



BULGARIA

FINANCIAL SECTOR ASSESSMENT PROGRAM

TECHNICAL NOTE—RISK ASSESSMENT AND STRESS TESTS OF THE BANKING SYSTEM

July 2017

This Technical Note on Risk Assessment and Stress Tests of the Banking System for Bulgaria was prepared by a staff team of the International Monetary Fund. It is based on the information available at the time it was completed in June 2017.

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INTERNATIONAL MONETARY FUND

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SYSTEM

Prepared By
**Monetary and Capital Markets
Department**

This Technical Note was prepared by IMF staff in the context of the Financial Sector Assessment Program in Bulgaria. It contains technical analysis and detailed information underpinning the FSAP's findings and recommendations. Further information on the FSAP can be found at

<http://www.imf.org/external/np/fsap/fssa.aspx>

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Glossary

AQR	Asset Quality Review
BNB	Bulgarian National Bank
BSD	BNB Bank Supervision Department
CBA	Currency Board Arrangement
CET1	Basel capital measure – Common Equity Tier 1
CRR	Capital Requirements Regulation
EBA	European Banking Authority
ELA	Emergency Liquidity Assistance
EBRD	European Bank for Reconstruction and Development
ESRB	European Systemic Risk Board
FSAP	Financial Sector Assessment Program
GDP	Gross Domestic Product
GFC	Global Financial Crisis
IAS	International Accounting Standards of the IASB
IASB	International Accounting Standards Board
IFRS	International Financial Reporting Standards of the IASB
LCR	Liquidity Coverage ratio
LGD	Loss Given Default
LLR	Loan Loss Reserve
LTD	Loan to Deposits ratio
MCM	Monetary and Capital Markets Department (IMF)
NPLs	Nonperforming Loans (used interchangeably with distressed assets)
NSFR	Net Stable Funding ratio
PD	Probability of Default
RAM	Risk Assessment Matrix
ST	Stress Test
STeM	Stress Test Matrix
TA	Technical Assistance
WEO	IMF World Economic Outlook

EXECUTIVE SUMMARY

Stress Test (ST) results reveal that the Bulgarian banking system is vulnerable to the extreme realization of internal and external risks coupled with the need to clean the balance sheets from nonperforming loans (NPLs). In the baseline scenario, characterized by a modest economic growth and decline in unemployment, as well as stable and low interest rates, two banks—including a systemic one—exhibit weakness in terms of capital buffers to cope with accumulated losses in the past. These banks experience substantial increase in their NPLs as a result of the asset quality review (AQR) adjustment. As the IMF ST approach excludes interest income from NPLs in both the baseline and adverse scenarios, the increase in NPLs leads to the reduction in the number of assets that generate cash-based interest income. With a significantly smaller base of performing loans, two banks do not generate enough recurring income to cover their interest expense and credit costs in the baseline scenario, which results in negative profits and declining capital levels.

In the adverse scenario, characterized by a large drop in output; increase in unemployment; decline in collateral prices; and increase in risk premiums, five banks fall below the minimum regulatory CET1 ratio threshold of 4.5 percent. Three banks fall below the threshold by the second year of the stress period. As the simulated economic slow-down continues into the third year of the scenario, two additional banks fall below the regulatory minimum threshold with aggregate capital shortfall of 1.8 percent of the annualized nominal GDP. Of the five banks falling below the regulatory minimum at the end of the simulation period, three become technically insolvent.

The largest driver of the change in capital positions in the adverse scenario is loan loss provisions. As the economic outlook deteriorates in the simulated adverse scenario, the NPLs increase significantly. As the loan loss provisions are increased by 20 percentage points from the assumed minimum provisioning level of 60 percent in the baseline scenario, the increase in NPLs leads to large loan loss provisions, which reduce the capital of banks. As the economic growth turns negative starting from the first year of the scenario period, NPLs increase significantly in the second year of the period. The corresponding increase in loss provisions reduces bank capital significantly. As the economy starts recovering in the third year of the scenario period, the flow of NPLs slows down, but loss provisions continue to exert a significant drag on profitability.

Liquidity risk analysis and ST reveal limited impact of severe run-off rates of liabilities and haircuts on cash inflows on the overall liquidity position as well as on LCR and NSFR ratios. All banks meet initial minimum total LCR ratios of 70 percent, with wide margins.

Implied cash flow-based liquidity ST shows that banks have enough inflows from liquid as well as less liquid assets to withstand severe structural shocks up to a one-year horizon. Implied cash flow-based stress tests measured banks' net liquidity positions over time horizons of 7, 30, and 90 days, and one year. This test incorporated assumptions about haircuts on sovereign securities, as well as lower inflows from loan portfolio by linking those with AQRs as well as solvency stress test scenarios. It was assumed that new nonperforming assets will not generate cash flows.

Under the simulated system-wide liquidity shocks and run-off rates (see Table 3 for assumptions), three banks fail to maintain positive cash flow over a seven-day horizon, two banks over one month, and one bank over three months. Over the one-year horizon, all banks have positive flows. System-wide shortage of liquidity is relatively small, less than 1 percent of GDP. The results, however, are sensitive toward assumptions on the availability and quality of securities pledged as collateral, as well as timing of withdrawal of deposits.

Contagion and spillover risks are minimal from banking system exposures. Local banks are funded mostly by domestic deposits and do not depend on significant foreign funding. Similarly, foreign-owned banks' reliance on parents for funding is minimal, i.e., they are predominantly funded by domestic deposits. Although the interbank market is shallow and, hence, there is little room for direct (balance sheet-based) contagion, a loss of confidence might affect the rest of the banking system via the psychological channel of deposit withdrawals, as was experienced during the 2014 Corporate Commercial Bank (KTB) episode.

Concentration risks are relatively high, albeit distributed in several banks only. Several banks have large exposures on their balance sheets, which represent a meaningful portion of their capital base. Concentration stress test reveals vulnerabilities of several banks with concentrated loan books. Two banks would fail in the case of a default of their largest nonfinancial corporate (NFC) exposures.

Recommendation	Authority Responsible	Timeframe¹
Analyze and stress test largest exposures separately, also taking into account potential cash flows from collateral in case of default.	BNB	I
Introduce cash flow based liquidity reporting template; in the absence of common European Banking Authority (EBA) template use examples from other EU countries, like Austria or BIS recommended one.	BNB	I
Promote high quality IFRS 9 implementation practices. See Technical Note on NPL Reduction Strategy.	BNB	I

¹ I (Immediately) is within one year.

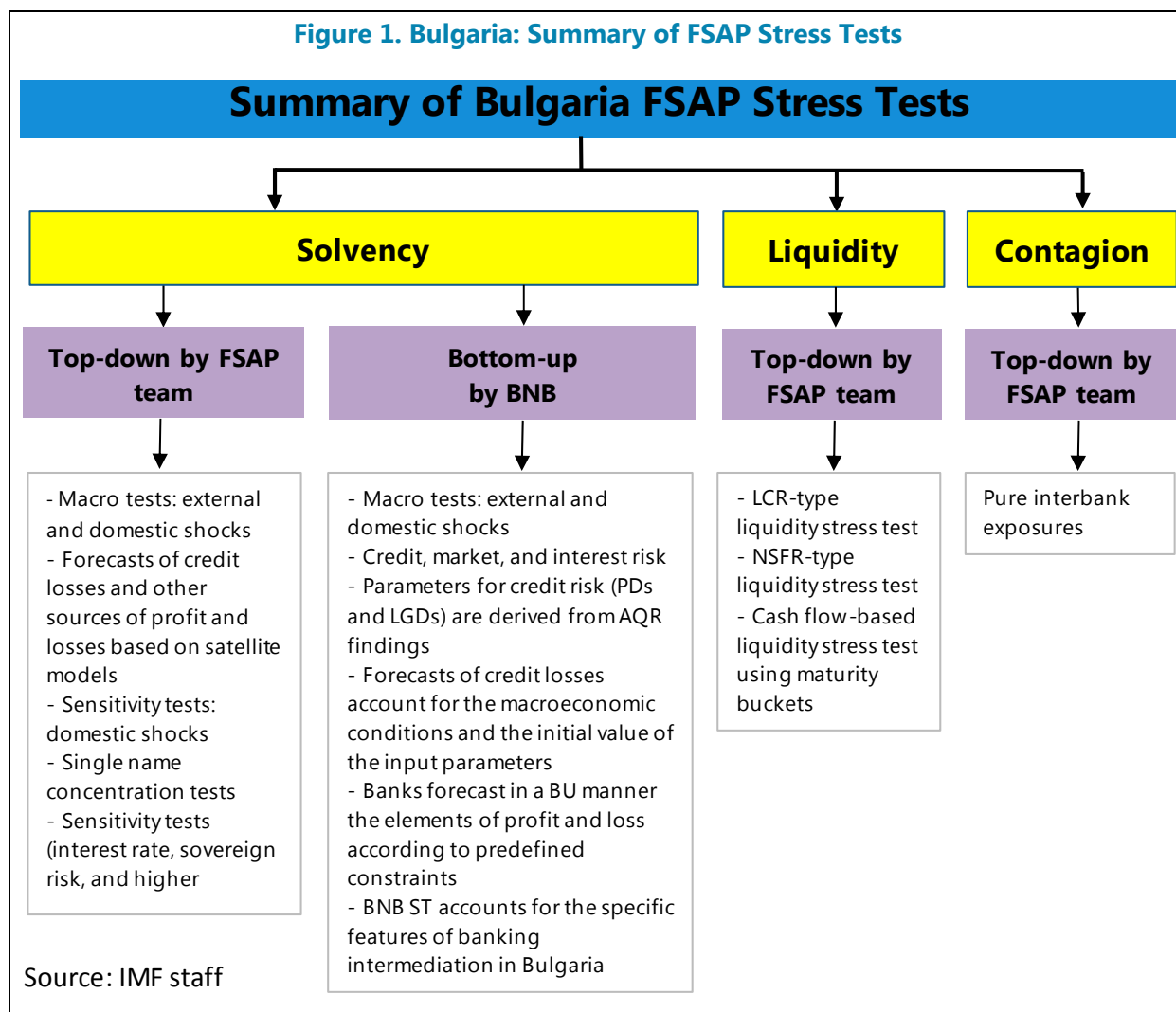
INTRODUCTION

1. The FSAP team, in coordination with the BNB, assessed bank resilience to solvency, concentration, liquidity, and balance sheet contagion risks. Solvency, liquidity, and balance sheet-based contagion tests were performed to estimate the impact on banks' capital against identified key vulnerabilities. The tests based on macroeconomic scenarios assessed the impact of combined external and domestic shocks on the economy over a three-year horizon (June 2016—June 2019), based on data available through June 2016.² The FSAP stress testing covered 17 banks, making up 95 percent of banking system assets. The results are reported as three-year projections of profits and losses, balance sheets, and of the impact on risk-weighted assets and capital. STs are based on end-June 2016 bank-by-bank balance sheets, income statements, and prudential reports. Both the baseline and adverse scenarios used in the ST incorporate AQR adjustments based on year-end 2015 data. ST results and their comparability with the BNB results shall be interpreted in the context of different hypothetical scenarios and different approaches of simulation—Top-down (TD) vs Bottom-up (BU). The approaches vary considerably in key areas, such as in the assumptions about interest accrual on nonperforming assets (loans), credit risk loss shocks, profitability of performing loan portfolios, market risk for certain debt instruments, as well as shocks to funding costs for domestic banks. For more details on comparison between the two ST simulations, see Annex III.

2. The FSAP stress tests included a TD exercise based on macroeconomic scenarios and sensitivity analyses, and a comparison with the BNB BU exercise (Figure 1). The effects of these shocks on individual banks' profitability and capitalization were assessed using satellite models and methodologies developed by the Fund staff. The TD liquidity tests assessed the capacity of banks to withstand large withdrawals of funding. It used a maturity ladder analysis, i.e., a cash flow-based analysis with different maturity buckets, and supervisory information. The contagion tests covered domestic interbank exposures only (based on data availability).

3. The main transmission channels of the external shocks are linked to external demand, investor confidence. The further contraction or renewed recession in Europe and emerging markets would bring about a drop in external demand. This would lead to lower growth, higher unemployment, fiscal pressures for the government, lower income for the corporate sector, higher household financial stress, and NPLs. At the same time, a higher country risk premium will lead to wider spreads for the sovereign, funding pressures for banks, and higher borrowing costs for NFCs.

² It is common practice in FSAPs to implement the stress tests over a two- to five-year horizon. A two-year horizon is used in countries subject to a high degree of macroeconomic uncertainty at the time of the exercise. A five-year horizon is appropriate for countries subject to moderate or low macroeconomic uncertainty.



4. The solvency ST incorporates assumptions about loan portfolio concentration. The scenario-based solvency ST is complemented by sensitivity tests that assess the impact of direct and indirect interest rate shocks (instantaneous upward and parallel shift in yield curve and increase in real interest rates by 500 bps), a decline in sovereign security prices, a significant increase in provisioning rates for NPLs, and concentration credit risks (default of largest borrowers).

5. The liquidity risk is tested with four separate exercises. Scenarios relate to the Basel Liquidity Coverage Ratio; a Basel Net Stable Funding Ratio scenario; cash-flows based on different maturity buckets; and a reverse liquidity stress test. The test was carried out bank-by-bank.³ At the same time, outputs from solvency STs and AQRs were used in liquidity stress tests to estimate the amount of loss in cash flows due to NPLs as well as haircuts on securities.

³The ST assumed full substitutability of LEV and EUR (two prevailing currencies) given the currency board arrangement.

6. Contagion across the financial sector was also examined. A balance sheet contagion model was used to analyze the connectedness of institutions within the banking network. The failure of one or several banks was simulated to judge whether any bank in Bulgaria is a source or destination of spillovers.

7. The Bulgarian authorities performed a separate bottom-up stress test in 2016. The ST was a supervisory assessment which was carried out in conjunction with an AQR. The ST aimed to assess the ability of Bulgarian banks to absorb losses that they would experience in an adverse economic environment. The ST used year-end 2015 data as the starting point and took into account the findings from the AQR. The ST utilized a three-year simulation period between year-end 2015 and year-end 2018, and, similar to the IMF ST approach, it simulated a baseline and an adverse macroeconomic scenario.

8. Profitability assumptions for the baseline and adverse scenarios and credit shocks calculations are the key differences between IMF TD stress testing and BNB BU exercises. IMF baseline and adverse scenarios assume that nonperforming loans will not accrue income, whereas the BNB includes this assumption only in the adverse scenario. The IMF stress test sets predefined minimum provisioning rates, whereas the BNB approach takes into account the findings from the AQR. The IMF adverse scenario incorporates a liquidity shock by assuming that domestic banks will be subject to liquidity shortages and will need to increase deposit interest rates to reduce the outflows. The differences between the IMF and BNB ST exercises' methodologies, scenarios, and assumptions are elaborated in Appendix III.

9. In general, the objective of the FSAP stress testing exercise is to assess the capacity of the banking system to withstand extreme but plausible macroeconomic shocks. The tests are meant to explore weaknesses in the financial system and the channels through which adverse shocks are transmitted. FSAP stress tests can help to identify priorities for policy actions, such as those aimed at reducing specific exposures or building capital and liquidity buffers. The FSAP stress testing process can also help the authorities identify informational and methodological gaps and assess their preparedness to deal with situations of financial distress.

10. Although stress tests are useful for exploring weaknesses in a financial system, results must be interpreted with caution. In all countries, the implementation of stress tests is conceptually challenging. Among other limitations, stress tests use macroeconomic and satellite models to calculate the impact of adverse scenarios or shocks on banks.⁴ These models are estimated using historical data and are subject to estimation uncertainty. These limitations can be mitigated, but not eliminated, by using state-of-the-art techniques. Choices must also be made regarding the severity of shocks, including imposing constraints, floors, and caps on certain variables. In adverse scenarios, the economy is typically affected by a combination of external and

⁴ Satellite models map the variables projected in the macroeconomic scenarios into credit factors that determine individual banks' gains or losses.

domestic shocks that (*ex ante*) have a very low probability of occurrence.⁵ Hence, by construction, adverse scenarios should not be interpreted as macroeconomic “forecasts.”

