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July 2015

BANKING SECTOR STRESS TESTING—TECHNICAL NOTE

This Technical Note on Banking Sector Stress Testing for Bosnia and Herzegovina 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 July 2015.

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BANKING SECTOR STRESS TESTING

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This Technical Note was prepared by IMF staff in the context of the Financial Sector Assessment Program in Bosnia and Herzegovina. 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

CONTENTS

GLOSSARY 4

EXECUTIVE SUMMARY 5

INTRODUCTION 7

BANKING SYSTEM AND STRESS TEST COVERAGE 8

MACROECONOMIC SCENARIOS 9

SOLVENCY STRESS TEST 11

A. Credit Risk 11

B. Market Risk 13

C. Risks Associated to Equity Instrument Holdings 17

D. Operational Risk 18

E. Concentration Risk 19

F. Impact of Asset Quality Reviews (AQRs) 19

LIQUIDITY STRESS TEST 20

CONTAGION RISKS AND SPILLOVER ANALYSIS 23

A. Cross-Border Contagion Risk 23

B. Domestic Interconnectedness and Contagion Risks 25

CONCLUSIONS 27

BOXES

1. Computation of Potential Losses due to Debt Instruments Risk 15
2. Impact from the AQRs on Stress Test Results 21

FIGURES

1. Evolution of the Level of Real GDP in the Stress Test Scenarios 9
2. Relationship Between Real GDP Growth and Operational Risk Losses 18
3. Liquidity Stress Test Results 20
4. Distribution of Liquidity Ratios Across Banks 22
5. Linkages between Banking and Non-Banking Sectors 26
6. Banks' Linkages to the Development Bank in Republika Srpska 26
7. Top-Down (lhs) and Bottom-Up (rhs) Estimated Capital Adequacy Ratios 30

8. Top-Down (lhs) and Bottom-Up (rhs) Estimated Potential Losses for the Entire Banking System (27 banks) 31
9. Cross-Border Financial Spillovers to BiH's Banking System 32
10. Spillovers from Banks to Insurance Sector under Adverse Scenario 2 32

TABLES

1. Main Recommendations Based on the Stress Tests 7
2. Balance Sheet Summary of the Banking Sector 8
3. Banking Sector Summary by Entity 33
4. Summary of the Banking Sector Loan Book in Bosnia and Herzegovina 34
5. Macroeconomic Projections in the Stress Test Scenarios 35
6. Summary of the Solvency Stress Test Results—Entire Banking System (27 banks) 36
7. Summary of the Top-Down Solvency Stress Test Results—Entity Level 37
8. Implied Non-Performing Loan Ratios under Adverse Scenario 2 38
9. Stress Test Results on Credit Concentration Risk 39
10. Summary of the Liquidity Stress Test Results 40
11. Summary of FSAP Team Access to Supervisory Data 41

APPENDICES

I. Risk Assessment Matrix 42
II. Stress Test Matrix (STeM) for Solvency, Liquidity, and Contagion Risks 45

Glossary

AFS	Available-For-Sale
AQR	Asset Quality Review
ASF	Available Stable Funding
BCBS	Basel Committee on Banking Supervision
BCP	Basel Core Principles
BiH	Bosnia and Herzegovina
BU	Bottom-Up
CAR	Capital Adequacy Ratio
CBBH	Central Bank of Bosnia and Herzegovina
CPI	Consumer Price Index
EAD	Exposure at default
FBiH	Federation of Bosnia and Herzegovina
FSAP	Financial Sector Assessment Program
FX	Foreign Exchange
GDP	Gross Domestic Product
GRAM	Global Risk Assessment Matrix
HFT	Hold-For-Trading
HQLA	High-Quality Liquid Assets
HTM	Hold-To-Maturity
IRBRS	Investment-Development Bank of Republika Srpska
KM	Bosnia and Herzegovina's Convertible Marka
LCR	Liquidity Coverage Ratio
LGD	Loss-Given-Default
MCO	Micro-Credit Organization
NPL	Non-Performing Loan
NSFR	Net Stable Funding Ratio
PD	Probability of default
RAM	Risk Assessment Matrix
RS	Republika Srpska
RWAs	Risk-Weighted Assets
STeM	Stress Test Matrix
TD	Top-down

EXECUTIVE SUMMARY

The stress tests focused on the banking system and covered all 27 banks operating in BiH. Top-down solvency stress tests were conducted jointly by the FSAP team and staff from the CBBH, using supervisory data provided by the banking agencies. These stress tests were complemented by bottom-up stress tests. They were conducted by individual banks using their own internal models with macroeconomic scenarios provided by the FSAP team and coordinated by both banking agencies. In addition, liquidity stress tests and contagion risk analysis, together with complementary sensitivity analysis were also carried out on all banks in the system.

Three macroeconomic scenarios were considered in the financial stability assessment. In addition to a baseline scenario, based on the latest Area Department staff projections, two alternative scenarios, one moderate and one severe, were designed to assess the stability of the banking system. Full-fledged five-year macroeconomic projections were quantified for each of these scenarios.

System-wide solvency and liquidity indicators appear broadly appropriate, but significant pockets of vulnerability remain. On the basis of the supervisory data used, stress tests suggest that aggregate stress losses, mainly related to increased provisions in the loan book, although non-negligible, remain broadly manageable. Similarly, system-wide liquidity ratios appear broadly adequate. Nevertheless, there are several banks within the system—mainly small domestically-owned banks—with a wide range of significant vulnerabilities. These include, low liquidity ratios, large concentration risks, and round-trip cross-border exposures. While these banks appear somewhat interconnected among themselves, they present low direct linkages with other banks in BiH, and therefore any potential losses are likely to have limited direct spillovers to the rest of the banking system. However, indirect contagion risks (through e.g., reputational risk), not assessed in the stress tests, could pose significant risks to the stability of the system as a whole.

Potential credit risk losses on the loan book represent the most important risk factor for the banking system. Top-down stress tests found that changes in non-performing loans (and loan category migrations) are sensitive to macroeconomic conditions. Top-down and bottom-up stress test results are broadly aligned, except for credit risk losses in the loan portfolio. Aggregate increases in non-performing loans from the top-down stress test are noticeably larger than those of the bottom-up stress tests in the most severe scenario. Although bottom-up aggregate losses tend to increase in line with the severity of the stress test scenario, the behavior of non-performing loans and loan migrations computed by some of the banks show very little reaction to the macroeconomic conditions depicted in the stress test scenarios, thus biasing aggregate results.

Concentration risks are high in specific segments of the banking sector. Although the average large exposure share at the system level remains moderate given the size of the economy, a few banks present very large single name exposures, posing significant concentration risks to these institutions. In the case of five banks, the combined amount of the two largest exposures exceeds the total regulatory capital of the bank. Overall, sensitivity analysis shows that the potential losses remain

broadly manageable at the system level, but a few banks could become insolvent if a small number of their largest exposures were to default.

Direct exchange rate risk and other sources of market risks appear to be contained. All banks comply with regulatory limits and exhibit fairly small net open FX positions. Thus the direct effects of exchange rate risks are fairly small. In fact, the net open FX positions for the different currencies reported by the banks do not necessarily move in the same direction, providing a natural hedge against currency risk. Owing to the fact that a large share of loans in BiH are de facto issued at a floating rate, the gap between assets and liabilities according to their time-to-repricing is quite small. Moreover, given the limited amount of securities on both banking and trading books, other sources of market risk appear to be contained.

However, inherent risks stemming from the presence of "unhedged borrowers" could be potentially large. Most banks do not collect any information regarding the currency denomination of their borrowers' income sources or assets. Owing to lack of data, the inherent risks related to "unhedged borrowers" could not be appropriately quantified. Data limitations, together with the absence of any historical episode of exchange rate movements against the euro, represent a major handicap in the stress test analysis. Nevertheless, indirect exchange rate risks are likely to be substantial owing to widespread issuance of foreign exchange-linked loans.

With a few exceptions, most bank liquidity positions appear to be sound. Liquidity stress tests, based on Basel III LCR and NSFR-type proxies, show that the banking system as a whole has ample liquidity, with the system-wide LCR exceeding 250 percent. Indeed, most banks exhibit sizeable amount of deposits at the central bank. However, there are a few banks that present relatively low liquidity ratios. This seems to be mainly the case among domestically-owned banks.

Contagion risks through the domestic interbank market are small, despite active overnight transactions among some banks. Based on reported data, and owing to the limited amount of domestic interbank exposures among banks (less than 1 percent of total regulatory capital), the hypothetical default of any bank in the system would not have any significant "cascade effects" on the rest of the system. However, some banks—mainly domestic-owned banks— have engaged in overnight transactions of deposits, foreign exchange, and cash in the interbank market based on bilateral agreements. Finally, contagion risks from banks to the insurance sector appear contained, and would operate mainly through deposits of insurance companies in banks.

