t}$ is the logit transform of the PD for asset class i at time t, $\boldsymbol{X}_t$ is a vector of macroeconomic and financial variables; $Y_{i,t-k}$ is vector of the lagged dependent variable ($k = 1\ to\ N$). $\varepsilon_{i,t}$ is an independent and identically distributed error-term, and α, and vectors $\boldsymbol{\beta}$, and $\boldsymbol{\delta}$ are parameters to be estimated;

- Bayesian model averaging (BMA) for panel regressions was used to test for significant explanatory variables and their lags. The use of BMA allows for a more informed choice of models. There may be many specifications with significant explanatory variables, giving rise to model uncertainty. Under the BMA procedure the models can be averaged using the posterior likelihood as a weight.

- The projected logit PDs under stress for each of the exposure classes were transformed to PD space.

2. Specifications of selected equations are provided in Tables 1 and 2 below. Estimation results reveal, that corporate PDs are mostly sensitive to lagged real GDP growth rate, equity indices and interest rates. Mortgage loans are sensitive to GDP, unemployment and interest rates. Respective elasticities are small, and this is reflected in relatively small multipliers. PDs for equity exposures do depend on equity prices, interest and exchange rates. Other retail loans depend on interest rates, GDP and unemployment.

Appendix Table 1. PD Estimation Equations

	Consumer	Retail Mortgage	SME nonRE	SME_RE
PD (t-4)	**0.433**	**0.423**	**0.378**	**0.589**
(p-values)	0.000	0.000	0.000	0.000
D_GDP	**-0.075**	**-0.108**	**-0.062**	**-0.076**
(p-values)	0.000	0.000	0.003	0.000
D_GDP (t-4)		**0.020**		
(p-values)		0.004		
EXR(t-2)	**0.037**	**0.046**		
(p-values)	0.040	0.008		
3-month rate (t-4)		**-0.069**		
(p-values)		0.000		
Government 10-yr (t-2)			**0.150**	**0.092**
(p-values)			0.003	0.024
Constant	**-2.454**	**-2.275**	**-4.174**	**-2.114**
(p-values)	0.000	0.000	0.000	0.000
[Various Bank Dummies]				
Observations	468	468	468	468
R-squared	0.3675	0.5134	0.3629	0.5336

Source: IMF staff calculations.

Appendix IV. Liquidity Stress Test Assumptions

A. Eligibility of liquid assets			
Scenario type	1 LCR	2 Retail	3 Wholesale
Level 1 Assets			
Coins and banknotes	100%	100%	100%
Withdrawable central bank reserves	100%	100%	100%
Central bank assets	100%	100%	100%
Central government assets	100%	85%	85%
Regional government / local authorities assets	100%	85%	85%
Public Sector Entity assets	100%	100%	100%
Recognisable domestic and foreign currency central government and central bank assets	100%	100%	100%
Credit institution (protected by Member State government, promotional lender) assets	100%	100%	100%
Multilateral development bank and international organisations assets	100%	100%	100%
Qualifying CIU shares/units: underlying is coins/banknotes and/or central bank exposure	100%	100%	100%
Qualifying CIU shares/units: underlying is Level 1 assets excluding extremely high quality covered bonds	95%	100%	100%
Alternative Liquidity Approaches: Central bank credit facility	100%	100%	100%
Central institutions: Level 1 assets excl. EHQ CB which are considered liquid assets for the depositing credit inst	0%	0%	100%
Alternative Liquidity Approaches: Inclusion of Level 2A assets recognised as Level 1	80%	80%	100%
Extremely high quality covered bonds	93%	93%	100%
Qualifying CIU shares/units: underlying is extremely high quality covered bonds	88%	88%	100%
Central institutions: Level 1 EHQ covered bonds which are considered liquid assets for	0%	0%	100%
L1 EHQCB collateral 30 day outflows	100%	100%	100%
L1 EHQCB collateral 30 day inflows	100%	100%	100%

Source: IMF.

B. Outflows (over 30 days)			
OUTFLOWS FROM UNSECURED TRANSACTIONS/DEPOSITS			
Retail deposits			
deposits where the payout has been agreed within the following 30 days	100%	100%	100%
deposits subject to higher outflows			
category 1	15%	15%	15%
category 2	20%	20%	20%
stable deposits	5%	10%	5%
derogated stable deposits	3%	3%	3%
deposits in third countries where a higher outflow is applied	0%	0%	0%
other retail deposits	10%	15%	10%
Operational deposits			
covered by DGS	5%	5%	50%
not covered by DGS	25%	25%	100%
maintained in the context of IPS or a cooperative network			
not treated as liquid assets for the depositing institution	25%	25%	25%
treated as liquid assets for the depositing credit institution	100%	100%	100%
maintained in the context of an established operational relationship (other) with non-financial customers	25%	25%	100%
maintained to obtain cash clearing and central credit institution services within a network	25%	25%	100%
Non-operational deposits			
correspondent banking and provisions of prime brokerage deposits	100%	100%	100%
deposits by financial customers	100%	100%	100%
deposits by other customers			
covered by DGS	20%	20%	40%
not covered by DGS	40%	40%	60%

Source: IMF.

References

EBA Report, "EBA Report on Net Stable Funding Requirements Under Article 510 of the CRR," EBA/OP/2-15/22.

Espinosa-Vega, Marco A., and Juan Solé, 2011, "Cross-Border Financial Surveillance: A Network Perspective," *Journal of Financial Economic Policy* 3, No. 3: 182–205.

IMF Guidance Note on Stress Testing, "Treatment of Liquidity Risks in Stress Tests," Number 11, November 2015.