11. The remainder of this technical note (TN) is structured as follows. The second section presents the different components of the solvency stress tests based both on macroeconomic scenarios and sensitivity analysis: their description, design, methodology for implementation, and results. The following sections present the stress tests of liquidity risk, and the analysis of contagion risks.

BANKING SECTOR RISKS

A. Structure

12. The Bulgarian financial system is relatively large, with assets of 115 percent of GDP. The banking sector is by far the largest group within the financial system, as it accounts for close to 87 percent of the system’s assets. Insurance companies and pension funds account for close to 4 percent and 10 percent of the financial system assets, respectively.

13. The banking system consists of 22 banks and 5 foreign branches, with total assets of approximately 100 percent of GDP. The system is dominated by foreign banks: the nine local banks’ total asset share in the system is 23.3 percent, while foreign banks and branches account for 74 percent and 2.6 percent of banks’ assets, respectively. The system is also concentrated, with the top five banks holding 58 percent of total bank assets. Only one of the top five banks is domestically owned.

14. Banks’ business models rely mostly on deposit taking and loan placement, with little wholesale funding or investment banking activities. Approximately half of total system assets is denominated in foreign currency, mostly Euro, with just under 50 percent of assets denominated in Bulgarian lev. The system’s rapid growth decelerated after the Global Financial Crisis (GFC), given the sluggish economic growth. Loan growth turned negative after the local banking crisis of 2014, and turned slightly positive only in 2016 (Figure 3⁶). Banks’ assets consist primarily of loans (close to 58 percent of total assets), balances with the central bank (12 percent), and investments in medium- and long-term government bonds (11 percent). Funding consists primarily of nonbank deposits (83 percent of liabilities), with very little reliance on wholesale funding markets.

⁵ The selection of the “relevant” historical episode and the length of data series used to construct severe stress scenarios are among the choices that must be made in the design of stress tests. There is often a temptation to dismiss the validity of historical episodes because structural changes alter the way in which economies function. Valid stress tests, however, should not fail to incorporate long history. As pointed out by Haldane (2009), stress testing exercises conducted before the global financial crisis failed to play a useful “early warning” role, in part, due to reliance on short data series—the tests underestimated true macroeconomic and financial volatility by failing to incorporate information contained in long data series, which undermined their validity and usefulness.

⁶ Based on BNB monetary statistics data for the banking system: Loans to nonfinancial corporations and households.

Table 2. Bulgaria: List of Banks and Asset Size (June 2016)

Bank Name	Assets in 000 LEV
Unicredit Bulbank	17,351,145
Dsk Bank	11,492,993
First Investment Bank	8,533,291
United Bulgarian Bank	7,020,804
Eurobank Bulgaria	6,701,780
Raiffeisenbank (Bulgaria)	6,258,158
Societe Generale Expressbank	5,449,107
Central Cooperative Bank	4,695,231
Piraeus Bank Bulgaria	2,886,726
Cibank	2,781,561
Allianz Bank Bulgaria	2,538,985
Investbank	1,985,189
Bulgarian Development Bank	1,595,301
Procredit Bank (Bulgaria)	1,539,578
Municipal Bank	1,350,433
International Asset Bank	1,173,876
Bulgarian-American Credit Bank	1,026,024
Citibank Europe-Bulgaria Branch	865,897
Bnp Paribas S.A.-Sofia Branch	777,657
D Commerce Bank	692,598
Ing Bank N.V.-Sofia Branch	594,452
Tbi Bank	506,547
Tokuda Bank	398,964
Teximbank	186,183
Commercial Bank Victoria	137,256
T.C. Ziraat Bank-Sofia Branch	102,490
Isbank Ag-Sofia Branch	7,933
Total	88,650,159

Source: BNB supervisory data.

15. ST exercise was based on the 17 largest banks in Bulgaria. The exercise covers 95 percent of the banking system assets and includes all large banks.

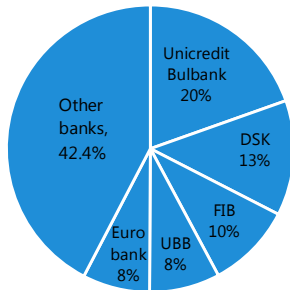
Figure 2. Bulgaria: Bank Assets and Liabilities

Five banks hold more than 50 percent of total assets

About 50 percent of total assets are in foreign currency

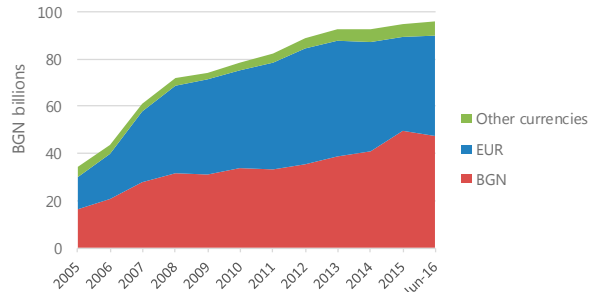
Bank Shares

In Percent of Banking System Assets



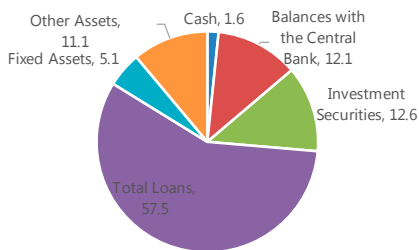
Source: BNB

Total Assets by currency



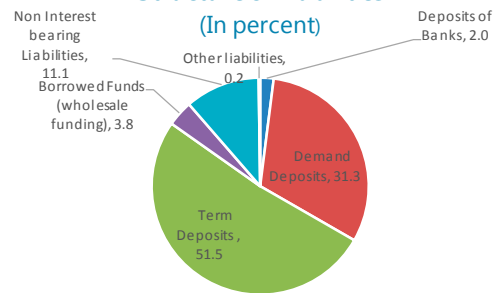
Source: BGN

Structure of Assets (In percent)



Source: BNB

Structure of Liabilities (In percent)



Source: BNB

Source: BNB supervisory data.

Figure 3. Bulgaria: Credit Growth

Rapid growth decelerated after the GFC

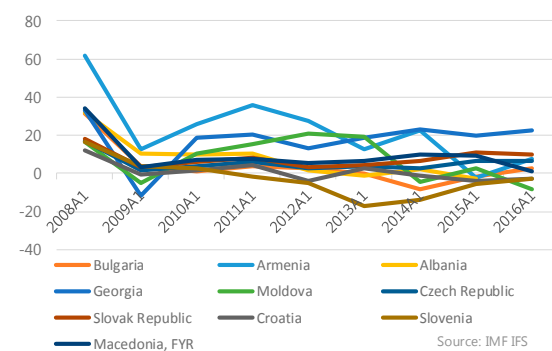
And is currently lower than most peers

Total Loan Growth In Percent



Source: BNB

Credit to the private sector Percent change



Source: IMF IFS

Source: Total loan growth data from BNB monetary statistics data for the banking system, credit to the private sector data from IMF International Financial Statistics (IFS) database.

B. Asset Quality

16. The Bulgarian banking system exhibits high NPL ratios. Based on the European Banking Authority (EBA) definition of NPLs, the ratio of gross NPLs to total loans and advances is 13.7 percent, while loan loss reserve to NPL coverage is 56.8 percent.

17. The credit risk is concentrated toward the trade, industry, and housing sectors. The highest exposures are to the trade and industry sectors with 29.5 percent and 27.7 percent of total loans, respectively. In these sectors, NPL ratios are already quite high at 21.9 percent and 16.6 percent of total loans.⁷ However, the sectors with the highest NPL ratios are the construction and real estate sectors at 47.1 percent and 32.6 percent of total loans. These sectors, combined, make up for 25.1 percent of the portfolio of the banking system exposed to housing market vulnerabilities. About 50 percent of the loans are denominated in foreign currency (predominantly EUR), but related currency risks are limited by the country's commitment to the currency board.

C. Profitability

18. Reported profitability is high, but the sustainability of these profits is less certain, given sluggish loan portfolio growth. Substantially reduced provisioning expenses, combined with lower interest and operational expenses, helped to remain profitable for most of the banks, although this business strategy might not be sustainable in the long run.

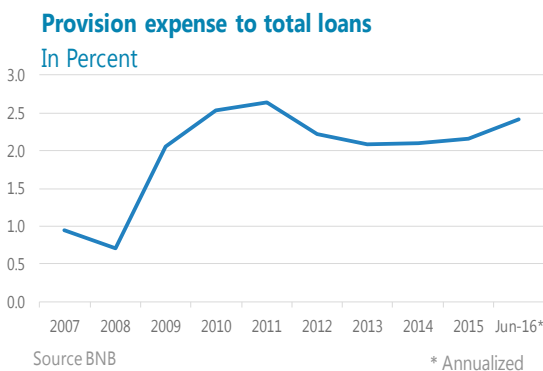
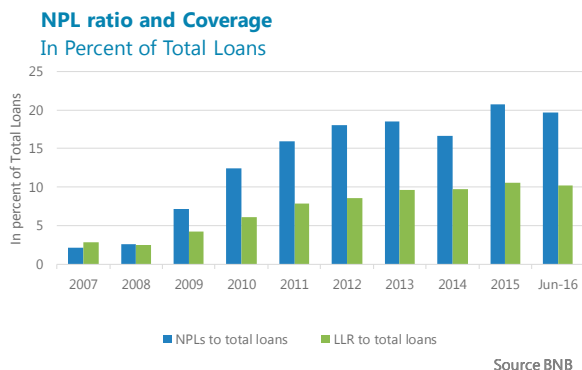
19. Banks' largely maintained their lending spreads after the GFC, as the decline in lending rates has been roughly in line with the decline in deposit rates (Figure 6). They also benefitted from gains on their portfolio of government securities in the declining interest rate environment after the crisis. Given the current low level of rates, similar gains are unlikely to occur in the future. Trading revenues are around 10.7 percent of total revenues. Fees and commissions revenue has grown to 20 percent of total revenue, but a new BNB ordinance regulating fees is being phased in. This development is likely to limit future profit growth.

⁷ Note that the NPL data until end-2014 are from the Bulgarian Credit Register and use the local definition of NPLs. Starting in 2015, Bulgaria adopted the EBA definition of NPLs and the source for 2015-onward is the Finrep Supervisory dataset.

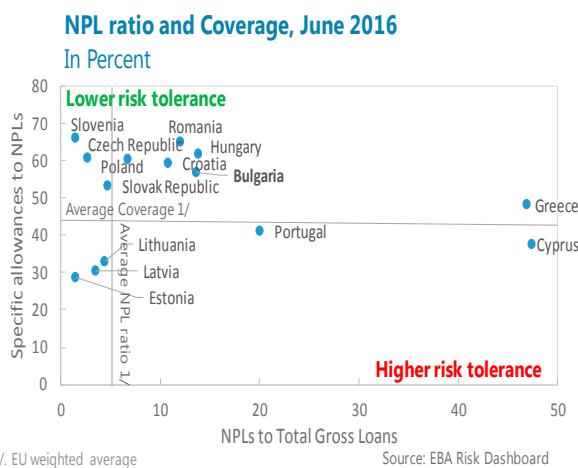
Figure 4. Bulgaria: Asset Quality

NPLs coverage has declined since the GFC

Provisions slowed down recently



Bulgaria displays higher risk tolerance than many peer countries based on EBA definitions



1/. EU weighted average

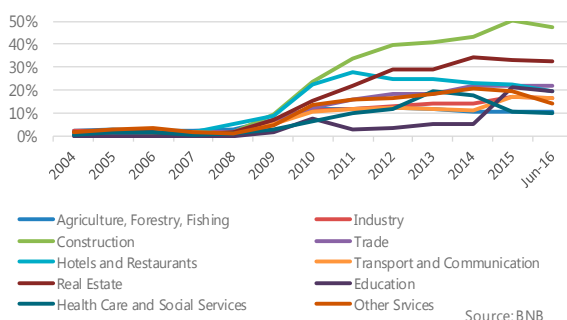
Source: EBA Risk Dashboard

Source: Time series of NPL ratio, Coverage, and Provisions are from BNB supervisory data and based on BNB definition of NPLs. The cross-country data on NPL ratio and Coverage are from EBA Risk Dashboard and are based on EBA definition.

Figure 5. Bulgaria: NPL Concentration

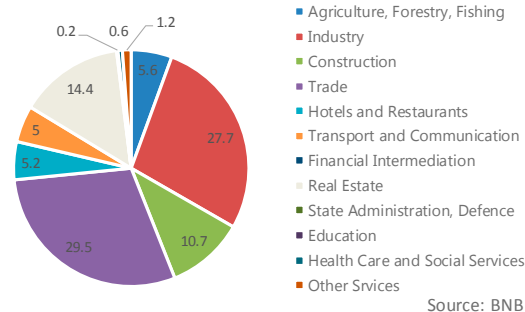
NPL ratios are highest in construction and real estate

NPL ratios by sector
In Percent, June 2016



And these two sectors account for 25% of total loans

Composition of loans
In Percent, June 2016



Source: BNB supervisory data. The NPL data until end-2014 are from the Bulgarian Credit Register and use the local definition of NPLs. Starting in 2015, Bulgaria adopted the EBA definition of NPLs and the source for 2015-onward is the Finrep Supervisory dataset.

D. Funding and Liquidity

20. Assets are overwhelmingly funded with cheap retail deposits, with little diversification into wholesale funding. Recent growth in deposits has mostly been in demand deposits, with term deposits growing only slowly. Deposit funding is abundant in domestic currency where system loan-to-deposit ratio (LTD) is 66 percent while LTD ratio for loans in Euro is close to 100 percent. Overall system LTD ratio is 76 percent.

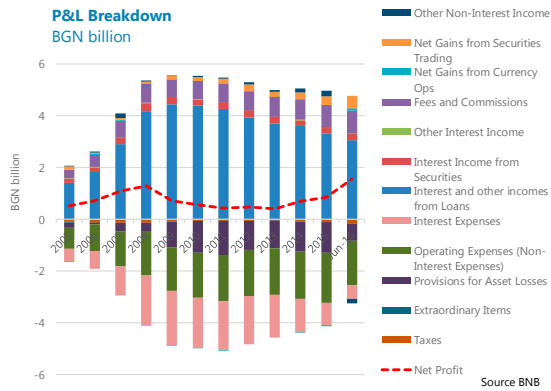
21. Lack of wholesale funding underscores the need for effective liquidity management. Banks have little access to wholesale funding due to under-developed capital markets. Wholesale funding (including repo and long-term debt) accounts for 3.4 percent of total funding.

22. In general, deposits are stable and covered by the Bulgarian Deposit Insurance Fund. Eligible deposits (up to EUR 100,000) are about 93.7 percent of total deposits and include foreign currency deposits. The fund ran into operational difficulties in the 2014 event when all payments to customers of the affected bank were suspended, including access to guaranteed deposits, for about six months. These operational issues have been addressed and the fund has been since recapitalized through a one-off Ministry of Finance EUR 2 billion loan for the repayment of deposits of the bankrupt bank and further bolstered by World Bank (WB) and European Bank for Reconstruction and Development (EBRD) loans of EUR 300 million each.

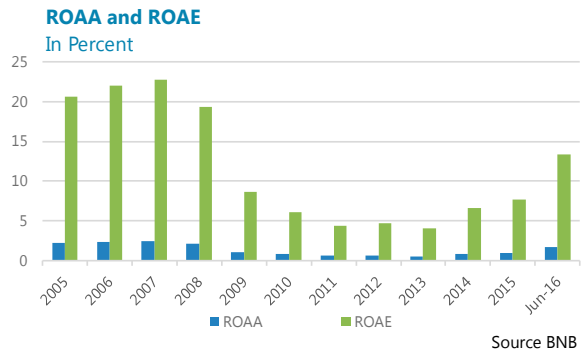
23. Liquid assets consist mostly of cash and balances with the BNB, with small amounts invested in liquid securities. This also leaves little scope for other secured funding such as repo.