Although in decline, banks still exhibit significant cross-border exposures. Foreign claims for BiH's banks are substantial, representing about 10 percent of total banking sector assets. Direct exposures to Austrian and German banks represent roughly half of all foreign claims. Three important types of cross-border exposures were identified. First, several foreign-owned banks benefit from credit lines from their parent companies abroad. Second, on the asset side, most banks in BiH hold large amount of deposits in their corresponding accounts abroad, mainly with large global financial institutions, for FX transaction and settlement purposes. Lastly, a few banks seem to exhibit "round-trip" cross-border exposures. Although the overall amounts are small, the banks involved in this type of transactions appear to be mainly domestically-owned banks. Furthermore, network

analysis suggests that the effects (both direct and indirect) from potential credit and funding shocks from abroad could be sizeable for the domestic banking system.

Table 1. Main Recommendations Based on the Stress Tests

Recommendation	Responsibility	Timeline
Conduct additional Asset Quality Reviews (AQR) in banks with weak solvency and liquidity indicators.	Banking agencies	Short-term
Improve modeling of credit risk losses, particularly through the computation of provisions based on "expected losses" and risk parameters (PDs, LGDs, EAD).	CBBH	Medium-term
Collect information on "unhedged borrowers."	Banking agencies	Medium-term
Fine-tune the parameters embedded in the LCR and NSFR to better reflect the specificity of the domestic banking system; in particular regarding the inclusion of "required reserves" in the HQLA.	Banking agencies	Short-term
Regular compilation of an LCR in euro.	Banking agencies	Short-term
Continue monitoring of systemic risks through periodic (at least once a year) bottom-up stress tests.	Banking agencies and CBBH	Ongoing
Monitor overnight interbank transactions, not captured in the banks' monthly supervisory report.	Banking agencies	Short-term

Notes: "short-term" denotes with within the next 12 months; "medium term" denotes 12 to 24 months.

INTRODUCTION

1. **This note discusses the stress tests that were carried out on the banking system in Bosnia and Herzegovina (BiH) as part of the 2015 Financial Sector Assessment Program (FSAP) Update.** The objective of this exercise was to assess the resilience of the banking system to major sources of risk. The stress tests were conducted in collaboration with the Central Bank of Bosnia and Herzegovina (CBBH) and the banking agencies of both entities, and complement other approaches, such as the analysis of financial indicators and the assessment of the quality of supervision.

2. **This note is structured as follows:** Section II presents a brief description of the banking sector in BiH and stress test coverage. Section III describes the macroeconomic scenarios used in the stress tests. Section IV details the different methodologies used in the solvency stress tests, whereas Section V describes the liquidity stress tests. Section VI presents the contagion and spillover risk analysis. Finally, Section VII concludes.

BANKING SYSTEM AND STRESS TEST COVERAGE

3. **The financial system in Bosnia and Herzegovina is largely dominated by the banking sector**. There are 27 licensed banks operating in Bosnia and Herzegovina (BiH), 17 in the Federation of Bosnia and Herzegovina (FBiH) and 10 in Republika Srpska (RS) (Table 3). As of end-March 2014, total banking sector assets amounted to KM 21.8bn, roughly equivalent to 86 percent of total financial system assets and close to 80 percent of GDP. Most of the banking sector (roughly 90 percent of assets) comprises of subsidiaries of foreign banks.

4. **Loans to the economy represent the largest share of the banks' balance sheet**. Gross loans account for over 70 percent of total assets in FBiH and over 65 percent in RS (Table 2). Corporate loans ("loans to legal entities")—including public sector loans—represent about half and close to 63 percent of total loans in FBiH and RS, respectively. The rest is made of retail loans, which include household loans and loans to small businesses (craftsmen). Whilst non-performing loans are higher for corporate loans compared to retail loans, sectoral concentration of loans appears broadly spread among different economic activities (Table 4). In addition, banks exhibit sizeable amounts of cash and deposits at the CBBH, whilst the trading book and holdings of securities remain limited (less than 5 percent of total assets). Domestic interbank exposures are fairly small; however foreign funding represents a noticeable share of liabilities for some banks. Finally, roughly two thirds of bank assets and liabilities denominated in foreign currency, mainly euro.

Table 2. Balance Sheet Summary of the Banking Sector
(In millions of KM unless indicated otherwise, end-March 2014)

	BiH	FBiH	RS
Number of banks	27	17	10
Total assets	22,619	15,238	7,381
Total loans	15,955	10,956	4,999
Total deposits	15,933	11,281	4,652
Total regulatory capital	2,939	2,101	838
Total risk-weighted assets (RWAs)	16,943	12,003	4,940
Capital adequacy ratio (in percent of RWAs)	17.3	17.5	17.0

Source: Authorities supervisory data and IMF staff calculations.

5. **The stress tests covered all 27 banks in the banking system**. The top-down stress tests were conducted jointly by the FSAP team and the staff at the CBBH to assess the solvency of the entire banking system. These top-down stress tests relied on bank-by-bank supervisory data provided by the authorities,[1] as of March 31, 2014.[2] In addition, top-down stress tests were

[1] Evidently, the accuracy and validity of the stress test assessment depends directly on the quality of reported data, and how well the latter depicts the economic reality of the banks' balance sheet.

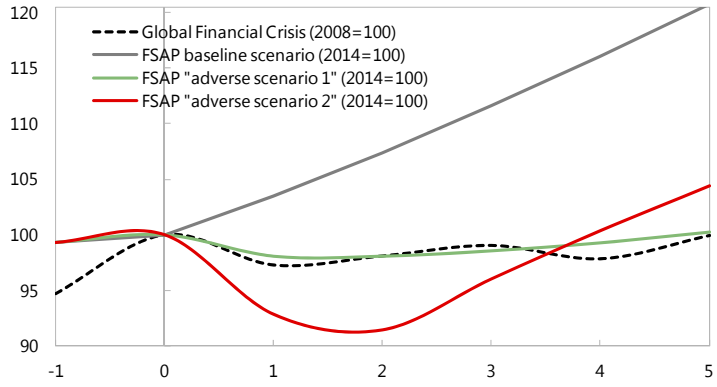
[2] Several banks in BiH were subject to comprehensive AQRs in recent months. However, balance sheet data as of March 31, 2014, still did not reflect the results from these AQRs. Box 2 presents the analysis of the impact of these AQRs on the stress tests results, which is found to be rather small at the system level.

complemented by individual bottom-up stress tests conducted by all 27 banks, using their own internal models and based on the macroeconomic scenarios provided by the FSAP team. The bottom-up stress tests were coordinated by the two banking agencies for the banks operating in their respective entities. Liquidity stress tests were also conducted for all the banks operating in BiH. Finally, the spillover and contagion risk assessment encompassed the entire banking system, and was supplemented with further analysis that included inter-linkages with the insurance sector, development banks, and other financial institutions.

MACROECONOMIC SCENARIOS

6. **Stress tests were based on the use of full-fledged macroeconomic scenarios.** To assess the solvency of the banking sector, three different macroeconomic scenarios were considered—one baseline and two alternative scenarios. Each scenario involved the projections of a large number of macroeconomic and financial variables over the period 2015-2019. The baseline scenario used the projections generated by the IMF area department team, established as part of their continuous monitoring of the economy in BiH. Two alternative scenarios were then developed by the FSAP team and the authorities, to test the resilience of the banking sector in the presence of adverse shocks. The real GDP projections under each of these scenarios and their relative severity are summarized in Figure 1. The two adverse scenarios include:[3]

Figure 1. Evolution of the Level of Real GDP in the Stress Test Scenarios



Source: IMF staff calculations.

- ***Adverse Scenario 1*:** a moderate adverse scenario that illustrates an external shock driven mainly by a further weakening in the economic outlook of euro area countries, combined with a further deterioration of the current geopolitical crisis in Ukraine.

- ***Adverse Scenario 2*:** the severe adverse scenario, the external risks described in the moderate scenario are accompanied by a severe reduction in external funding for banks (mainly through the removal of support of parent banks to their local subsidiaries), compound with a further deterioration in the health of commercial banks and loss of confidence.[4]

[3] The moderate adverse scenario relates to Risks #1 and 2 identified in the RAM; whilst the most severe adverse scenario relates to all three, Risks # 1, 2, 3, and 4 in the RAM (Appendix I).

[4] Although qualitatively we assign a very small probability to this scenario, it is considered within the stress test, to assess the stability of the banking system in the eventual case that a tail-risk event would materialize.

7. **The projections under each of these scenarios were based on satellite models.** Following the identification of broad macroeconomic risks, derived from the Risk Assessment Matrix (RAM), these risks were translated into quantitative macroeconomic scenarios. Broadly speaking, the quantification of these scenarios entailed the projection of macroeconomic and financial variables—such as real GDP, CPI inflation, (short and long-term) interest rates, exchange rates (e.g., against the USD), unemployment rate, real estate prices, equity price index, and credit growth, among others—in a consistent manner, over the stress test horizon.[5] The full-fledged numerical representation of these macroeconomic scenarios appears in Table 5.

Behavioral assumptions

8. **Stress tests were conducted under the constant balance sheet assumption.** Stress tests usually exhibit limited flexibility in terms of management actions under stress conditions. This ensures that all the banks in the system are assessed in a consistent manner, and only based on their existing assets and liabilities, thus enabling the comparison of stress test results across different banks. In addition, some items necessitate specific and clear assumptions about their evolution, which are incorporated by banks on their own internal models for the bottom-up stress tests. For instance, some of the main behavioral assumptions include: RWAs will remain constant at their pre-shock level; banks are not allowed to raise fresh capital from existing shareholders or the market; apart from changes in the ratio of non-performing loans, the composition of the loan book will remain unchanged; and loan write-offs are not allowed.

9. **No specific managerial action would be allowed in the stress tests.** Optimization of bank portfolios (both banking and trading books) is not allowed, and the balance sheet positions in every year of the stress test horizon should only reflect the initial position of the portfolios and the effects of the different stress test shocks. Taxes were assumed to be paid at a fixed rate (11.5 percent) on positive net profits, whilst dividend payouts would represent a fixed share of after-tax-profits (50 percent), provided that the regulatory capital ratio of the bank in question exceeds a predetermined threshold.[6]

10. **Other relevant income items are to be estimated as a function of the macroeconomic scenarios.** There are several other net income items which might have a significant income on bank capitalization. These include net fees and commissions, and operating expenses such as wages and salaries, rental income, and sale of fixed assets, among others.[7] When relevant these income items were modeled as a function of the macroeconomic variables included in the stress test scenarios, based on expert judgment and historical trends. Other sources of income or losses, such as potential losses due to legal cases (not related to the execution of collateral from non-performing loans), were not to be taken into account.

[5] The link between the different macroeconomic variables within the stress test scenarios was established based on both historical relations and "expert judgment."

[6] In this case, banks should be allowed to pay dividends only when their CAR exceeds 14.5 percent.

[7] Note that net interest income, which is one of the most important sources of income for the banks in BiH, is dealt with separately in the "interest rate risk" section. The same applies for the calculation of "operational risk" losses.

SOLVENCY STRESS TEST

11. **The FSAP stress tests covered the main risks faced by the banking sector.** The solvency stress tests involved a very extensive coverage of risks factors (see STeM in Appendix II), these include: credit risk, in both the loan book and fixed income (debt instrument) holdings (i.e., "issuer default risk"); market risk, through the analysis of interest and exchange rate risks; risks related to equity instrument holdings; concentration risk; operational risk; and contagion risk through interbank exposures and real sector exposures, both domestic and foreign.

A. Credit Risk

Credit Risk in the Loan Book

12. **Credit risk in the loan book represents the most important risk factor for the banking system.** Loans to the economy represent more than two thirds of total banking sector assets. System-wide NPLs stood at 15 percent of total loans at end-March 2014, and the ratio is even higher for loans issued to the private corporate sector.

13. **Following a large body of theoretical and empirical literature, credit risk measures were modeled as a function of a set of macroeconomic variables.** Owing to lack of data relating to risks parameters such as default probabilities (PDs) and loss-given-default (LGDs) for most banks, the ratio of NPLs (in percent of total loans) was used to assess credit risk in the loan portfolio. Losses related to credit risk were then computed based on the increase in provisions implied by the loan migration associated to the increase in NPLs under stress.[8] The NPL-ratio was modeled as a function of the macroeconomic variables that featured in the stress test scenarios. To ensure that the model only produces predictions for the NPL-ratio between 0 and 1 (equivalently, between 0 and 100 percent), the following logit transformation is applied to the original NPL-ratio:

$$Y = \ln\left(\frac{\text{NPL}}{1-\text{NPL}}\right) \qquad [1]$$

This logit transformation is then assumed to be a linear function of the different (exogenous) macroeconomic factors mentioned above. The estimation model can be expressed as:

$$Y_{i,t} = \alpha + \boldsymbol{\beta}\boldsymbol{X}_t + \mu_i + \epsilon_{i,t} \qquad \text{for } t = 1, \dots, T \quad \text{and } i = 1, \dots, N \qquad [2]$$

where $Y_{i,t}$ is the logit transform of the NPL-ratio for bank i at time t, $\boldsymbol{X}_t$ is a vector of macroeconomic variables,[9] μ_i is the individual banks fixed effects, $\epsilon_{i,t}$ is a well-behaved error-term, and α and the vector $\boldsymbol{\beta}$ are parameters to be estimated. Overall, the NPL-ratio under stress was computed at every point in time t as:

[8] This framework explicitly models the behavior of NPLs, i.e., loans classified in categories C, D and E ("substandard," "doubtful," and "compromised (losses)," respectively) together. In addition, the stress test assumes that the proportion of loans classified in each of these three (non-performing) categories remains the same before and after the shock.

[9] In the case of BiH banks, only real GDP growth and the short-term interest rate were found to have a meaningful impact on the NPL ratio. Given that the currency board has been in place throughout the estimation period, the statistical impact of the exchange rate on the NPL ratio cannot be assessed within this framework.

$$NPL_t^{stress} = \left(\frac{NPL_{t-1}}{1-NPL_{t-1}}\right) exp\{\boldsymbol{\beta}\, \Delta \boldsymbol{X}_t\} \,/\, \left[1 + \left(\frac{NPL_{t-1}}{1-NPL_{t-1}}\right) exp\{\boldsymbol{\beta}\, \Delta \boldsymbol{X}_t\}\right] \quad [3]$$

14. **Equation [2] was estimated using annual data over the period 1999-2013.** Data on NPLs were available at an annual frequency, and were disaggregated along 13 different economic sectors, and by type of currency (KM, EUR, and "other currencies"). However, most of the estimations were derived from the overall NPL series at the individual bank level. Among the main macroeconomic variables, real GDP growth and the (short-term) interest rates were found to be the main drivers of NPLs. The resulting coefficients for the effects of these two macroeconomic variables on the logit transform of the NPL-ratio were found to be -0.15 and 0.05, respectively. In other words, real GDP growth was found to have a negative and significant effect on credit risk, that is, when economic activity increases, the NPL-ratio decreases as expected. Likewise, an increase in the interest rate leads to an increase in the NPL-ratio. Similar results were obtained using slightly different specifications of equation [2].

15. **Potential credit risk losses on the loan book represent the largest vulnerability of the banking sector.** Top-down stress tests suggest that banks are likely to experience large increase in NPLs under the adverse scenarios (Table 8). In particular, asset quality in the loan book appears to be highly sensitive to changes in economic conditions. These credit risk losses on the loan book range from KM 545mn in "Adverse Scenario 1" to KM 2,019mn in "Adverse Scenario 2," equivalent to 2 and 7 percent of GDP, respectively (Table 6). Furthermore, these credit risk losses appear to be evenly distributed among the banking systems in both entities given the relative size of their respective loan book (Table 7). Finally, these losses highly depend on the quality of supervisory data—reported by the banks—related to initial loan classification and provisioning. Thus, actual economic losses could be potentially even higher than those implied by the supervisory data.[10]

16. **Inherent risk stemming from "unhedged borrowers" difficult to quantity, but could be potentially large.** Roughly two thirds of all loans issues by the banks in BiH are FX-indexed loans. Although the exact numbers are not available,[11] it is widely thought that a large portion of borrowers of FX-linked loans do not receive any income nor possess assets denominated in euros. This is particularly the case for retail borrowers whose main source of income is denominated in domestic currency. In the eventual (and unlikely) case in which there would be a depreciation of the domestic currency vis-à-vis of the euro, the large presence of these "unhedged borrowers" could lead to a sharp deterioration of the loan portfolio in the entire banking system.

17. **Top-down credit risk losses on the loan book are larger than the bottom-up losses estimated by the banks (Figure 8)**. In general, the implied increases in aggregate NPLs from the

[10] On-site inspections often find several irregularities in banks reporting. These include: incorrectly classified loans, inadequate provisions, exceeding lending limits because "connectedness" was not properly identified, and also issuance of new loans to repay existing loans. See the BCP assessment for details.