Figure 6. Bulgaria: Profitability

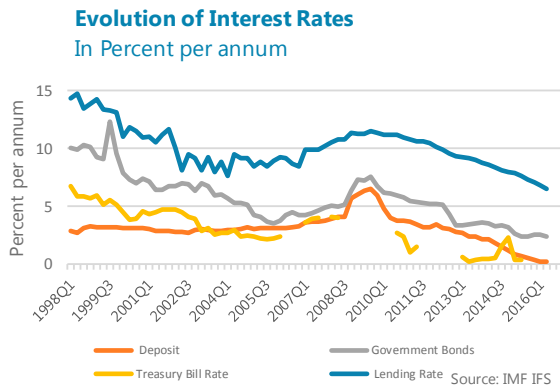
Lower revenues but even lower expenses



...have resulted in higher profitability



Lending spreads have been maintained benefiting NIMs

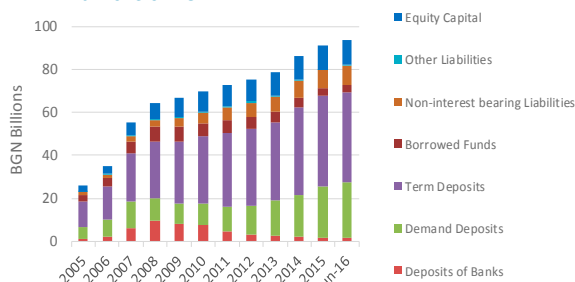


Source: P&L Breakdown, ROAA, and ROAE series are from BNB supervisory data. Interest Rates are from IMF IFS database.

Figure 7. Bulgaria: Funding and Liquidity

Assets are funded mostly through retail deposits

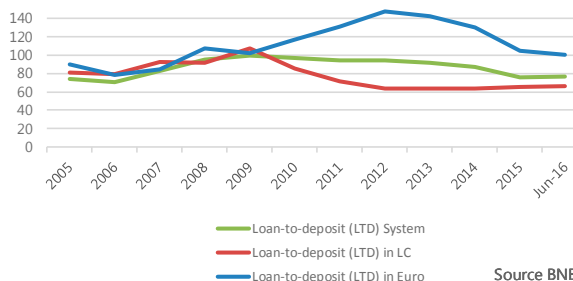
Funding Breakdown
In billions of BGN



Source BNB

Deposit funding is most abundant in local currency

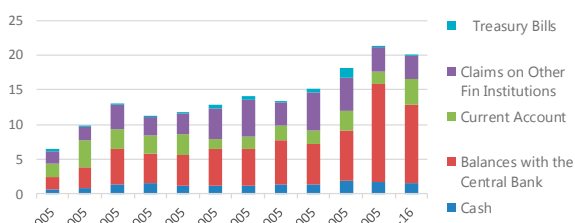
Loan-to-deposit ratio (LTD)
In Percent



Source BNB

Liquidity is mostly held as cash and balances at the BNB

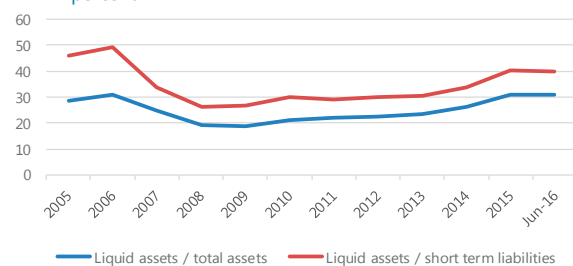
Liquid Asset Breakdown
In billions of BGN



Source: BNB

Slower loan growth results in high liquidity ratios

Liquidity ratios
In percent



Source BNB

Source: BNB.

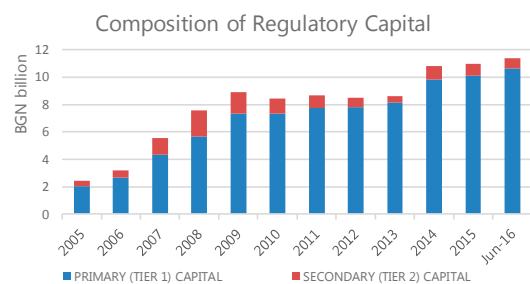
E. Capital

24. The quantity and quality of capital has improved to account for the higher risk profile.

In 2009 the BNB issued recommendations to the credit institutions to retain profits to support capital. Banks are now not allowed to pay dividends, or they need express approval from the BNB to be able to do so. As a result, most profits are retained and contribute to the capital base of banks. Capital ratios have also benefited from a decline in risk weights, as risk-weighted assets (RWAs) have remained roughly constant since the GFC, while assets increased slightly during the same period. This has resulted in an overall Tier 1 capital ratio of 21.1 percent as of June 2016.

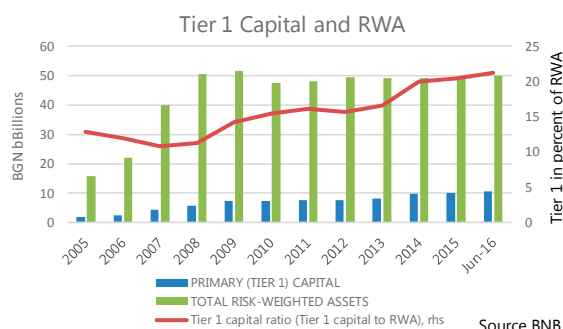
Figure 8. Bulgaria: Capital

The quantity and quality of capital has improved



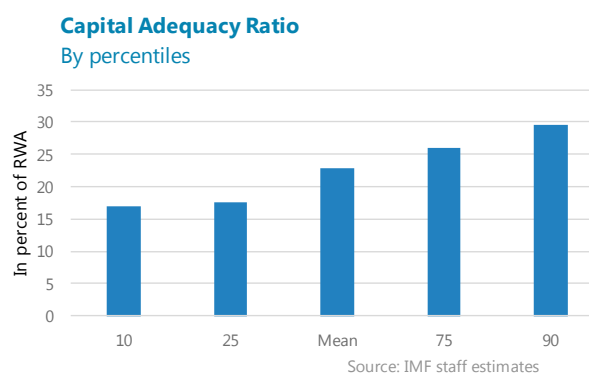
Source BNB

while RWAs were mostly unchanged since GFC



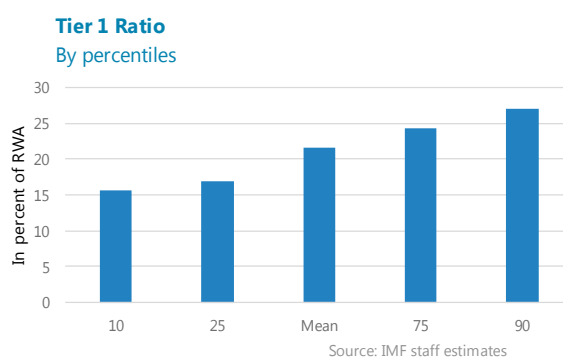
Source BNB

CAR distribution for banks



Source: IMF staff estimates

Tier 1 capital ratio distribution for banks



Source: IMF staff estimates

Source: IMF staff estimates based on BNB supervisory data.

F. Key Risks and Vulnerabilities

25. The main vulnerabilities of the Bulgarian banking system are concentrated exposures of banks, high levels of NPLs, and high corporate sector indebtedness. These vulnerabilities have the potential to lead to significant credit losses for banks if key risk events materialize. The key risks that are identified in the Risk Assessment Matrix (RAM) in Appendix IV are:

- **Protracted slowdown of European growth.** A long period of slow growth in Europe would result in slower growth and higher unemployment in Bulgaria. The external shocks would lead to lower income for the corporate sector as well as for the households, which will have adverse effects on bank profitability and asset quality.
- **Change of investor sentiment toward emerging markets and resulting financial stress for these countries.** This is likely to lead to higher country risk premiums, wider spreads for the sovereign, and funding pressures for banks.

- **Increasing geopolitical tensions related to countries in the region.** This is likely to lead to higher country risk premiums.
- **Asset price uncertainty over NPLs.** The corresponding declines in collateral values would result in the need for higher provisions, which will lower banks' profitability and capital levels.

SOLVENCY STRESS TESTS

A. Scenarios

26. The stress tests utilized two scenarios, baseline and adverse, over a three-year horizon.

The baseline scenario reflects the IMF's World Economic Outlook (WEO) projections as of October 2016. The year-end projections of WEO for 2016, 2017, and 2018 were used as the baseline scenario for the stress tests. As the latest available balance sheet data were as of June 2016, the three-year WEO projections were used as the baseline projections for the three years following the date of the latest balance sheets: June 2017, June 2018, and June 2019.

27. The main macrofinancial variables utilized in the baseline scenario are annual GDP growth rate, unemployment rate, and short-term interest rate (Sofibor).

Building on the recent strong growth of the Bulgarian economy, the first year of the baseline scenario projects a GDP growth rate of 3 percent, which slightly slows down to 2.8 percent in the second year, and to 2.5 percent in the third year. In line with the sustained growth in the economy, the unemployment rate declines gradually under the baseline scenario. After the first year of the scenario period, the unemployment rate falls to 8.2 percent from its June 2016 level of 8.9 percent, and it continues to decline to 7.1 percent as of June 2018, and to 6.9 percent as of June 2019. Finally, Sofibor stays constant at its June 2016 level, 13 basis points, in the following three years. These variables are then combined with satellite models to project banks' NPL ratios under the baseline scenario. Additionally, a minimum provisioning ratio of 60 percent is assumed for NPLs under this scenario. The following table summarizes the values of the macrofinancial variables under the baseline scenario.

	Actual	Baseline Scenario Projections		
	June 2016	June 2017	June 2018	June 2019
	(In percent)			
Annual GDP Growth	3.6	3.0	2.8	2.5
Unemployment Rate	8.9	8.2	7.1	6.9
SOFIBOR	0.13	0.13	0.13	0.13

28. The adverse scenario envisions a significant contraction in GDP and increase in the unemployment rate. The calibration of the size of the shocks under the adverse scenario is based on the Flexible System of Global Models developed by the IMF Research Department, and is benchmarked with the BNB's own BU stress testing scenarios and expert judgment. The adverse

scenario simulates annual real GDP growth rates of -3 percent in the first year, -3.6 percent in the second year, and -0.9 percent in the third year. These numbers represent a cumulative GDP growth deviation of close to 16 percentage points over the three-year period from the baseline scenario, which corresponds to approximately 1.5 times the standard deviation of the three-year cumulative growth rates observed during the 1996–2015 period. In line with the contraction in the economy, the unemployment rate increases to 10.4 percent by June 2017, and it continues to increase to 11.5 percent as of June 2018, and to 12 percent as of June 2019.

29. The adverse scenario also incorporated assumptions on increases in Sofibor reflecting higher risk premium in the economy. The increases in Sofibor, relative to the baseline scenario, are 33 basis points, 23 basis points, and 6 basis points for June 2017, June 2018, and June 2019. These shocks are the same ones used by BNB in its stress test and are based on the adverse scenario shocks used in 2016 EBA stress test. Similarly, the adverse scenario utilizes average haircuts on sovereign bonds from 2016 EBA stress test to simulate the declining values of banks' available-for-sale (AFS) sovereign securities holdings. The following table summarizes the values of the macrofinancial variables under the adverse scenario.

	Actual	Adverse Scenario Projections		
	June 2016	June 2017	June 2018	June 2019
	(In percent)			
Annual GDP Growth	3.6	-3.0	-3.6	-0.9
Unemployment Rate	8.9	10.4	11.5	12.0
SOFIBOR	0.13	0.46	0.36	0.19

30. The adverse scenario is based on external shocks, driven by a protracted period of slower growth in key export markets. A renewed recession or a further contraction of economies in Europe and in emerging markets would bring about a drop in external demand. This would lead to lower growth, higher unemployment, and lower income for the corporate sector. These developments would lead to higher NPLs for banks. The level of NPLs is projected using the satellite models and the macrofinancial variables simulated under the adverse scenario. The provisioning ratio is increased uniformly by 20 percentage points under the adverse scenario to capture the impact of declining collateral values in an extreme adverse economic environment.

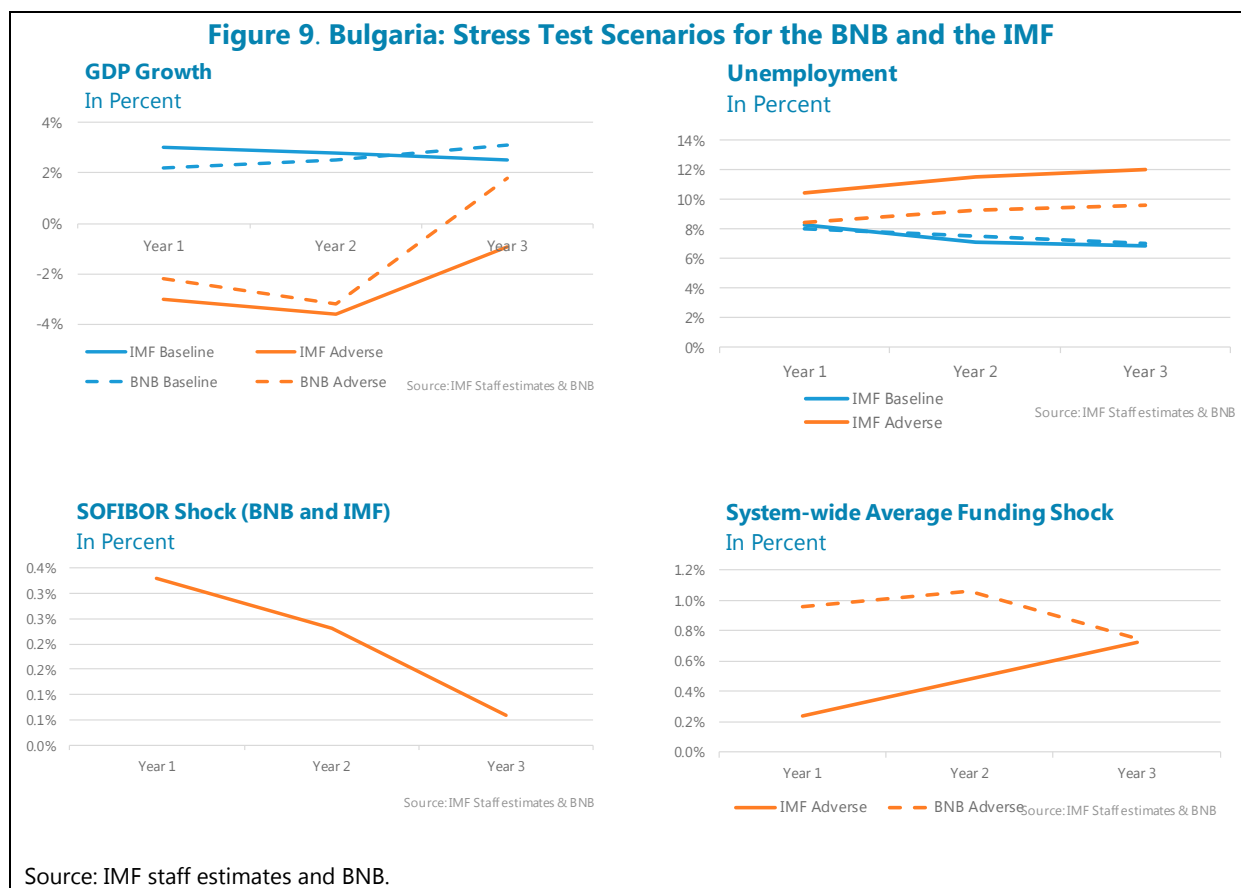
31. Finally, the adverse scenario simulates funding cost increases for domestic banks to reflect higher risk premiums. On average, domestic banks offer higher interest rates on deposits than foreign-owned banks do. The KTB failure episode suggests that retail depositors are sensitive to unfavorable developments in domestic banks. Faced with adverse economic developments, domestic banks might need to increase interest rates more than foreign-owned ones do to retain deposits. The adverse scenario simulates bank-specific funding shocks for domestic banks, which are calibrated using each bank's liquidity ratio (the ratio of total deposits to liquid assets of the bank), and the largest historical shock to deposit interest rates during 2007–2016. The average funding shock for domestic banks that this calibration methodology yields is 80 basis points. This

methodology excludes two state-affiliated domestic banks, which are assumed not to experience any bank-specific funding shocks due to their stable sources of funding. Similarly, foreign-owned banks are assumed not to experience any bank-specific funding shocks.