[11] The authorities (banking agencies and the CBBH) as well as the vast majority of banks do not collect any information regarding "unhedged borrowers."

top-down stress test are noticeably larger than those of the bottom-up stress tests (Table 8). The differences appear to be evenly distributed among those loans denominated in domestic and foreign currencies, where top-down results call for a significantly larger amount of provisions for impaired loans. That said, although the sensitivities tend to be lower than those estimated in the top-down stress tests, bottom-up losses tend to increase in tandem with a deterioration of the overall economic outlook, as expected. However, in a few cases, the NPLs computed by the banks show very little reaction to the macroeconomic conditions depicted in the stress tests scenarios, which seems less plausible.

Debt Instruments Risk

18. **Stress tests also included an assessment of credit risk on fixed income holdings.** In addition to testing for credit risk related losses on the loan book, both bottom-up and top-down stress tests should entail the computation of expected losses on debt instrument holdings in the banking book. Credit risk losses on these holdings derive from the potential default by the issuer of these instruments in the stress scenarios. Box 1 describes the methodology that could be used in the top-down stress tests to estimate such losses. These debt instrument holdings include domestic government bonds, corporate bonds, and other domestic debts instruments in hold-to-maturity (HTM) portfolios. Note that expected losses on holdings related to other risk factors (such as valuation changes due to interest or exchange rate movements) in HFT and AFS portfolios (trading book) were treated separately, and are described in the "Market Risk" section.

19. **Banking sector exposure to fixed income instruments remains limited.** Owing to their limited exposure regarding debt instruments, the expected losses from the implicit increase in the credit spreads of these debt instruments' issuers are relatively small (Tables 6 and 7). Government bonds represent almost all of these holdings.[12] Therefore, these losses can be perceived mainly as the result from an increase in the probability of sovereign distress when the overall macroeconomic outlook deteriorates. The more severe the negative economic shock, the higher this probability, and thus the higher the expected losses. However, potential losses from these portfolios remain dwarfed by the estimated stress losses in the loan book.

B. Market Risk

20. **Stress tests also assessed the resilience of banks when facing different sources of market risk.** In addition to credit risk related losses, banks can experience important losses due to changes in market variables (for instance, interest rates, exchange rates, stock prices, etc). These losses, or gains, might be due to the existence of "open positions" in the banks' balance sheets (due to e.g., currency, maturity, time-to-repricing mismatches between assets and liabilities) or to valuation changes in the different securities (AFS and HFT) held by the banks. Given that banks in BiH

[12] Basically, government bond holdings represent 100 percent of the domestic fixed income (HTM) holdings of the banks in FBiH, whilst the banks in RS exhibit a share of 97 percent for government bonds and 3 percent for corporate bonds.

do not hold large amount securities for trading purposes, interest and exchange rate risks were found to be the main two market risks included in the stress tests. Losses associated to equity investments are dealt with separately in the next section.

Interest Rate Risk

21. **Part of the impact of interest rate risk was assessed using time-to-repricing buckets.** Different interest rate sensitive assets and liabilities are to be lumped together in different buckets depending on their time-to-repricing. For instance, a loan and a deposit whose effective interest rate can change within the next month would be placed in the same bucket; their difference would represent the "time-to-repricing gap."[13] The expected losses – or gains – on interest income are to be simply computed as the product of this gap and the changes in the interest rate. This particular analysis only deals with the direct effects of interest rate risk. Indirect effects, that is, through credit risk and their effect on asset quality in the loan portfolio, were dealt with in the credit risk section. Nevertheless, expected interest income losses related to the increase in non-performing loans (as the latter are assumed to default on their interest payment obligations) were added to net interest income, on top of the direct interest rate impact based on the time-to-repricing gaps.

22. **Potential losses on interest income are small owing to the widespread use of floating rate loans.** Given that a large share of the banks' lending book is made of floating (i.e., variable) rate loans, the time-to-repricing gaps are fairly small. Moreover, 53 percent of interest rate sensitive assets[14] and 56 percent of interest sensitive liabilities exhibit a time-to-repricing lower than three months. In fact, some banks even exhibit some positive, albeit relatively small, time-to-repricing gap (i.e., assets can be repriced faster than liabilities), enabling them to make some moderate interest income gains when interest rates rise. Overall, net interest margins appear to be relatively large in BiH, and banks are able to generate sizeable amount of profits related to net interest income throughout the different stress test scenarios (Tables 6 and 7). Further sensitivity tests show that the direct effect of a larger increase in interest rates on the banking sector capitalization remains fairly small. In fact, in that case, most banks would generate some small net income gains.[15]

[13] Data were available for the following time-to-repricing buckets: less than 3 months; 3 to 6 months; 6 to 12 months; 12 to 24 months; 24 to 36 months; and more than 36 months. Conservatively, the largest net losses on any gap with a time-to-repricing less than 12 months were considered as representing the "instantaneous loss" due to the interest rate shock in the first year (2015), whilst the amount related to the "more than 36 months" gap was split evenly among the years 2018 and 2019.

[14] The share of interest rate sensitive assets with time-to-repricing less than three months is 61 percent and 36 percent for the banks in FBiH and RS, respectively.

[15] An interest rate increase of 5 percentage points would lead to an increase in the system-wide CAR from 17.3 percent to 17.4 percent. Likewise, an increase in interest rates of 10 percent would lead to an increase in the system-wide CAR from 17.3 percent to 17.6 percent.

Box 1. Computation of Potential Losses due to Debt Instruments Risk

For sovereign bond holdings in the banking book (HTM) there is an implied expected loss, which—in principle—should be covered by provisions. In order to estimate this expected loss, the corresponding risk parameters (PD, LGD, and EAD) need to be estimated.

First, if the rating for the sovereign is available from one of the main rating agencies (e.g., Moody's, S&P or Fitch), then such rating should be used to determine the corresponding default probability of the sovereign. Usually, mapping tables are available, enabling the conversion of a given rating into expected default probabilities over a given period of time. The implied default probability obtained this way represents the level that would be taken as a starting point in the FSAP stress test (call it,PD_0).

Then, based on panel regression analysis,[1] the following elasticity was estimated:

$$\gamma = \frac{\Delta logit(PD_t)}{\Delta drgdp_t}$$

Where $drgdp_t$ is the year-on-year growth rate of real GDP, and logit denotes the logistic transform. The above expression can thus be rearranged as:

$$PD_t = \frac{\left(\frac{PD_{t-1}}{1-PD_{t-1}}\right) \cdot \exp\{\gamma\, \Delta drgdp_t\}}{1 + \left(\frac{PD_{t-1}}{1-PD_{t-1}}\right) \cdot \exp\{\gamma\, \Delta drgdp_t\}}$$

Hence, based on the above elasticity and the changes in real GDP growth under each scenario, the implied probability of default for the sovereign can computed. In addition, if no historical evidence of an actual technical default is available, the recovery rate (36 percent) that features in the World Bank's *Doing Business Report* for Bosnia and Herzegovina can be used as a proxy for LGD in the stress tests.

Regarding expected losses due to issuer risk for corporate bond holdings, the same methodology can be used. In the absence of corporate ratings, the stress tests would assume that corporate sector ratings are the same as that of the sovereign. Using the same elasticity γ above, the corporate default probabilities can be obtained for the different scenarios. In terms of LGD, the latter would be again based on the latest *Doing Business Report* from the World Bank.

[1] This includes a sample of 117 countries with a total of 2120 observations. Panel fixed effects were used for the estimation of γ. This elasticity γ was estimated to be -0.088792.

23. **Interest rate risk through valuation effects on debt instrument holding was also assessed.** The other potential sources of gains or losses related to changes in interest rates are valuation changes on government and corporate bond holdings in AFS and HFT portfolios, as well as foreign bond holdings (which are all marked-to-market). First, the duration of each of these holdings is computed.[16] Second, for each portfolio, the average duration is calculated as the weighted average of the individual durations weighted by the amount (in KM) of each individual bond holding. Finally,

[16] The Macaulay duration is the weighted average term-to-maturity of the cash flows from a bond. Its computation depends on the maturity date, annual yield, and periodic coupon payment and frequency (if applicable).

the expected gains or losses due to valuation changes are computed as the product of the size of the bond portfolio, its average duration, and the change in the relevant interest rate (i.e., the bond yield). An increase in interest rates translates into a valuation loss in the bond portfolio, and vice versa.

24. **Potential valuation losses on fixed income instruments remain limited.** Owing to their limited exposure regarding debt instruments, the implied valuation changes in the adverse scenarios are relatively small, particularly when compared to credit risk losses (Table 6). Banks do not hold any domestic corporate debt instrument for trading purposes; the vast majority of domestic government bonds are held on an AFS basis. Additional sensitivity analysis also confirms the small effect of direct sovereign risk on the banks' balance sheet.[17] In terms of foreign bond holdings, the estimated losses are evenly spread among all three (HTM, HFT, and AFS) portfolios. However, the latter remain rather small.

Exchange rate risk

25. **The direct effects of exchange rate risks were assessed based on the banks net open FX positions.** Data on net open FX positions were available by currency along the following six categories: USD, EUR, CHF, HRK, RSD, and "other currencies."[18] The implied gains or losses on these positions were computed as the product of the net open position and the expected depreciation of the corresponding currency in each of the scenarios.[19] Note that this section only deals with the direct effects of exchange rate risk, as the indirect effects of exchange rate risk (i.e., through credit risk) could not be adequately quantified within the credit risk section. However, the potential indirect effects of credit risk are likely to be significant for the loan book, given widespread issuance of FX-linked loans.

26. **Most banks tend to exhibit small net open FX positions, limiting potential losses.** In addition to the existing regulatory limits,[20] bank risk managers in Bosnia and Herzegovina tend to aim at keeping their net open FX positions (excluding EUR) close to "zero." Therefore, the implied gains or losses due to exchange rate risk remain small, despite the generalized depreciation of the local currency (against a number of currencies) in the adverse stress test scenarios (Tables 6 and 7). Given that all the macroeconomic scenarios assume no movement of the domestic currency vis-à-vis the euro—based on the existing currency board arrangement—and that the vast majority

[17] Total holdings of government bonds (HTM, AFS, and HFT) represent close to 2 percent of total assets. Thus, even under an extreme hypothetical scenario which assumes a 50 percent loss (haircut) on these holdings would imply a fall in the system-wide CAR from 17.3 percent to 16 percent, with recapitalization needs of around BAM 20mn (less than 0.1 percent of GDP).

[18] The amount included in the "other currencies" category is small, with the corresponding position representing around only 2 percent of the banks' total FX positions.

[19] Explicit exchange rate paths for the USD, EUR, HRK, and RSD exchange rates (against the BAM) were provided in all four stress test macroeconomic scenarios. For "other currencies," the path for the NEER was used.

[20] Net open FX positions are capped at 30 percent of capital for EUR, and 20 percent of capital for the aggregate of all other currencies.

(93 percent) of the banks' net open FX position relate to EUR,[21] the macroeconomic scenario-based stress tests were supplemented with additional sensitivity analysis, following standard IMF practices. Sensitivity tests assuming a hypothetical 30 percent depreciation of the local currency against the euro show that the effect on the banking sector capitalization is fairly small. In fact, most banks exhibit a positive—albeit small—net open EUR position (i.e., banks are "long EUR"), and thus would make slight gains from the hypothetical depreciation of the domestic currency against the euro.[22]

27. **Market risk losses are broadly in line in both top-down and bottom-up stress tests.** Unlike the estimated credit risk losses on the loan book, losses related to market risk factors are roughly similar in the top-down and bottom-up stress tests. In particular, the two set of stress tests produce very similar estimates of net interest income, which represent most of the net gains throughout all stress test scenarios (Figure 8). Most of the small differences in the estimated market risk losses are mainly explained by the way in which individual banks translated the macroeconomic scenarios into effective risk parameters used in their stress tests.

C. Risks Associated to Equity Instrument Holdings

28. **Expected losses on equity instruments can derive from two main sources or risk: credit and market risks.** On the one hand, equity losses may relate to potential bankruptcies of the companies in which banks have invested. These credit risk losses on equity investments could materialize, for instance, when one of the (non-financial) companies in which a bank has invested goes bankrupt. Whereas, on the other hand, market risk losses on equity instruments may relate to changes in their market prices and volatilities. Thus, conceptually, potential losses on equity instruments could be treated in the same way as debt instrument holdings, and could be separated in both credit risk and market risk-related losses. Losses due to potential corporate bankruptcies arising in each of the stress test scenarios were computed using the same PDs and LGDs as those used for corporate bond holdings in the HTM portfolio (using the methodology described in Box 1). In contrast, market risk losses on equity investments are simply computed as the product of the actual amount held and the percent change in equity prices.

29. **Equity related losses remain small, owing to the banks' limited exposure to equity instruments.** Total equity holdings amount to less than 1 percent of total assets in the banking system. In fact, supervisory data shows that some banks have no equity investments at all on their balance sheet. Consequently, the potential losses derived from these equity instrument exposures are relatively small despite the severity of the stress test scenarios (Tables 6 and 7).

[21] The net open position in EUR represents 87 percent and 96 percent of the total net open FX position of the banks in FBiH and RS, respectively.

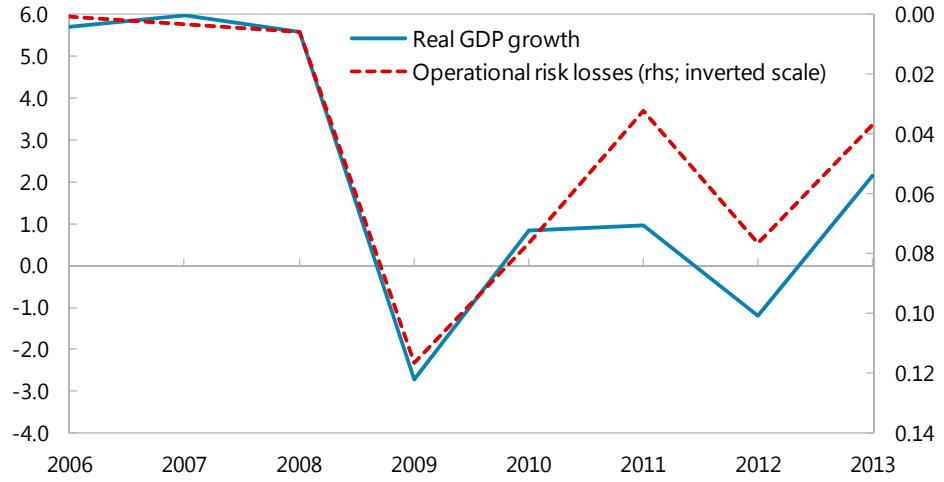
[22] Under the assumption of a 30 percent depreciation of the domestic currency against the euro, the system-wide capital ratio would increase slightly, from 17.3 percent to 17.6 percent.

D. Operational Risk

30. **Operational risk losses were computed as a direct function of the macroeconomic scenarios.** Data on actual historical losses due to operational risk are available on an annual basis for all 27 banks operating in BiH, over the period 2006–2013. These operational risk losses relate to items such as internal and external fraud; business disruptions; business disruption and system failures; damage to physical assets; execution, delivery and process management; among others. Incidentally, these losses seem to correlate well with macroeconomic conditions, in particular, real GDP growth (Figure 2). The relationship between the ratio of operational risk losses to total assets and real GDP growth was quantified using simple regression analysis.[23]

31. **Overall, operational risk losses could be sizeable in the adverse stress test scenarios.** Although operational risk losses are smaller than potential credit risk losses, or even the gains due to net interest income, the former could still be sizeable. Indeed, estimated operational risk losses in the top-down stress test represent close to 12 percent of total net losses in the adverse scenarios (Table 7). Despite the strong correlation with past macroeconomic conditions, operational risk losses could, in reality, prove difficult to predict. Thus banks should continuously improve their internal operating and monitoring systems, to mitigate the possibility of large operational risk losses occurring.

Figure 2. Relationship Between Real GDP Growth and Operational Risk Losses
(In percent change, and in percent of total assets, respectively)



Sources: Authorities supervisory data and IMF staff calculations.

[23] The elasticity of the logit transformation of operational risk losses (in percent of total assets) and real GDP growth was found to be -0.46. The ratio of operational risk losses to total assets under stress was computed using a similar model to that described in equation [3] for the NPL ratio.

E. Concentration Risk

32. **Name concentration risk was tested by assessing the impact of the default of the largest exposures.** Supervisory data on the largest bank exposures and their corresponding collateral were used to perform this sensitivity analysis-type of stress test. The test assesses the impact of the hypothetical default of the largest *N* borrowers, and computes the implied losses for various assumptions on the recovery rate. In our central case, we used a recovery rate of 36 percent (based on the latest World Bank "Doing Business" report), but alternative assumptions were also used (Table 9).