32. The average funding shock for domestic banks is 80 basis points in the first year of the adverse scenario. As the economy continues to contract and risk premiums continue to increase, the average funding shock increases to 160 basis points in the second year, and to 240 basis points in the third year. Including all banks in the system, the system-wide average funding shock is 24 basis points in the first year, which increases to 48 basis points in the second year, and to 72 basis points in the third year. In comparison, the system-wide average funding shocks that the BNB used in its stress tests are 97, 106, and 75 basis points in the first, second, and the third year of years of the scenario period, respectively. Note that the system-wide average BNB shocks are lower than those used by the IMF; however, they are applied uniformly to all banks. The IMF stress tests apply funding shocks only to domestic banks, based on their liquidity ratios, and assume zero-funding shock for foreign-owned banks. This difference in the choice of funding shocks between domestic and foreign-owned banks leads to sizeable differences in the performance of these groups of banks in the IMF ST results.

Comparison with the BNB ST Adverse Scenario

33. The adverse scenarios utilized by the IMF and the BNB have similar structures in the first two years of their simulation periods and differ in the last year. Both scenarios simulate a sizeable contraction in real GDP and an increase in unemployment in the first two years. Under the IMF adverse scenario, the real GDP growth displays a cumulative deviation of close to 12 percentage points from the baseline scenario at the end of the second year of the simulation period. Similarly, under the BNB adverse scenario, the real GDP growth displays a cumulative deviation of close to 10 percentage points from the baseline scenario by the end of the second year. The IMF and the BNB adverse scenarios differ in the third year of the simulation period. The IMF adverse scenario stimulates a third year of GDP contraction at a rate of 0.9 percent, while under the BNB one the economy starts recovering and grows at a rate of 1.8 percent in the third year. As for the unemployment rate, although both scenarios simulate increasing unemployment throughout the scenario period, the IMF adverse scenario displays significantly higher deviations from the baseline in all three years. Finally, both the IMF and the BNB stress tests utilize the same Sofibor shocks relative to the baseline scenario: 33 basis points in the first year, 23 basis points in the second year, and 6 basis points in the third year of their scenario periods. Figure 9 summarizes the values of the main variables for the IMF and BNB stress tests.

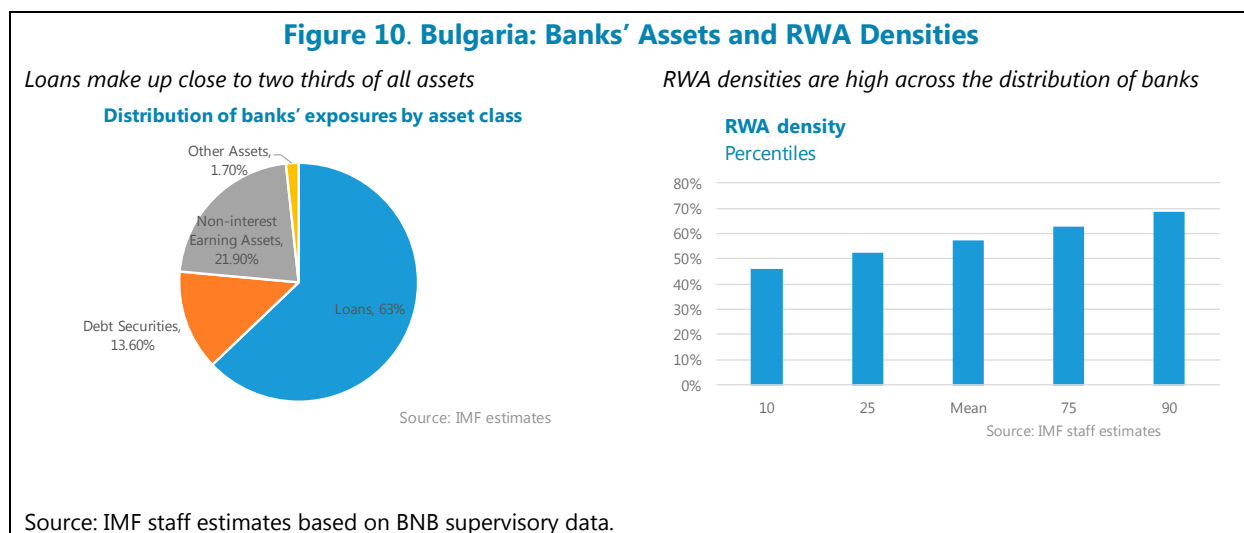


B. Satellite Models and Assumptions

Credit risks

34. Credit risk in the loan book along with the market risk in securities portfolio constitutes key risk factor for the banking system. Total loans represent more than 60 percent of banks' assets. A vast majority of exposures in loan books are domestic, therefore, the stress tests focused on how domestic and regional macrofinancial shocks affect domestic exposures. Debt securities represent close to 14 percent of assets, and most of them are marked to market (Figure 10).

35. Exposures of the 17 banks included in the stress test exercise are almost exclusively based on Standardized Approach (STA), with two banks only applying Internal Rating-based approach for some of their exposures. The banks included in the exercise apply the STA approach to sovereign and other public exposures (e.g., public sector enterprises, development banks) exposures. The use of the STA leads to very high capital requirements, as well as high RWA density. The average RWA density in the system is close to 60 percent. For RWA densities across the full population of banks, see Figure 10.



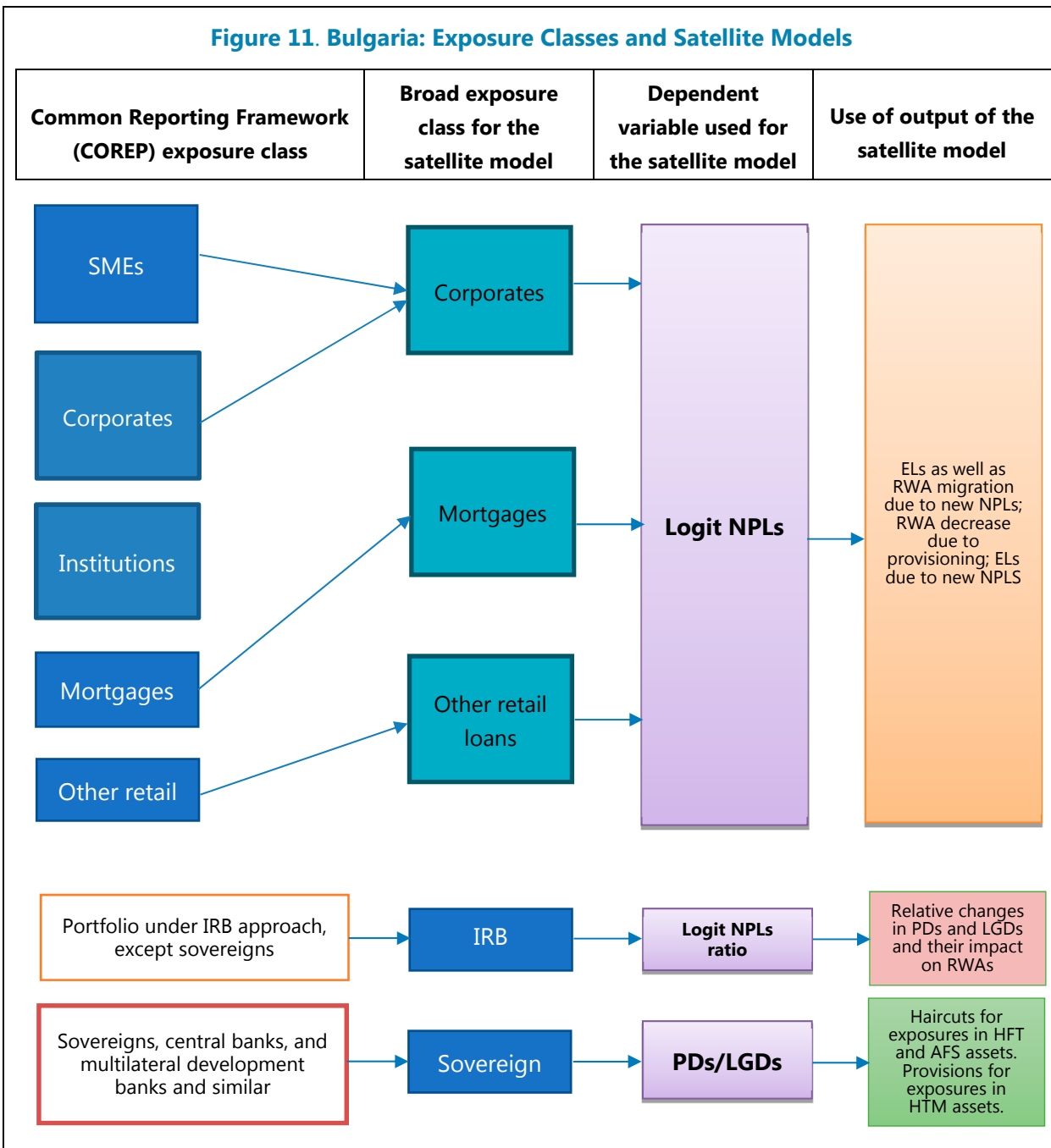
Solvency stress testing methodology

36. The transmission of macroeconomic shocks to probabilities of default for individual banks was assessed by estimating specific satellite models of credit risks. Available public and historical supervisory data was used to build various credit risk satellite models and overcome multiple data limitations with the aim to replicate the regulatory approach as closely as possible. Supervisory data, as well as data provided by banks, were used to construct credit risk satellite models for the three broad exposure classes; namely, corporate loans; mortgages; and other consumer loans. Exposures to institutions were excluded from the ST. The NPL time series used for satellite models starts in Q4 2009 and covers only one credit cycle when NPLs increased above their means (2011–2016). Capital Requirements Regulation (CRR) standard risk weights were used for the migration of loans under the Basel II STA portfolio. Own and foreign sovereign exposures were stressed by applying average haircuts from the EBA 2016 ST adverse scenario.

37. Expected losses were calculated for each exposure class. The FSAP team developed time series models to project NPLs, while provisioning projections were based on bank-level historical average provisioning rates (2011–2016), which were floored by judgment at 60 percent for the baseline scenario. For STA portfolios (except sovereigns), flows of NPLs were multiplied by bank-level historical average provisioning rates. For IRB portfolios, expected losses related to credit risk were calculated as the product of hybrid probabilities of default (PDs), loss given default (LGD) and exposure at default (EAD). For sovereign exposures, RWAs were not stressed to be in line with the CRR approach, and only expected losses were calculated for own sovereign exposures. The classification of exposures is displayed in Figure 11.

38. For the estimation of the credit risk satellite models and the conduct of the solvency stress test, the FSAP team had access to supervisory data at the individual bank level on a solo basis. In the analysis, the FSAP team also used publicly available data, such as banks' annual reports, and data from the EBA. Further details on the choice of modeling approaches are provided in Appendix III.

Figure 11. Bulgaria: Exposure Classes and Satellite Models



39. Under both the baseline and the and the adverse scenarios, the balance sheets were adjusted to frontload the AQR results fully. For each bank, the 2016 Q2 data of stock of performing loans, capital levels, RWAs, and provisions were adjusted to reflect the bank-level AQR findings provided by the BNB. For example, if the AQR results indicated that loans totaling BGN X million should be re-classified as nonperforming loans, the 2016 Q2 stock of loans were adjusted to reflect this re-classification of BGN X million as nonperforming. Similarly, the AQR adjustment numbers for capital levels, RWAs, and provisions were applied to the 2016 Q2 data. In

addition, the interest income from loans was adjusted with the same percent adjustment that was applied to the stock of loans. For example, if the stock of performing loans were to be reduced by Y percent due to the AQR adjustment described above, the loan interest income reported for 2016 Q2 would be reduced by Y percent.

40. Potential credit risk losses in the banking book represent a large vulnerability of the banking sector. IMF top-down ST results suggest that banks are likely to experience significant increases in NPLs under the severe stress scenario in contrast with the baseline scenario under which NPLs decline (see Figure 12). Under the severe stress scenario, the combined effect of higher unemployment rate and the economic slowdown leads to an increase of approximately 8 percentage points in the banking system's average NPLs between 2016 Q2 and 2019 Q2. Corporate loans and mortgage loans experience the highest increases compared to their starting points. Similarly, in the BNB stress test, corporate loans and mortgage loans experience the highest increases in their PDs (as a multiple of the starting point PDs).

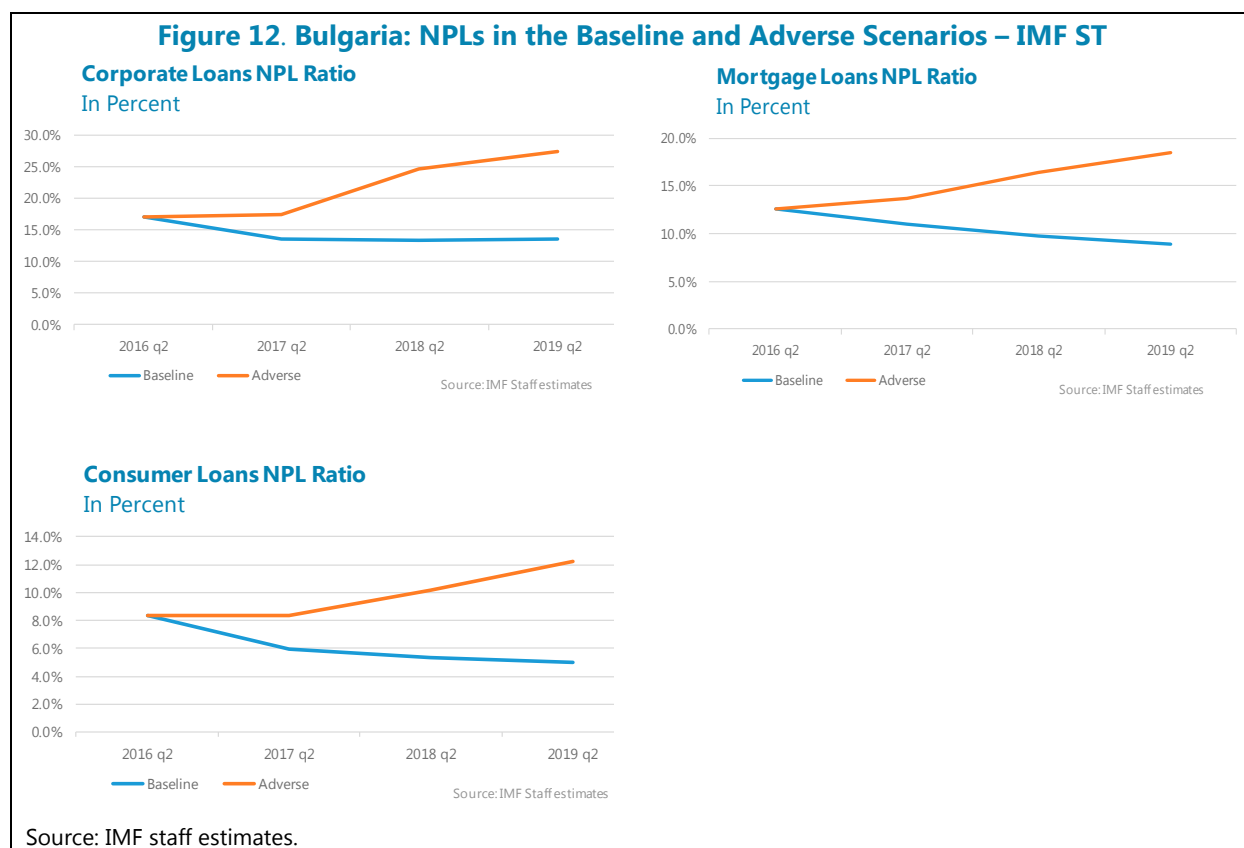
41. The rise in NPLs requires additional provisions that significantly affect bank profitability in the adverse scenario. Credit losses over the three-year horizon in the loan book amount to BGN 4.4 billion in the adverse scenario (equivalent to approximately 5 percent of total banking system assets as of June 2016) as a result of the credit risk increase caused by the adverse macroeconomic conditions and assumed provisioning rates.⁸

42. Given the projected path of NPL ratios, balance sheets, and profit/loss accounts were simulated for individual banks. A number of initial adjustments and assumptions were made to track the change in individual banks' balance sheets and profits over time.