33. **Credit concentration remains one of the largest risks in some segments of the banking system.** A few banks in the system exhibit very large single name exposures, posing significant concentration risks. On average, the relative size of the single largest exposure of the banks in BiH is around 33 percent of total regulatory capital.[24] Indeed, several banks on both entities contravene the regulatory requirement in terms of largest exposure size.[25] Furthermore, there is a wide dispersion among different banks, where the largest exposure ranges from 10 percent to an astonishing 156 percent of capital. In other words, these risks seem to be concentrated within a few banks, and are particularly acute amongst domestically-owned banks.[26]

34. **Overall, the potential losses at the system level seem to be broadly manageable.** The default by the largest exposure of each bank in the system would imply a capital shortfall of around KM 91mn (0.3 percent of GDP). Even under the most extreme case scenario, with a simultaneous default by the five largest exposures of each bank in BiH and assuming a "zero" recovery rate, seven banks would become insolvent, and the total capital shortfall would be around KM 1,094mn (3.8 percent of GDP), with broadly half of the losses coming from the banking sectors in each entity (Table 9). Nevertheless, despite the significant name concentration on the banking sector in BiH, sector concentration appears to be relatively low. Indeed, the loan portfolio of the banking sector seems to be broadly spread among different economic activity sectors (Table 4).

F. Impact of Asset Quality Reviews (AQRs)

35. **The asset quality reviews conducted so far entail a rather small impact on the banking system's capitalization.** Several banks operating in BiH were subject to comprehensive AQRs in recent month. However, at the time of the FSAP, only the results for the banks in FBiH were known. Although these AQRs would imply a capital ratio below the regulatory minimum for three banks in FBiH, the implied capital shortfalls are fairly small, and would not alter the main stress test results in any meaningful way (Box 2). Nevertheless, future AQRs – including those already conducted in RS, but whose results are yet to be known – could have a more significant impact if capital deductions

[24] The relative size of the single largest exposure is around 29 percent and 41 percent of total regulatory for the banks in FBIH and RS, respectively.

[25] The existing regulatory framework limits the largest single exposure to 25 percent of the bank's core capital.

[26] These exposures mainly relate to loans issued by several banks to a few large state-owned enterprises.

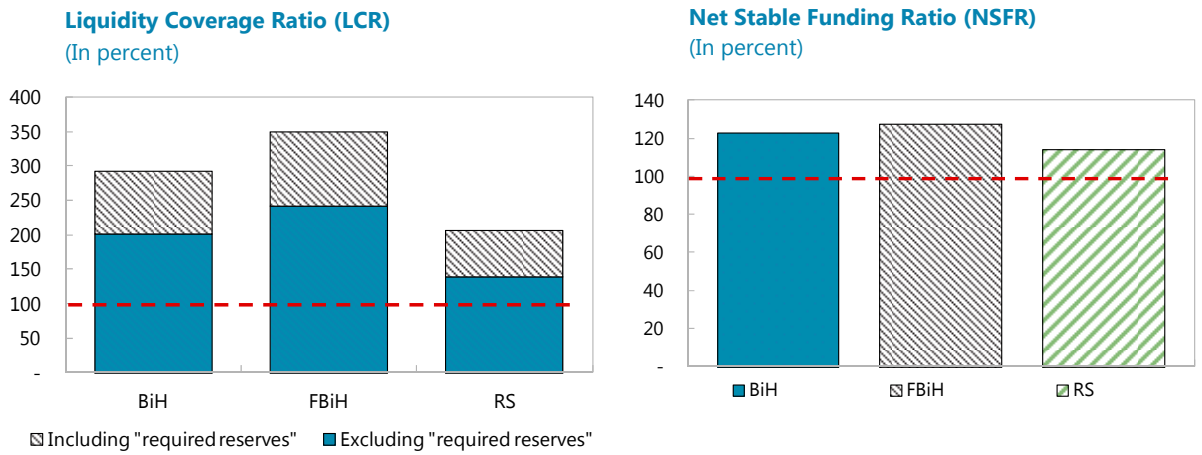
were found to be larger. In particular, potential AQRs in a few medium-to-large size banks could have noticeable consequences for system-wide capitalization levels.

LIQUIDITY STRESS TEST

36. **Liquidity stress tests will be based mainly on Basel III LCR and NSFR-type proxies (Appendix II)**. The main liquidity indicators are based on the "stressed" LCR and NSFR rooted in Basel III. Owing to the lack of data on specific experiences historically observed in the country, the assumed potential run-off rates and haircuts were based on the suggested assumptions embedded in BCBS documentation regarding these two liquidity ratios.[27]

37. **The LCR measures the banks' potential net outflows over the next 30 days, and the counterbalancing capacity of the banks to be able to cover these potential outflows.** The counterbalancing capacity is essentially the amount of available high quality liquid assets (HQLA). Banks should maintain an LCR above 100 percent. Specific deposit run-off rates and asset haircuts are included to emulate stress conditions.

Figure 3. Liquidity Stress Tests Results



Sources: Authorities supervisory data and IMF Staff Calculations.

[27] See "The LCR and liquidity risk monitoring" by the BCBS (2013), and "The NSFR" by the BCBS (2014), for details on the assumptions used in these two ratios.

Box 2. Impact of the Recent AQRs on Stress Test Results

Several banks in BiH were subject to comprehensive AQRs in the first half of 2014. These AQRs were based on balance sheet data as of December 31, 2013. At the time of the FSAP (November 2014), the main results from these AQRs were already known for the banks in FBiH, but not for the banks in RS which were subject to the AQR. Nevertheless, both top-down and bottom-up stress tests were based on supervisory data as of March 31, 2014, which did not incorporate the results from these AQRs.

In order to assess the impact of the AQRs on the stress tests and, more generally, on the system capitalization, the implied net capital deductions based on these AQRs were deducted from the reported regulatory capital at end-March 2014 (see table below).

Impact of the AQRs on the Banking System in FBiH

(In millions of KM unless indicated otherwise)

	Data as of Mar 31, 2014		Data as of Sep 30, 2014
	reported data	**"AQR-adjusted"**	**reported data**
Total regulatory capital	2,101	2,079	2,100
Total risk-weighted assets	12,003	12,003	12,214
CAR (in percent of RWAs)	**17.5**	**17.3**	**17.2**
No. of banks with a CAR below 12 percent	1	3	1
Implied capital shorfall 1/	0.4	14.3	7.5

1/ The "implied capital shortfall" is the amount of system wide recapitalization needs so that the CAR of each bank is equal or above 12 percent.

Overall, the total capital deductions from these AQRs amounted to around KM 22.2mn for the banks in FBiH. This would have resulted in a slight fall in the overall capital ratio in FBiH from 17.5 percent to 17.3 percent, and an implied capital shortfall of only KM 14.3mn (0.05 percent of GDP) at end-March 2014. Furthermore, subsequent recapitalizations have taken place in some of those banks following the AQRs. Thus, only one bank reported a capital ratio below 12 percent at end-September 2014, with a resulting capital shortfall of KM 7.5mn (0.03 percent of GDP).

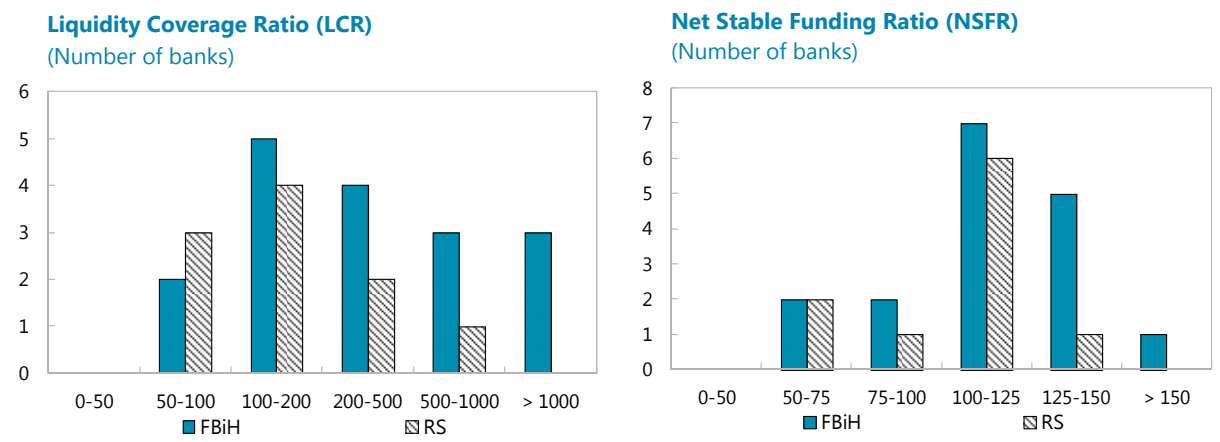
Given that the amounts involved are dwarfed compared to the overall capital shortfalls estimated in the stress tests (around KM 1,148mn in the most severe scenario), the AQR results do not affect the stress test results in any meaningful way. The only minute difference would be the undercapitalization of a small bank in the baseline and moderately adverse scenarios. Therefore, the main conclusions from the stress tests remain unchanged when the results from these AQRs are taken into account. Nevertheless, subsequent AQRs might have important consequences for the system's capitalization if the capital deductions in those AQRs turn out to be much larger than in those conducted to date.

38. **The NSFR measures the aptitude of banks to fund their activities with sufficiently stable sources of funding.** The NSFR is defined as the ratio of available stable funding over the amount of required stable funding. Essentially, the amount of required stable funding is computed as the weighted average of a bank's assets, using predetermined weights defined in BCBS documentation. This ratio should be equal to at least 100 percent on an ongoing basis.

39. **Overall, system-wide liquidity appears to be broadly appropriate.** Liquidity stress test results suggest that aggregate LCR is quite high, at around 292 percent for the entire system in BiH. Regarding the individual entities banking systems, their corresponding LCR is 349 percent and 205 percent of the banks in FBiH and RS, respectively (Figure 3). These high system-wide LCR ratios observed in the banking system are mainly driven by large amount of deposits at the CBBH. Indeed, bank deposits at the central bank represent around 76 percent of the banks' HQLA, of which roughly 40 percent are "required reserves." If these required reserves were to be excluded from the banks' HQLA, the system-wide LCR ratio would fall to around 200 percent for the banking sector as a whole, which is still relatively high. Likewise, the system-wide NFSR is around 123 percent for the banking sector as a whole, and around 127 percent and 114 percent for the banking systems in FBiH and RS, respectively (Table 10).

40. **However, a few banks in both entities exhibit significant vulnerabilities to liquidity risk.** Indeed, system-wide liquidity ratios mask important difference across the individual banks liquidity positions. In particular, the smaller mainly domestically-owned bank exhibit much lower liquidity ratios compared to their peers. Furthermore, this seems to be the case for the banking sectors in both entities (Figure 4). Overall, five banks (two from FBiH and three from RS) exhibit an LCR below 100 percent, whilst seven banks (four from FBiH and three from RS) present and NSFR below 100 percent.[28] Furthermore, the shallow interbank-market (see next section) exacerbates the liquidity risks, as banks with excess liquidity are usually not interested in lending to other banks on the interbank market.

Figure 4. Distribution of Liquidity Ratios Across Banks



Sources: Authorities supervisory data and IMF staff calculations.

[28] The overall potential "liquidity shortfall" implied by the LCR would be around BAM 70mn (0.2 percent of GDP), whilst that implied by the NSFR would be close to BAM 323mn (1.1 percent of GDP).

CONTAGION RISKS AND SPILLOVER ANALYSIS

41. **Contagion risks from cross-border linkages and domestic financial interconnectedness are assessed using network analysis.** Inward spillovers from foreign financial systems could pose significant systemic risks to the domestic banking system, mainly due to large foreign claims roughly equivalent to 10 percent of total banking sector assets. In addition, leaving development banks aside, the interlinkages between banking and insurance sectors represent the largest potential contagion risk within the domestic financial system (Figure 5). This section relies on network analysis to assess these two contagion risks, by simulating credit and funding shocks on each bank in BiH coming from the banking systems of relevant countries to which BiH is exposed. The credit shock assumes the hypothetical default of a financial institution such as a bank or a foreign banking system, whereas the funding shock assumes that the default of a given financial institution leads to a liquidity squeeze for other financial institutions funded by the defaulting institution. The analysis captures not only the direct contagion from one financial institution to another, triggered by hypothetical credit and funding shocks, but also the indirect contagion through other (intermediate) financial institutions (i.e., "cascade effects").

A. Cross-Border Contagion Risk

42. **Although in decline, cross-border spillovers to BiH's banks are still significant and could be transmitted through many channels.** BiH banks' foreign claims are substantial, standing at KM 2,146mn (about 10 percent of banks' total assets) as of March 31, 2014.[29] Direct exposures to Austrian and German banks represent roughly half of all foreign claims. Thus, a large shock to a country to which BiH banks have significant exposures can have both direct and indirect spillover effects ("cascade effects") through BiH's financial system as well as foreign financial systems.

43. **Three important types of cross-border exposures were identified.** First, several foreign-owned banks benefit from credit lines from their parent companies abroad. Although still sizeable, these exposures are decreasing over time, as foreign-owned banks are now relying more on domestic sources of funding. Second, on the asset side, most banks in BiH hold large amount of deposits in their corresponding accounts abroad, mainly with large global financial institutions, for FX transaction and settlement purposes. Lastly, a few banks seem to exhibit "round-trip" cross-border exposures, where both claims and liabilities to a particular counterpart (often in neighboring countries) are roughly of the same amount.[30] Although the overall amounts are very small, the banks involved in this type of transactions appear to be mainly domestically-owned banks.

44. **Network analysis was used to identify key systematically important banking systems for BiH's banking system.** The methodology is based on Espinosa-Vega and Solé (2010), which

[29] Over 75 percent of these foreign claims are on foreign banking systems, mainly deposits in foreign banks.

[30] The "round-trip" cross-border exposures here mainly describe the situation where the loans or deposits that a domestic bank provides to or receives from a particular sector of a foreign country subsequently come back to the home country (directly or indirectly). While some of these "round-trip" cross-border transactions are for maturity transformation, some are conducted to circumvent one country's banking regulation such as restrictions on lending concentration and hence could pose significant risks to the banks involved.

simulates the hypothetical failure of the banking system in a given country, and tracks its spillover effects on other countries.[31] In the analysis, spillovers are estimated using both asset and liabilities by considering the impact of two separate shocks:[32] (i) the impact of a banking system defaulting on its liabilities to foreign banks (credit shock), and (ii) the impact of a banking system deleveraging by withdrawing funding from foreign banks, triggering asset fire sales in the latter (funding shock). The potential knock-on effects of banking sector distress on the sovereign sector of each foreign country are also computed. The analysis is based on two types of bilateral exposures: (i) bilateral exposures among the 27 banks in BiH, and those between each of the 27 banks and the banking and public sectors of 106 foreign countries to which BiH banks are exposed to,[33] and (ii) bilateral exposures among foreign banking systems obtained from the (restricted) BIS locational statistics.[34]

45. **The results suggest that both direct and indirect cross-border spillovers to BiH banks could be sizeable.** Direct spillovers from Germany and Austria are the key contagion risks for BiH banks. Indirect contagion from the U.K. could also be substantial since hypothetical stress in the U.K. banking system could spill-over to other foreign banking systems that have direct exposures with BiH banks. Credit shocks to these three banking systems through the foreign interbank linkages would cause severe capital impairments throughout the entire banking system, resulting in undercapitalization of multiple banks. In particular, the default of the Austrian banking system would cause five BiH banks' regulatory capital to fall below the 12 percent minimum requirement (four in FBiH and one in RS), equivalent to a loss of 20 percent of BIH's total regulatory capital (Figure 5).

46. **Direct contagion risks are concentrated in the German and Austrian banking systems.** In particular, in the credit shock scenario, their joint default would result in the impairment of nearly half of the total regulatory capital of the banking system in BiH. These risks are mainly associated with BiH banks' correspondent accounts in large global banks in Germany and Austria, and could also be amplified through third parties whose banking systems have direct linkages with BiH banks. Although the direct exposures of BiH banks to the U.K. are very limited, the indirect contagion risk from the U.K. is the largest, and it mainly operates through the "cascade effects" on other foreign

[31] See Espinosa-Vega, M. and J. Solé, 2010, "Cross-border Financial Surveillance: A Network Perspective," IMF Working Paper 10/105.

[32] Key assumptions are: (i) for the credit shock, a loss given default of 100 percent is assumed on interbank exposures based on the difficulty of recovering assets at the time of bank failures; (ii) for the funding shock, a haircut of 50 percent is assumed on the fire sale of assets and 80 percent is assumed on the roll-over ratio of interbank debt; and (iii) a loss of 20 percent is assumed on BiH banks' exposures to foreign public sectors. Different roll-over ratios for interbank debt are also tried, and the 80 percent roll-over ratio makes the results more robust than the 65 percent ratio assumed by Espinosa-Vega and Solé (2010). The analysis is also extended by calculating the number of undercapitalized banks in BiH associated with the default of each foreign banking system. A bank is defined as undercapitalized if its capital adequacy ratio (CAR) falls below the minimum CAR requirement, which is 12 percent in BiH.

[33] Data on all the exposures (domestic and foreign) for the BiH banks, as of March 31, 2014, were provided by the banking agencies of FBiH and RS.