- **Growth of banks' balance sheets:** Banks' balance sheet size was projected to grow in line with nominal GDP, with a zero-growth floor. Thus, the size of the banking system assets remains constant relative to the size of the economy. This assumption ensures that banks do not meet capital requirements simply by shrinking their balance sheets in the adverse scenario.
- **Profits:** Non-interest profit items, such as operational and administrative expenses, and net fee and commission income, were projected to grow in line with the size of banks' balance sheets. However, it was assumed that income from extraordinary items would not recur during the simulation period in both the baseline and the adverse scenarios. Finally, the stress tests exclude income from the accrued interest from nonperforming exposures in both the baseline and the adverse scenarios.
- **Distribution of dividends:** Banks satisfying capital requirements during the stress test simulation were assumed to distribute 50 percent of after-tax profits in the baseline scenario. Banks were not allowed to distribute dividends under the adverse scenario.

⁸ It is important to note that expected loss models used for provisioning purposes will be changed in 2018 when new IFRS standards become binding. It is expected that banks will form more provisions for expected losses. Top-down stress testing results partially accounted for that by using stressed PDs and LGDs.

- Provisioning: The stress tests used historical average provisioning rates (2011–2016) based on the bank-level credit quality data provided by the BNB. For the baseline scenario, the bank-level provisioning rates were floored at 60 percent based on judgment. For the adverse scenario, the bank-level provisioning rates were uniformly increased by 20 percentage points from their baseline scenario levels and were capped at 100 percent. In the adverse scenario, in addition to the provisions for the new flow of nonperforming loans, 20 percentage points of provisions were added for the loans that were re-classified as nonperforming in the AQR results. For example, if the AQR results indicated that loans totaling BGN X million should be re-classified as NPLs in a bank’s portfolio, total provisions of BGN 0.2*X million were added to the bank’s results during the three-year scenario period, divided equally over the three years.



C. Results

Baseline Scenario Results

43. The overall banking system performs well under the simulated baseline scenario; however, two banks fall below the regulatory minimum threshold. The baseline economic scenario is characterized by economic growth and declining unemployment ratio. Under this scenario, the predicted NPL levels decline and banks’ performing loan portfolios are assumed to generate interest income. With a stream of positive profits, the average CET1 ratio increases modestly, from slightly under 20 percent at June 2016 to 21 percent at June 2019. On a system-wide

basis, profits are the largest driver of this change in the capital levels, while loss provisions lead to a small negative effect on capital as the average NPL levels decline in this scenario (see Figure 14). Despite the strong performance of the overall banking system, two banks fall below the regulatory minimum CET1 threshold of 4.5 percent under the baseline scenario. These banks experience substantial increase in their NPLs as a result of the AQR adjustment, which leads to the reduction in the amount of assets that are assumed to generate cash-based interest income. With a significantly smaller base of performing loans, these two banks do not generate enough recurring income to cover their interest expense and credit costs in the baseline scenario. The negative effect of provisions overcome the substantially reduced interest income, which results in negative profits and declining capital levels for these banks.

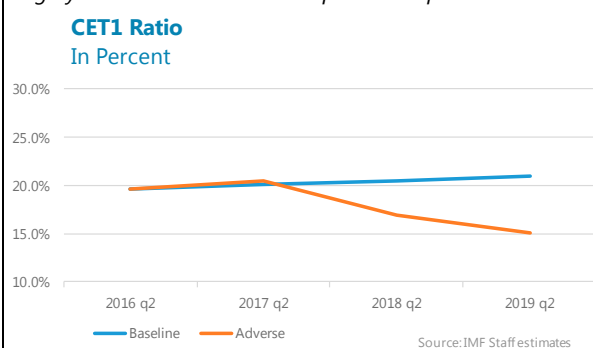
Adverse Scenario Results

44. In the adverse scenario, five banks fall below the supervisory threshold, including the two that were falling below the threshold in the baseline scenario. On a system-wide basis, the aggregate CET1 ratio falls to around 15 percent by the end of the stress period (June 2019) which is significantly higher than the regulatory minimum. Similarly, the system-wide leverage ratio falls from 11 percent to 8 percent, and remains comfortably above the Basel III reference level of 3 percent. However, the bank-level results show that five banks will not meet minimum capital requirements, as well as the referenced 3 percent leverage ratio. The ST suggests that three banks will fall below the regulatory minimum CET1 ratio of 4.5 percent by the second year of the stress period (at June 2018). As the simulated economic slow-down continues into the third year of the scenario, two additional banks fall below the regulatory minimum threshold with aggregate capital shortfall of 1.8 percent of the annualized nominal GDP. Although this is a modest number, of the five banks falling below the regulatory minimum at the end of the simulation period, three become technically insolvent.

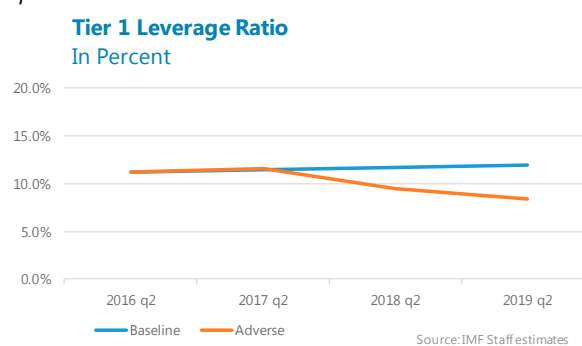
45. The largest driver of the change in capital positions in the adverse scenario is loan loss provisions (see Figure 14). As the economic outlook deteriorates in the simulated adverse scenario, the NPLs increase significantly. Together with the assumed increase in the provisioning ratio of 20 percentage points, this increase in NPLs leads to large loan loss provisions, which reduce the capital of banks. The estimated satellite models indicate that changes in macroeconomic variables (GDP growth, unemployment, and interest rates) lead to increases in NPLs with a lag of several quarters. The lagged effect of the positive growth that the economy experiences up to June 2016 results in only modestly higher NPLs by June 2017. As the economic growth turns negative starting from the first year of the scenario period, NPLs increase significantly in the second year of the period. The corresponding increase in loss provisions reduces banks' capital significantly. As the economy starts recovering in the third year of the scenario period, the flow of NPLs slows down, but loss provisions continue to exert a significant drag on profitability. For the domestic banks, the interest rate-related losses, due to the sizeable funding shocks that these banks receive, are the second largest driver of the decline in their capital positions.

Figure 13. Bulgaria: Stress Test Results – Capital Adequacy

System-wide CET1 ratio declines, however, it remains highly above the minimum 4.5 percent requirement



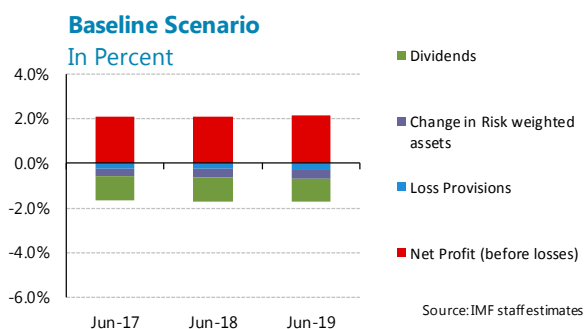
System-wide leverage ratio remains above the reference 3 percent level



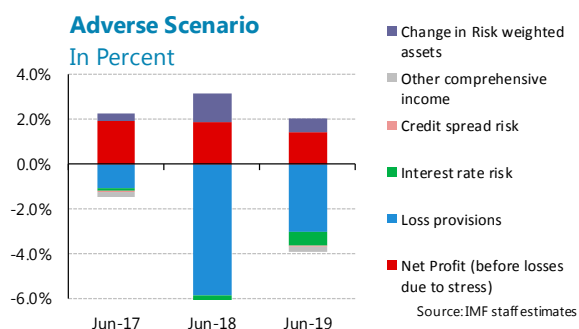
Source: IMF staff estimates.

Figure 14. Bulgaria: Stress Test Results – Drivers of the Change in Capital Levels

Positive net profit leads to a slight increase in CET1 ratios



Loss provisions drive CET1 down in the adverse scenario



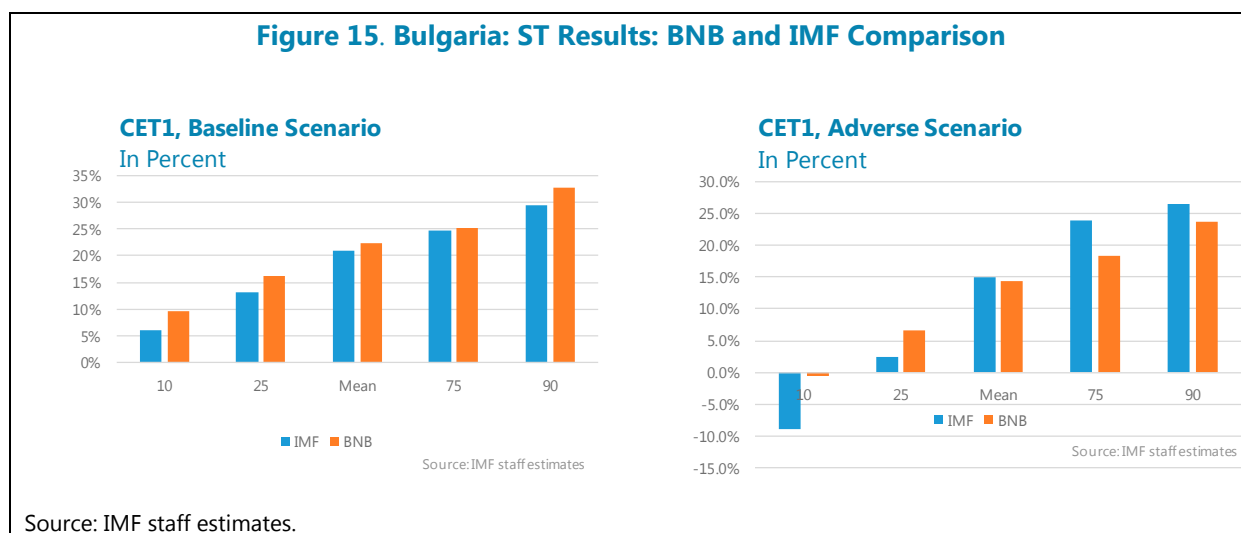
Source: IMF staff estimates.

Bulgarian authorities' stress test results

46. The overall banking system performs well under the BNB ST baseline scenario, with only one bank falling below the regulatory minimum threshold. In an environment of continuous economic growth and declining unemployment ratio, most banks generate positive profits. The average CET1 ratio for the 17 banks included in the IMF ST exercise increases to 22 percent at year-end 2018.

47. In the adverse scenario of the BNB ST, three banks fall below the regulatory minimum threshold, including the bank that was falling below the threshold in the baseline scenario. On average, the banking system remains well capitalized at the end of the three-year simulation period, with the average CET1 ratio for the 17 banks included in the IMF ST exercise falling to 14.4 percent. At the same time, three banks will not meet minimum capital requirements under this scenario, two of which will become technically insolvent at the end of the simulation period.

48. The results of the BNB ST are broadly in line with those of the IMF ST. Under the baseline scenario, the final level of CET1 ratios at the end of the simulation period are slightly lower for the IMF ST across the distribution of banks (see Figure 15). As the IMF ST does not allow for interest income accrual on NPLs, while the BNB ST allows for it if it is in line with international accounting standards, banks can potentially recognize higher income under the BNB ST exercise, which contributes to the slightly higher capital levels under the BNB ST results. Under the adverse scenario, the IMF ST results show a larger variation than those of the BNB ST. Banks at the lower end of the capital distribution have significantly lower final capital levels under the IMF ST than those under the BNB ST. At the same time, banks at the higher end of the capital distribution have higher final capital levels under the IMF ST than those under the BNB ST. The IMF ST utilizes bank-specific funding shocks and assumes zero shock for foreign-owned banks, whereas the BNB ST applies uniform funding shocks to all banks in the system. Under the IMF ST, some banks receive sizeable funding shocks, which leads to significant losses and reductions in capital levels, while others do not receive any shock. This heterogeneity in the funding that banks receive in the IMF ST contributes to the wider range of capital levels than those observed under the BNB ST.



D. Sensitivity Analysis

49. In addition to the stress scenario analysis, sensitivity tests were used to assess the vulnerabilities of the Bulgarian banking system to key stand-alone shocks. The stand-alone shocks used in the sensitivity analyses were: a decline in the prices of sovereign securities; an increase in interest rates that affects banks' net interest income; and an increase in provisions for NPLs due to decline in collateral values. The first two stand-alone shocks assess the sensitivity of banks' balance sheets to market risk, whereas the third one assesses the sensitivity to credit risk. Apart from considering one shock at a time, these sensitivity tests differ from the scenario analysis in the time dimension. These tests are static; that is, they assess the instantaneous impact of different shocks on the banks' balance sheet positions as of June 2016 (after the AQR adjustments were applied). In addition, in these tests banks' RWAs are assumed to stay constant after the application of the shocks.

A decline in the prices of sovereign securities

50. The first sensitivity test assessed the impact of decline in the prices of domestic sovereign securities that were designated either as held for trading (HFT) or as available for sale (AFS). The test was carried out via the application of average valuation haircuts based on EBA (2016) ST adverse scenario. The results show that banks would suffer minimal losses from this shock, given the modest size of the sovereign security holdings for most banks. No bank falls below the regulatory minimum threshold for capital, and the aggregate CET1 ratio in the system declines by only 0.2 percentage points.

Interest rate risk: impact on net interest income

51. The second sensitivity analysis assessed the impact of a sharp increase in interest rates using a maturity gap analysis. The test simulates an instantaneous upward shift of 500 basis points in the yield curve and evaluates the impact on the net interest income that banks generate. Each bank's gap between its interest earning assets and its interest paying liabilities, with maturities up to one year, determine the effect of the simulated interest rate shock on the net interest income of the bank. For example, deposits maturing within one year must be rolled over at the higher deposit rates, which results in higher interest payments for the bank. Similarly, loans with maturities of less than one year are also renewed at higher interest rates, increasing bank interest income. The impact of this shock is highly heterogeneous across banks due to the heterogeneity in their maturity gap profiles. Only one bank falls below the regulatory minimum threshold for capital and the aggregate CET1 ratio in the system declines by 1.3 percentage points, still a relatively modest amount compared to the CET1 ratio of close to 20 percent in June 2016.

Increased provisions

52. The third sensitivity test assessed the impact of an increase in provisioning rates for the stock of NPLs. Asset price uncertainty over NPLs, which can lead to declines in collateral values, was identified as a key risk for the Bulgarian banking system. In such a case, banks would need to increase the provisioning rates for NPLs. Another motivation for this sensitivity test is the fact that Bulgarian banking system is preparing for the implementation of IFRS 9 starting from 2018. This standard requires the banks to record loan loss provisions based on lifetime expected credit losses for exposures 30 days or more past due. As a result, it is expected that provisions will need to increase significantly from their current levels. This sensitivity test assessed the impact of uniformly increasing the provisions by 20 percentage points for the existing stock of NPLs. As a result of this increase, two banks fall below the regulatory minimum threshold for capital and the aggregate CET1 ratio in the system declines by approximately 6 percentage points. Due to the large stock of NPLs across the system, this shock leads to much larger declines in capital levels compared to the other two.

E. Concentration Risk

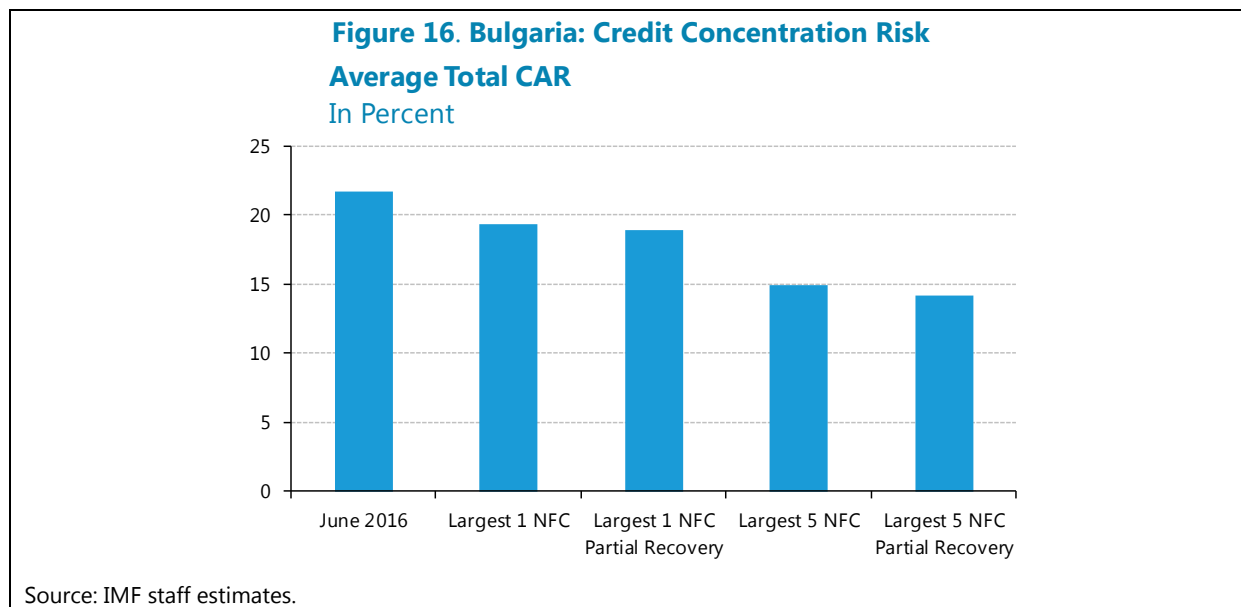
53. Name concentration risk (i.e., exposure to a single borrower) was tested by assessing the impact of the default of the largest exposures. Supervisory data on the large bank exposures were used to perform this sensitivity analysis type of stress test. The analysis included exposures to groups of clients, which exceed 10 percent of regulatory capital, but excluded sovereign exposures. Bulgarian banks' exposures consist of direct credit risk exposures. The test assessed the impact of the hypothetical default of up to five of the largest NFC borrowers, and calculated implied losses from these exposures under two different assumed levels of recovery rates. In addition to the base case of the default of the largest NFC borrowers, we carried out a sensitivity analysis to assess the impact of potential default of the largest borrower, including financial institutions to capture the exposure to parents. These shocks were applied to banks' capital levels from balance sheets as of June 2016 after the AQR adjustments were applied.

54. Single name concentration risk in Bulgaria is two-tiered: foreign owned banks are mostly exposed to their parents, while domestic ones mostly to nonfinancial corporates. Some of the banks have large exposures on their balance sheets, which shows high name concentration risk for these banks. On average, the size of the first largest exposure is 24 percent of total capital. These large exposures typically include parent financial institutions and are reported by foreign-owned banks. Considering only the exposures to the NFC borrowers, the average ratio of the first largest exposure to total capital declines significantly to just under 16 percent. Excluding exposures to financial institutions, foreign-owned banks report, on average, significantly lower single name concentrated exposures than domestic banks do.

55. Concentration test shows that Bulgarian banks are, on average, adequately capitalized to absorb losses from the default of large NFC exposures, however, a few banks would become undercapitalized. In this analysis, we assumed zero recovery on the unsecured part of the exposure and full recovery of the value of the collateral and other credit protection instruments. Under this scenario, the default of the largest NFC exposure of each bank in the system would imply an average total CAR of more than 19 percent, well above the 8 percent total CAR hurdle rate. At the same time, two banks would fall below the 8 percent total CAR hurdle rate. The total regulatory capital shortfall would be equivalent to 0.2 percent of GDP. Following the default of the five largest NFC exposures in each bank, the number of banks falling below the 8 percent total CAR hurdle rate increases to five and the total capital shortfall increases to 1.5 percent of GDP (see Figure 16).

56. Under a more severe scenario of the default of the largest NFC exposures and a partial recovery on credit risk mitigation measures, several banks would become undercapitalized. In this scenario, we assumed zero recovery on the unsecured part of the exposure and a 50 percent haircut on the value of the collateral and other credit protection instruments. In this case, the default of the largest NFC exposure of each bank would lead to two banks' falling below the 8 percent total CAR hurdle rate with total regulatory capital shortfall equivalent to slightly over 0.2 percent of GDP. Following the default of the five largest NFC exposures, the number of banks falling below the 8 percent total CAR hurdle rate increases to seven, while the total capital shortfall would still be a

relatively modest amount equivalent to 1.7 percent of GDP. The haircut of 50 percent on collateral valuation and other credit protection instruments in a stress period is an admittedly conservative scenario. Indeed, as far as financial guarantees are concerned, it would imply losses on both the bank's obligor and its guarantors.



57. Finally, a sensitivity analysis was carried out to capture the exposure to parent banks.

In this analysis, we considered the default of the largest exposure of each bank, including exposures to financial institutions (if any). The default of the largest exposure would imply an average total CAR of 17 percent. Only two banks would fall below the 8 percent total CAR hurdle rate with a total regulatory capital shortfall equivalent to 0.2 percent of GDP. Under the more severe scenario of zero recovery on the unsecured part of the exposure and a 50 percent haircut on the value of the collateral and other credit protection instruments, the default of the largest exposure leads to four banks falling below the 8 percent total CAR hurdle rate, while the total capital shortfall would be equivalent to slightly more than 0.6 percent of GDP. This sensitivity analysis suggests that potential losses from parent exposures correspond to modest amounts at the system level.

58. Single name concentration tests revealed important risks, and overall resilience of the system, however this analysis is not without caveats.

In general, concentration risk stress test should be based on the highest level of consolidation of exposures and clients; however, in the absence of such information, risks might be underreported, especially for connected clients and related parties. Moreover, the formal large exposure definition is floored at 10 percent of capital (as is defined by CRR); hence, some exposures might be seemingly unrelated (but de facto connected) and thus underreported.

LIQUIDITY STRESS TESTS

A. Scenarios and Models

59. Short-term and long-term liquidity stress tests were conducted using Basel III standards. Using bank-by-bank supervisory data, the FSAP team approximated the Basel III Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR) and assessed banks' vulnerability to increasing outflows of less stable deposits. The tests were based on solo (non-consolidated) data for domestically incorporated solo banks in Bulgaria and covered 17 out of 22 local banks and foreign subsidiaries banks for both LCR and NSFR.

60. The stress tests aimed to assess risks due to the potential volatility that banks' funding sources might display. Bulgarian banks' funding mostly consists of deposits that are mostly retail and concentrated in very short maturities with little wholesale funding from financial or nonfinancial customers. Short maturity deposits and high reliance on less stable deposits can increase liquidity risks in the banking system. About 80 percent of deposits have maturities of less than 90 days and 43 percent of retail deposits are classified as less stable (according to EBA reporting templates).

61. Various run-off rate assumptions were applied to less stable deposits. For the purposes of the LCR, benchmark run-off rates of 5 percent for stable deposits and a simulation of 10 percent to 50 percent for less stable deposits was used. Similarly, a simulation of 10 percent to 50 percent for less stable deposits was used in the NSFR. The simulations covered the whole scenario spectrum from 0 percent to 50 percent run of stable deposits (See Appendix I for a complete list of assumptions, including run-off rates, roll-over rates, and haircuts).

62. In addition, a cash flow-based liquidity stress test was performed. This test used liquidity reporting templates used by the central bank capturing the temporal structure of cash flows generated by different liabilities and assets.

B. Results

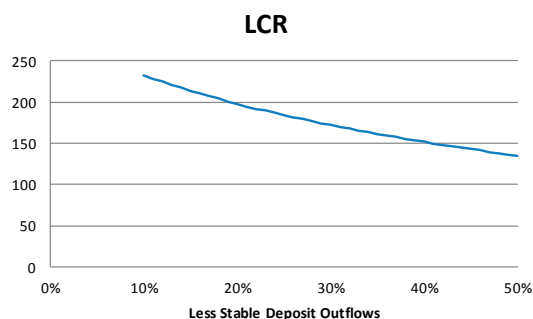
63. The LCR baseline scenario was the BCBS-recommended minimum 10 percent run-off for less stable deposits (see BCBS, 2013).⁹ Under the baseline scenario, no bank underperformed the standard and the system LCR was 232 percent, which suggests high levels of liquidity at the system level.

64. Moreover, the LCR stress test suggests that most banks had enough buffers to withstand a significant shortage of liquidity in the short term. For the system, LCR remained above 100 percent threshold even in the extreme scenario of 50 percent deposit outflow with only one bank underperforming the standard. The resulting liquidity shortfall was of less than BGN 740 million or 0.85 percent of 2015 GDP.

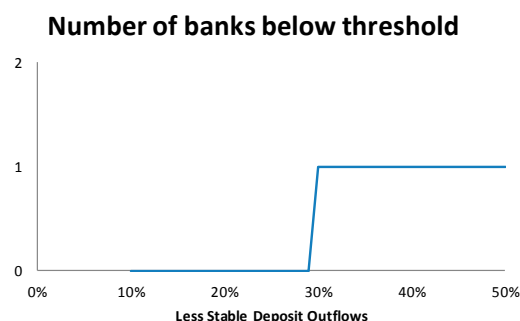
⁹ BCBS, 2013: Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools, January 2013.

Figure 17. Bulgaria: LCR-based Stress Tests Results

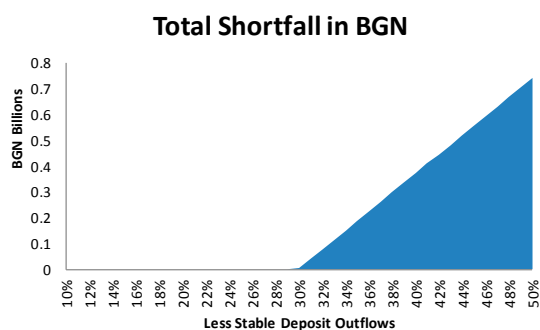
System LCR remained above 100 percent threshold even in the extreme scenario of 50 percent deposit outflow



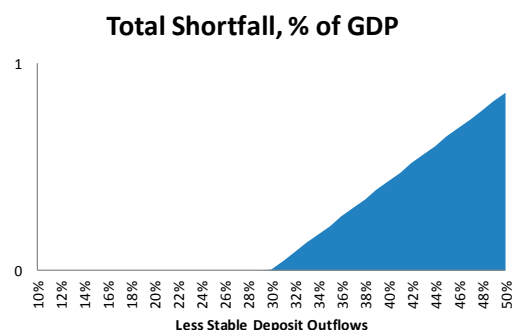
One bank fails in the extreme scenario 50 percent deposit outflow



Total shortfall in the extreme scenario is less than 1b BGN



Or less than 1 percent of GDP



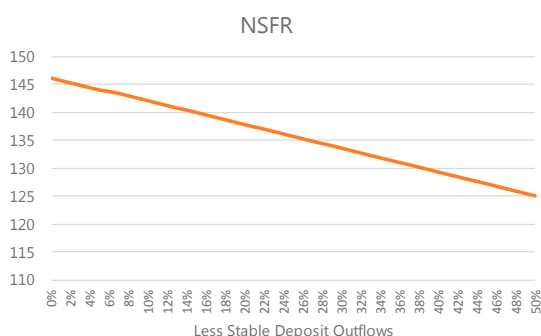
Source: IMF staff estimates.

65. For the longer term NSFR, three banks already underperform the threshold in the baseline Basel scenario of zero percent of deposit outflows (there is no EBA guidance on a minimum less stable deposit outflow as in the case of the LCR). The initial shortfall for these three banks amounts to BGN 600 million, or 0.7 percent of GDP. Despite the shortfall for these banks, system-wide NSFR is 146.2 percent, with the ratio well above 100 percent for several banks. Since there was no EBA guidance on NSFR at the time of this analysis, this measure was not binding and was calculated for reference only.

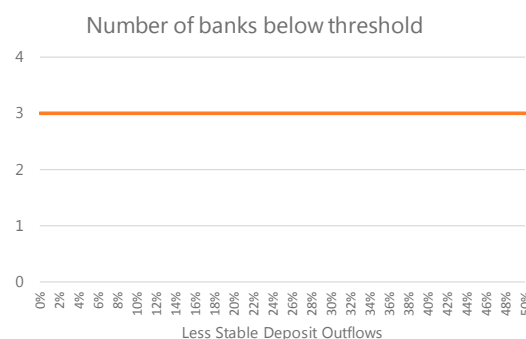
66. Under stress the system performs well, with no new banks underperforming the standard and aggregate NSFR level only dropping to 125.2 at the extreme scenario of 50 percent of less stable deposits outflow. At the same time, the shortfall for the three underperforming banks increases to BGN 1 billion, or percent of 1.2 percent of GDP, in this scenario.

Figure 18. Bulgaria: NSFR-based Stress Test Results

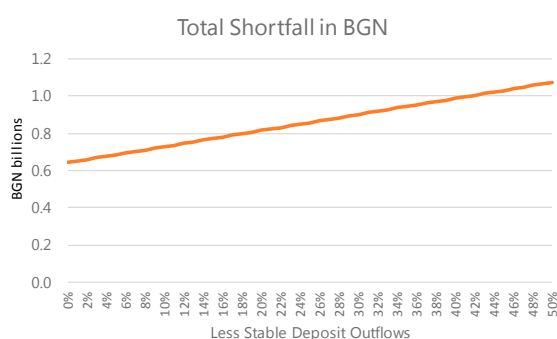
System NSFR is of 146.2 and remains above 100 percent throughout the scenario simulation range



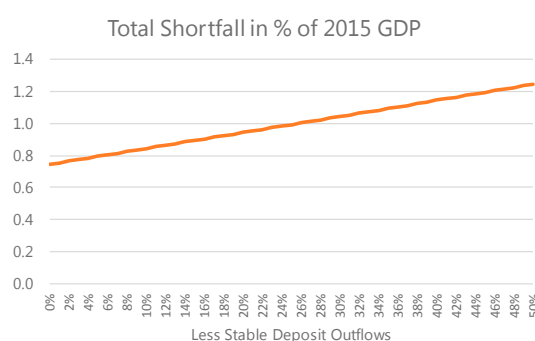
Three banks remain below the threshold from baseline to the extreme scenario of 50 percent outflow



Liquidity shortfall grows from 600 million to 1 billion BGN



Or from 0.74 to 1.24 percent of GDP



Source: IMF staff estimates.

67. A cash flow-based liquidity stress test was performed using bank-level data on the temporal structure of cash flows generated by different liabilities and assets. These were mapped to scenarios of run-off rates for liabilities and roll-over rates for assets, for time horizons ranging from seven days to one year (see Table 3 for scenario assumptions). The results were similar to those from the LCR- and NSFR-based analyses. Most banks had adequate buffers to meet the cash outflows in the simulated scenario, with a few banks experiencing cash shortfalls. The aggregate cash shortfalls in the various time horizons correspond to a small portion of the GDP. Specifically, in the very short term (seven-day horizon), three banks (including a large one) could be vulnerable to cash outflows with a combined shortfall of 0.7 percent of GDP against a simulated cash outflow for the banking system equal to BGN 16.7 billion. Going out to 30-day horizon, the number of banks that may experience cash shortfalls declines to two, with a simulated cash outflow of BGN 18.4 billion. At the 90-day horizon only one bank becomes vulnerable, with total cash shortfall equaling 0.5 percent of GDP, against a simulated cash outflow of BGN 19.8 billion. At the longer horizon of one year, none of the banks experiences shortfalls, as all banks have adequate cash inflows to meet the cash outflows in the simulated scenario.

Table 3. Bulgaria: Cashflow-Based Liquidity Stress Test Scenarios
(In percent)

Run-off Rates	Assumptions			
	7 Days	30 Days	90 Days	1 Year
Withdrawal of deposits by non-residents (financial institutions)				
Group entities	0	0	0	0
Non-Group entities	25	25	50	100
Withdrawal of deposits by non-residents (non-financial institutions)				
Group entities	0	0	0	0
Non-Group entities	25	25	50	100
Inability to issue bonds which mature within one year	50	50	25	0
Withdrawal of deposits from residents				
Credit institutions	100	100	100	100
Non-financial companies and households	40	30	20	10
Flow of new loans	3.5	3.5	3.5	3.5
Roll-over Rates				
Cash and CB reserves	100	100	100	100
Balances with other banks	50	50	70	100
Tradeable debt securities	80	85	90	95
Gold and other commodities	90	75	70	65
Loans and receivables				
Central governments	100	100	100	100
Credit institutions	100	100	100	100
Non-credit institutions	100	100	100	100
Corporate	90	90	90	90
Retail	90	90	90	90

Source: IMF Staff.

CONTAGION AND INTERCONNECTEDNESS TESTS

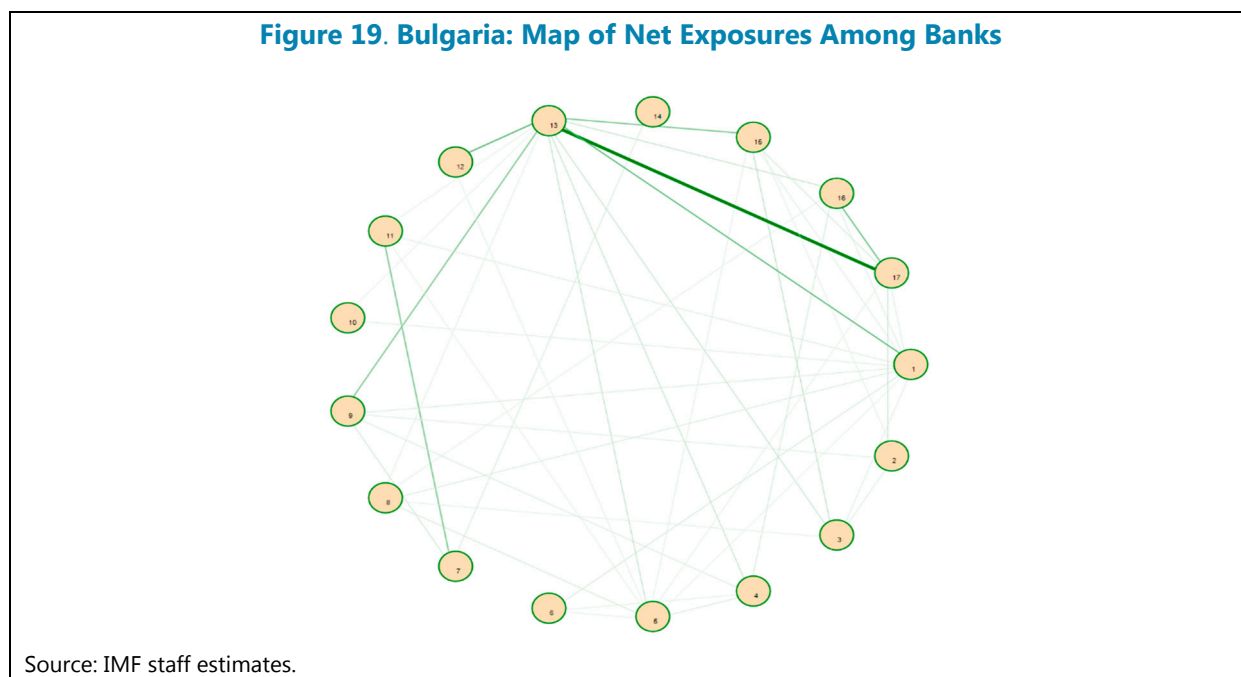
Domestic interbank contagion test

68. Domestic interbank contagion risks were assessed using a network model of contagion based on Espinosa-Vega and Solé (2010). The analysis is based on a matrix of bilateral domestic interbank net credit exposures of the seventeen largest banks composing our sample, with information as of end-June 2016.¹⁰ Interbank exposures were provided as a part of the interbank reporting template and are on the asset side of banks' balance sheets, i.e., not on liabilities. The analysis includes pure contagion whereby failure of a bank triggers direct credit and capital losses in other banks—and the subsequent fire sales caused by funding shocks (assuming some typical

¹⁰ In a system with 17 banks, the interbank exposure matrix is of size 17x17.

parameters for the model, i.e., 50 percent haircut in the fire sale of assets and a 65 percent roll-over ratio of interbank debt).

69. Data based on net exposures reveal limited interbank market activity as well as a limited number of connections among banks (Figure 19). Overall, only a few banks are systemically important; however, their net exposure is still limited. A higher level of interconnectedness exists among foreign owned banks compared to domestic ones.

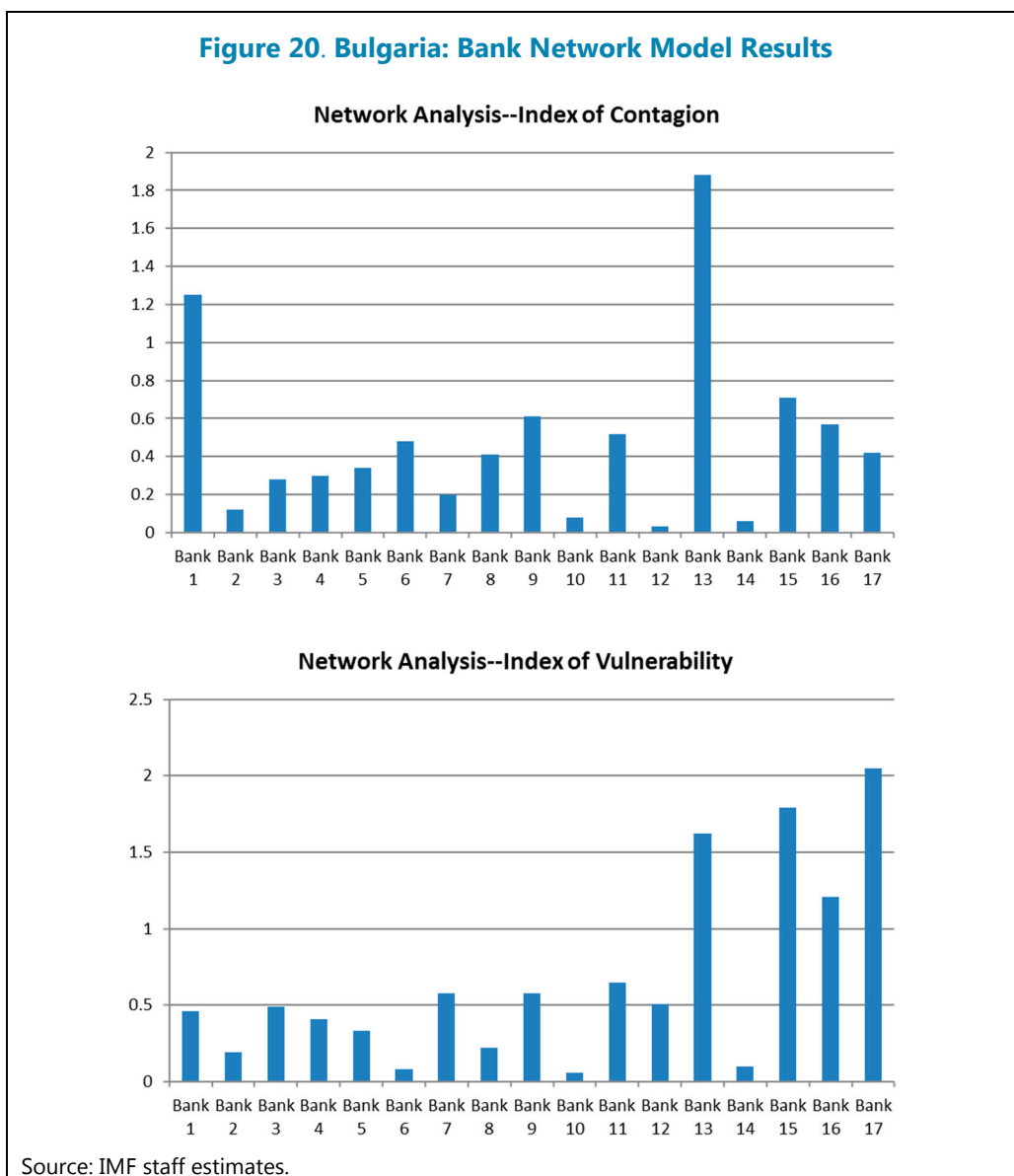


70. The stress test assumes the hypothetical default of each bank, one at a time. The default occurs on all interbank obligations of the bank, and the test assesses the impact on other banks. If the default of any given bank on its interbank obligations implies the default of another bank in the system, a subsequent round is calculated and so on (i.e., “cascade effects”). With regard to funding shocks, in addition to the direct loss of capital, a bank needs to replace a fraction of the funding lost due to the default. It does so by selling other assets at deep discounts in the market, and these fire sales cause further losses of capital.

71. The analysis reveals that contagion risks stemming from domestic net interbank exposures are very limited. In Bulgaria, domestic net interbank positions are found to be small, especially compared to banks’ capitalization. For the banks in the system, the sum of their net domestic exposures to the other banks is smaller than their regulatory capital. Therefore, no single failure of a domestic bank would trigger the failure of another bank, and thus no “cascade effect” would take place through this four-bank market. Moreover, as of end-June 2016, none of the banks is found to be undercapitalized with regard to the Tier 1 capital regulatory minimum after a shock on one or several of its domestic interbank exposures. Nevertheless, four banks present a significantly higher level of vulnerability of spillovers to others. For these banks, the index of vulnerability, which is the percentage of loss at a single institution due to the default of all other

institutions, is significantly higher than for the other banks (Figure 20). The index of contagion, which corresponds to the average percentage of loss of other banks due to the failure of a given bank, is higher at two banks.

72. The banks that fail stress tests (IMF) have very limited impact on the rest of the system. Banks which fail both baseline and adverse scenarios would not trigger cascading effects for the rest of the banks. However, this assessment is based on net exposures and does not include potential “psychological” contagion on other banks which the markets might treat as similar to the ones that failed.



Appendix I. Liquidity Stress Tests Assumptions

1. LCR Assumptions

Assumptions for outflows (run-off rates)

Retail Deposits	
Demand deposits	
<i>Stable deposits</i>	5
<i>Less stable retail deposits</i>	10
Term deposits, residual maturity > 30d	0
Institutional Deposits	
Deposits subject to higher outflows	
<i>Category 1</i>	15
<i>Category 2</i>	20
<i>Category 3</i>	25
Operational deposits generated by clearing, custody, and cash management activities	25
<i>Portion covered by deposit insurance</i>	5
Nonfinancial corporates, sovereigns, central banks, multilat development banks, PSEs	
<i>Fully covered by deposit insurance</i>	20
<i>Not fully covered by deposit insurance</i>	40
Other legal entity customers	100
Secured Funding	
Secured funding with a central bank, or backed by Level 1 assets	0
Secured funding backed by Level 2A assets	15
Secured funding backed by non-Level 1 or non-Level 2a asset, with domestic sovereign, multilat dev banks, or domestic PSEs as a counterparty	25
Funding backed by RMBS eligible for Level 2B	25
Funding backed by other Level 2B assets	50
Other secured funding transactions	100
Additional Requirements	
Valuation changes on non-Level 1 posted collateral securing derivatives	20
Excess collateral held by bank related to derivate transactions that could be called anytime	100
Liquidity needs related to collateral contractually due on derivatives transactions	100
Increased liquidity needs related to derivative transactions allowing collateral substitution	100
ABCP, SIVs, conduits, SPVs, or similar	
<i>Liabilities from maturing</i>	100
<i>Asset backed securities</i>	100
Undrawn but committed credit and liquidity facilities	
<i>Retail and small business</i>	5
<i>Nonfinancial corporates, sovereigns, central banks, multilat dev. banks, PSEs</i>	
<i>Credit facilities</i>	10
<i>Liquidity facilities</i>	30
<i>Supervised banks</i>	40
<i>Other financial institutions</i>	
<i>Credit facilities</i>	40
<i>Liquidity facilities</i>	100
<i>Other legal entity customers, credit and liquidity facilities</i>	100
Other contingent funding liabilities	
<i>Trade finance</i>	5
<i>All other</i>	50
Additional contractual outflows	100
Net derivate cash outflows	100
Any other contractual cash outflows (not listed above)	100

Assumptions for inflows (roll-over rates)

Level 1 Assets	100
Coins and bank notes Qualifying marketable securities form sovereigns, central banks, PSEs, and multilat. Dev banks Qualifying central bank reserves Domestic sovereign or central bank debt for nonzero risk-weighted entities	
Level 2a Assets	85
Qualifying marketable securities form sovereigns, central banks, PSEs, and multilat. dev banks (with 20% risk weighting) Qualifying corporate debt securities rated AA- or higher Qualifying covered bonds rated AA- or better	
Level 2b Assets	
Qualifying Mortgage Backed Securities	75
Qualifying corporate debt securities rated between A+ and BBB-	50
Qualifying common equity shares	50

Assumptions for liquid assets (1-haircut)

Level 1 assets	0
Level 2a assets	15
Level 2b assets	
<i>Eligible Residential Mortgage Backed Securities (RMBS)</i>	25
<i>Other</i>	50
Margin lending backed by all other collateral	50
All other assets	100
Credit or liquidity facilities	0
Operational deposits held at other financial institutions	0
Other inflows, by counterparty	
<i>Retail counterparties</i>	50
<i>Nonfinancial wholesale counterparties, transactions not listed above</i>	50
<i>Financial institutios and central banks, transactions not listed above</i>	100
Net derivative cash inflows	100
Other (contractual) cash inflows	100

2. NSFR Assumptions

Available Stable Funding Factors

ID	Item	Maturity				
		1-3 Months	3-6 Months	6-9 Months	9-12 Months	12 Months and Over
1	ITEMS PROVIDING STABLE FUNDING					
1.1	Own funds	100	100	100	100	100
1.2	Liabilities excluding own funds:					
1.2.1	Retail deposits:					
1.2.1.1	As defined in Article 411(2) that qualify for the treatment in Article 421(1)	95	95	95	95	95
1.2.1.2	As defined in Article 411(2) that qualify for the treatment in Article 421 (2)	90	90	90	90	90
1.2.2	Liabilities from customers who are not financial customers:					
1.2.2.2	Liabilities from unsecured lending transactions	50	50	50	50	100
1.2.2.3	Liabilities that qualify for the treatment in Article 422(3) and (4)	95	95	95	95	95
1.2.3	Liabilities from customers who are financial customers	0	0	50	50	100
1.2.8	Any other liabilities	0	0	50	50	100

Source: IMF staff estimates.

Note: Outflows of less stable deposits (1.2.1.2) were stressed from 10 percent to 50 percent (or multiplied by factors from 90 percent to 50 percent). No factors were assigned for line items with zero outstanding amounts in the data files.

Required Stable Funding Factors

Required Stable Funding Factors						
ID	Item	1-3 Months	3-6 Months	6-9 Months	9-12 Months	12 Months and Over
1	ITEMS REQUIRING STABLE FUNDING					
1.1	Assets referred to in Article 416					
1.1.1	Cash	0	0	0	0	0
1.1.2	Exposures to central bank	0	0	0	0	0
1.1.3	Transferable assets representing claims on or guaranteed by sovereigns	50	50	50	50	50
1.1.4	Transferable assets representing claims on or guaranteed by central banks and non central government public sector entities	50	50	50	50	50
1.1.10	Other transferable assets not specified elsewhere	50	50	50	50	50
1.1.11	Non-financial corporate bonds	50	50	50	50	50
1.3	Securities and money market instruments not reported in 1.1 qualifying for credit step 2 under Article 122	50	50	50	50	85
1.4	Other securities and money market instruments not reported elsewhere	50	50	50	50	85
1.6	Other equity securities	50	50	50	50	85
1.9	Non-renewable loans and receivables					
1.9.1	The borrowers of which are natural persons other than commercial sole proprietors and partnerships	50	50	50	50	65
1.9.2	SMES that qualify for the retail exposure under the Standardized or IRB approaches	50	50	50	50	85
1.9.3	The borrowers of which are sovereigns, central banks, and public sector entities	50	50	50	50	85
1.9.4	The borrowers of which are not reported in item 1.9.1, 1.9.2, or 1.9.3 other than financial customers	50	50	50	50	85
1.9.5	The borrowers of which are credit institutions	15	15	15	50	85
1.9.6	The borrowers of which are financial customers (not referred to in 1.9.1, 1.9.2) other than credit institutions	15	15	15	50	85
1.1	Non-renewable loans and receivables reported in 1.9 that are collateralized by real estate	50	50	50	50	50
1.11	Derivatives receivables	0	0	0	0	0
1.12	Any other assets	0	0	0	0	0
1.13	Assets deducted from own funds not requiring stable funding	0	0	0	0	0
1.14	Undrawn committed credit facilities that qualify as 'medium risk' or 'medium/low risk under Annex 1	0	0	0	0	0

Source: IMF staff estimates.

Appendix II. Financial Soundness Indicators

	In percent									
	2008	2009	2010	2011	2012	2013	2014	2015	Jun 2016	Dec 2016
Regulatory capital to risk-weighted assets	14.9	17.0	17.4	17.6	16.6	17.0	21.9	22.2	22.7	22.2
Regulatory Tier 1 capital to risk-weighted assets	11.2	14.0	15.2	15.7	15.1	16.0	20.0	20.5	21.2	20.9
Nonperforming loans net of provisions to capital	3.5	15.1	28.0	36.9	38.9	36.2	43.5	49.8	47.2	44.7
Nonperforming loans to total gross loans	2.4	6.4	11.9	15.0	16.6	16.9	16.7	14.6	14.4	13.2
Return on assets	2.1	1.1	0.8	0.6	0.7	0.6	0.8	1.1	1.8	1.4
Return on equity	19.5	9.8	7.8	5.7	6.3	5.7	7.2	7.9	13.1	10.4
Interest margin to gross income	75.1	74.8	74.1	73.2	68.8	68.5	67.4	66.2	68.6	69.2
Noninterest expenses to gross income	50.1	49.9	49.1	50.6	52.1	54.0	49.9	47.3	42.1	44.0
Liquid assets to total assets	19.0	18.9	20.9	22.0	22.4	23.4	26.1	31.1	30.8	32.4
Liquid assets to short-term liabilities	26.4	26.6	30.0	29.1	30.0	30.6	33.7	40.2	39.9	41.0
Capital to assets (Based on Tier 1 capital)	11.4	10.8	10.5	10.8	10.1	10.4	11.6	12.0	12.3	11.6
Large exposures to capital	76.5	65.2	90.6	111.6	115.1	119.7	64.3	51.4	55.3	58.2
Trading income to total income	2.8	4.4	5.4	5.0	7.4	5.8	7.0	7.9	12.0	10.3
Personnel expenses to noninterest expenses	37.9	37.1	36.4	36.5	36.7	36.7	37.1	36.3	42.2	41.7
Customer deposits to total (noninterbank) loans	83.9	83.0	87.8	95.4	100.2	107.4	115.5	127.7	130.2	134.7
FX-denominated loans to total loans	57.2	58.7	61.3	63.7	64.0	61.2	57.0	50.0	48.4	45.1
FX-denominated liabilities to total liabilities	60.0	64.4	58.6	54.8	51.8	50.2	49.0	42.6	43.2	41.7

Source: IMF IFS

Appendix III. IMF and BNB Stress Test Key Differences

Scenarios	Baseline		Adverse	
	IMF	BNB	IMF	BNB
Macro scenarios	October 2016 WEO forecast	BNB macroeconomic forecast prepared as of March 15, 2016	WEO (2016 October) hypothetical forecast	Hypothetical scenario
Time horizon	3 years, starting from Q2 2016	3 years, starting from Q4 2015	3 years, starting from Q2 2016	3 years, starting from Q4 2015
Approach	Top-down (in-house)	Bottom-up with predefined constraints	Top-down (in-house)	Bottom-up with predefined constraints
Balance sheet	Dynamic	Static	Dynamic	Static
Credit shock	. NPL evolution based on scenario . Fixed shock provisioning rates	Evolution of PDs and LGDs based on the scenario	. NPL evolution based on scenario . Fixed shock to provisioning rates	Evolution of PDs and LGDs based on the scenario
Interest income	No interest income accrual on NPLs	Interest income according to international accounting standards	No interest income accrual on NPLs	No interest income accrual on NPLs
Funding shock	No funding shock	No funding shock	Funding shock based on increase in Euribor and individualized premiums calibrated based on each bank's liquidity ratio (taking into account deposit flow from domestic to foreign owned banks) multiplied by largest historical shock to deposit interest rates. Shocks applied only to domestic banks, assuming that foreign owned banks will not experience deposit outflows	Uniform funding shock based on increase in sovereign yields and Euribor
Haircut on sovereign bonds (AFS and HFT securities)	No shock	No shock	Haircuts based on averages from EBA (2016) adverse scenario	Haircuts based on EBA (2016) adverse scenario
AQR adjustments	Adjustments applied on Q2 2016 reported results	Adjustments applied on Q4 2015 reported results	Adjustments applied on Q2 2016 reported results	Adjustments applied on Q4 2015 reported results

Appendix IV. Risk Assessment Matrix (RAM)

Source of Risk	Relative Likelihood (high, medium or low)	Impact if Realized (high, medium or low)
1. Protracted period of slower European growth	High Bulgaria's exports are highly dependent on Euro-area markets. There would be direct negative influence through trade and investment channels.	High Low potential growth, high structural unemployment, and low FDI, continued fiscal pressures. External shocks will lead to lower income for corporate sector as well as households. Fixed exchange rate will be maintained, thus external shocks will materialize in lower public spending, corporate sector income, and household wages. In the stress tests, this risk will be modeled through lower GDP growth and higher unemployment shocks which lead to higher NPLs.
2. Financial stress in emerging markets	Medium Adverse effects on banks and corporates due to increased investor risk aversion which leads to higher risk premiums.	Medium Increased country risk premium, leading to wider spreads for the sovereign, funding pressures for banks, higher borrowing costs for nonfinancial corporates, and lower FDI. In the stress tests, this risk will be modeled through wider spreads for the sovereign (losses on domestic mark-to-market securities) and higher funding costs for banks.
3. Intensification of geo-political tensions related to Russia, Ukraine, and Turkey	High/Medium Negative spillovers from trade and investment channels. Increase in country risk, sovereign rating downgrade.	High/Medium Adverse effect on economic activity and social tensions leading to the higher country risk premiums and potential sovereign rating downgrade by one to three notches. This risk will be modeled through a standalone sensitivity shock (sovereign downgrade).
4. Asset price uncertainty over NPLs	High Delayed recognition of NPLs, and loan foreclosures. Impediments to releasing collateral associated with NPLs, including judicial bottlenecks and administrative costs.	Medium Collateral prices decline. The need for higher provisions lowers bank profits and capital; investment and growth prospects are in turn weakened. In the stress tests, this risk will be modeled through higher provisioning rates for banks.

Appendix V. Stress Testing Matrix (STeM) for the Banking Sector

Domain		Top-down Stress Test by FSAP Team - Assumptions
Banking Sector: Solvency Risk		
1. Institutional Perimeter	Institutions included	17 banks.
	Market share	95 percent of the banking system assets.
	Data and baseline date	Source: Supervisory and publicly-available data. Baseline date: End-June 2016. Scope of Consolidation: Consolidated level data for banks which have their headquarters in Bulgaria and subsidiary level data for the subsidiaries of foreign banks.
2. Channels of Risk Propagation	Methodology	Satellite models developed by the FSAP team. Balance sheet-based approach.
	Satellite models for macro-financial linkages	Models for credit losses, pre-impairment income, credit growth, expert judgment on coverage ratios. Models to integrate solvency-funding interactions. Methodology to calculate sovereign risk. Methodology to calculate losses from bonds and money market instruments (sovereign and other issuers). Net fee income and commission income projected based on nominal GDP growth and expert judgment. No accrued income on NPL loans.
	Stress test horizon	3 years (2016 Q2–2019 Q2)
3. Tail Shocks	Scenario analysis	Scenario-based tests, which assess the impacts on the entire portfolio, including the loans and, if applicable, the trading book, will be conducted in the top-down exercise. Variables in the scenarios include domestic macro- financial variables (e.g., GDP and inflation), and GDP for key trading partners (EU, Russia, neighboring non-EU countries). In the Bulgaria-specific severe stress scenario, the GDP growth rate declines to -6 percent, -6.4 percent, and -3.4 percent, in 2017, 2018, and 2019, respectively. A set of external sector shocks, including large declines in exports and FDI, is calibrated to magnitudes similar to those observed in countries with currency board system during 2008–2009.
	Sensitivity analysis	Sensitivity analyses will be conducted in the top-down exercise. They will evaluate <i>external</i> shocks: sovereign rating downgrade and a decline in the prices of sovereign bonds. Default of large corporate borrowers. Decline in real estate prices. Increase in interest rates (risk premiums).

Domain		Top-down Stress Test by FSAP Team - Assumptions
4.Risks and Buffers	Risks/factors assessed	Credit losses. Losses from bonds and money market instruments (sovereign and other issuers) in the banking and trading books. Funding costs.
	Behavioral adjustments	Balance sheet grows in line with nominal GDP. Dividends are paid out by banks that remain adequately capitalized throughout the stress period. Dividend payout ratio is determined by using historical data.
5. Regulatory and Market-Based Standards and Parameters	Calibration of risk parameters	Through-the-cycle and point-in-time for credit risk parameters or proxies.
	Regulatory/ accounting and market-based standards	European and national regulation. Basel II/III STA approach.
6. Reporting Format for Results	Output presentation	System-wide capital shortfall. Number of banks and percentage of banking assets in the system that that fall below microprudential hurdle rates (Basel minimum: 4.5 percent and 8 percent for common equity tier 1 and total capital ratios, and 3 percent leverage ratio).
Banking Sector: Liquidity Risk		
1. Institutional Perimeter	Institutions included	17 largest banks in the system.
	Market share	95 percent of the banking system assets.
	Data and baseline date	Source: Supervisory data. Baseline date: End-June 2016. Scope of Consolidation: Consolidated level data for banks that have their headquarters in Bulgaria, and subsidiary level data for the subsidiaries of foreign banks.
2. Channels of Risk Propagation	Methodology	Basel III-LCR and NSFR type proxies. Cash-flow based liquidity stress test using maturity buckets by banks.
	3.Risks and Buffers	Risks Funding liquidity (liquidity outflows). Market liquidity (price shocks and haircuts).
	Buffers	Counterbalancing capacity (HQLA). Central bank facilities.
4. Tail shocks	Size of the shock	Runoff rates calculated based on historical events and LCR/NSFR rates. Bank run and dry up of wholesale funding markets, taking into account haircuts to liquid assets.
5. Regulatory and Market-Based Standards and Parameters	Regulatory standards	European Commission Delegated Regulation (EU) 2015/61.
6. Reporting	Output presentation	Bank-level and aggregate banking-level liquidity gaps.

Domain		Top-down Stress Test by FSAP Team - Assumptions
Format for Results		Survival period in days by bank, number of banks that can still meet their obligations.
Banking Sector: Interconnectedness		
1. Institutional Perimeter	Institutions included	17 largest banks in the system.
2. Modeling Approach	Methodology	Simple balance sheet contagion model.

Appendix VI. Specification of Satellite Models of Credit Risk

The NPL ratios of individual banks under the stress test scenarios (baseline and adverse) were estimated using satellite models of credit risks. Losses related to credit risk were computed based on the changes in provisions resulting from the loan migration as predicted by the changing levels of NPLs under each scenario. Panel data models were developed to predict bank-specific NPL ratios for three exposure classes in bank's portfolios: corporate loans, mortgage loans, and other retail loans. These models used the macrofinancial variables that were included in the scenarios (GDP growth, Sofibor, unemployment rate), and added the lagged NPL ratios when necessary. The exact specifications and coefficient estimates for each asset class are presented in the table below.

The dependent variable in the panel regression for each asset class was the logit transformation of the NPL ratio:

$$Y_{it} = \ln(NPL_{it} / 1 - NPL_{it}) \quad (1)$$

This variable is then estimated using the following the below general specification:

$$Y_{i,t} = \alpha + \mu_i + \rho Y_{i,t-1} + \beta X_{t-s} + \varepsilon_{i,t} \quad \text{for } t = 1, \dots, T \quad \text{and} \quad s = 1, \dots, S \quad (2)$$

where $Y_{i,t}$ is the first difference of the logit transformed NPL ratio for bank i at time t , X_t is a vector of macrofinancial variables, s denotes time lags, μ_i denotes bank-specific fixed effects, $\varepsilon_{i,t}$ is the error-term, and α , ρ , and β are the parameters to be estimated. The exact specification for each exposure class was chosen based on Bayesian Model Averaging approach, to avoid handpicking of models and macrofinancial variables. See the table below for final estimates.

Credit Risk Satellite Models Estimation Results					
	Corporate Loans Coefficients		Mortgage Loans Coefficients		Other Retail Loans Coefficients
Dependent Variable(t-1)	0.7293*** (12.87)	GDP(t-5)	-0.7033*** (-2.79)	GDP(t-5)	-1.7204*** (-3.71)
GDP(t-2)	-2.1783*** (-3.92)	Unemployment(t-2)	0.0841 (14.31)	Sofibor(t-3)	0.0956*** (14.64)
Sofibor(t-2)	0.0353*** (-4.93)			Unemployment(t-2)	0.1250*** (10.39)
<i>R-Squared</i>	0.97		0.99		0.96
<i>Observations</i>	190		286		198
Source: IMF Staff Estimates t-Statistics in Parentheses * Denotes significance at 10 percent, ** at 5 percent, and *** at 1 percent.					