[34] By using the (restricted) BIS locational statistics database, we are implicitly assuming that the bilateral exposures are measured on locational (rather than consolidated) basis. This is likely to underestimate the spillovers from some countries such as Russia, given that Sberbank (a Russian-owned bank) has a number of registered subsidiaries across several European countries.

banking systems (including Austria, Belgium, France, Germany, Italy, among others). Adding funding shocks to the simulation would increase the number of undercapitalized banks, especially when the shocks come from the top five systematically important countries for BiH. However, the knock-on effects on BiH banks from the exposures to foreign public sectors are very limited, except for Romania and Slovenia whose government bonds are held in relatively large amounts by a few foreign banks in BiH.[35]

B. Domestic Interconnectedness and Contagion Risks

47. **Banks in BiH are mainly connected to development banks and insurance companies.** Interconnectedness between banks and the insurance sector, as well as between the banks and the development bank in RS (IRBRS), is significant.[36] Indeed, the largest three linkages reflect the liabilities of the largest three RS banks to the IRBRS (Figure 9). Interlinkages between banks and insurance companies are mainly through insurance deposits in banks, amounting to over KM 550mn (equivalent to about 40 percent of the insurance sector's total assets but only 3 percent of total banking sector assets). Despite ongoing concerns regarding the microcredit sector, the exposures between banks and microcredit organizations (MCOs) are fairly small.[37]

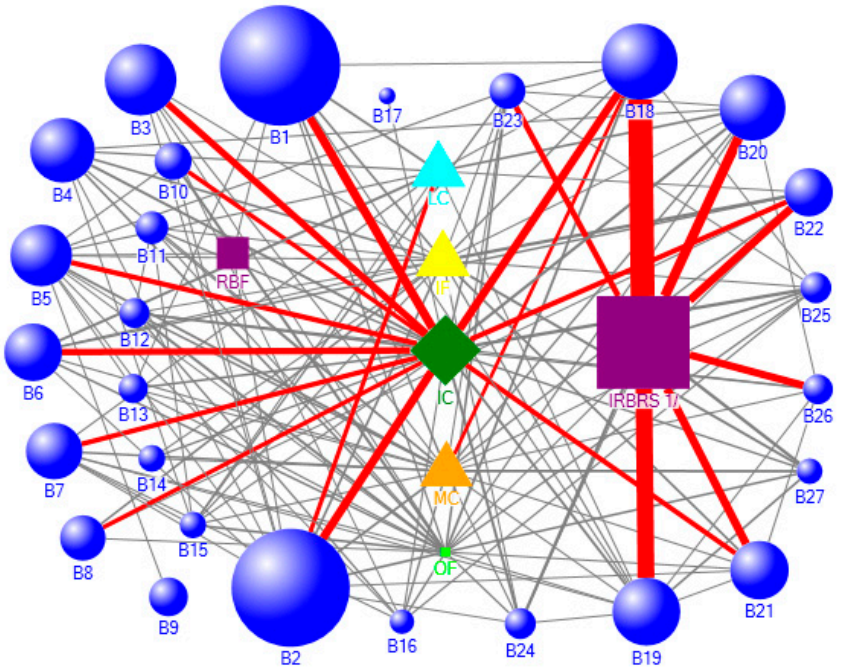
48. **A number of domestically-owned banks rely heavily on public sector support.** In RS, the development bank (IRBRS), along with the six development funds under its management, exhibit large credit lines with all commercial banks in RS. In addition, the IRBRS also holds sizeable amounts of shares and subordinated debt issued by some of the domestically-owned banks (Figure 6). In contrast, the relatively small development bank in FBiH does not play an important role vis-à-vis the banks operating in that entity. However, for a few small domestically-owned banks, some cantons in the FBiH have bought their subordinated debt and some state-owned enterprises also hold sizable amounts of their capital. Furthermore, there is widespread cross-ownership of shares among small domestically-owned banks in FBiH, although the amounts involved are fairly small. Finally, some private conglomerates also hold significant amounts of shares issued by several small domestically-owned banks in FBiH, some of which through various companies (engaging in both real sector and financial activities) under their control.

[35] Since a loss rate of 20 percent is assumed on banks' exposures to foreign sovereigns, the overall impact on the banking system or the foreign banks which hold these two countries' government bonds is very small.

[36] Two development banks currently operate in the country, one in each Entity. Both development banks are non-deposit taking institutions supporting investments and export-oriented activities in the respective Entities. The development bank in RS (IRBRS) plays a major role in providing credit lines to the banks via its six development funds and holds sizeable deposits and capital in some smaller banks in RS.

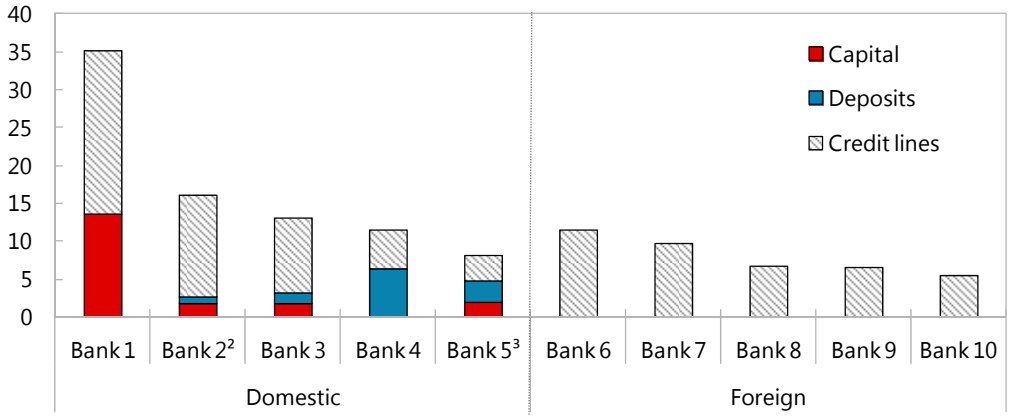
[37] Indeed, bank claims and liabilities on all MCOs account for only BAM 48mn and 37mn (roughly 0.2 percent of banks' assets), respectively. In addition, one of the largest MCOs is currently in the process of liquidation, but the overall impact on banks' balance sheets is muted.

Figure 5. Linkages between Banking and Non-Banking Sectors



Sources: CBBH; Banking Agency of FBiH; and Banking Agency of RS.
1/ The size of the IRBRS reflects the total assets of the development bank in RS (IRBRS) consolidated with the 6 development funds under its management.
Note: The size of each node reflects the total assets of each institution. Linkages (edges) are bilateral claims and liabilities. Top 20 largest linkages are represented by red edges. Blue solid spheres B1–B17 and B18-27 denote commercial banks in FBiH and RS. The two purple solid squares denote the two development banks in FBiH (RBF) and RS (IRBRS), respectively. The green solid diamond represents insurance companies (IC). The aqua, yellow, and orange solid triangles represent leasing companies (LC), investment funds (IF), and microcredit organizations (MC), respectively, and the lime solid square denotes the other financial institutions (OF).

Figure 6. Banks' Linkages to the Development Bank in Republika Srpska[1/]
(Percent of each bank's total liabilities; as of March 31, 2014)



Sources: IRBRS; Banking Agency of RS; and IMF staff calculations.
1/ Consolidated with banks' liabilities to the six public funds.
*/ This bank is classified as a domestic bank due to an ownership change in 2014Q3.
^/ This bank is a "round-trip" investment.

49. **Contagion risks through the domestic interbank market are small, despite active "overnight" transactions among some banks.** Based on the reported data as of end-March 2014, and owing to the limited amount of domestic interbank exposures among banks (less than 1 percent of total regulatory capital), the hypothetical default of any bank in the system would not have any significant "cascade effects" on the rest of the system.[38] However, some banks—mainly domestically-owned banks and a couple of medium-sized foreign-owned banks—have engaged in "overnight" transactions of deposits, foreign exchange, and cash in the interbank market based on bilateral agreements. Furthermore, since these bilateral claims usually mature within any given month, system-wide reported exposures (monthly) appear to be relatively small.

Spillovers in the Domestic Financial System

50. **Owing to its relatively small size, spillovers from the insurance sector to the banking sector are rather small.** Banks' total claims and liabilities with the insurance sector amount to roughly KM 5mn and KM 550mn (less than 3 percent of total banking sector deposits), respectively. Although, these liabilities can be withdrawn at any time without penalty except for interest loss,[39] the vast majority of these deposits (80 percent) are concentrated in large foreign-owned banks, while deposits at domestically-owned banks only account for 3 percent of their total balance sheet.

51. **In Adverse Scenario 2, contagion risks from banks to the insurance sector are also limited.** Five banks in the most severe macroeconomic scenario become insolvent (Table 6). Based on the reported data by both banking agencies, total claims of insurance companies on these five banks only account for 3 percent of total insurance sector assets. Network analysis assuming the joint default of these five banks suggests a capital impairment of around KM 43mn (14 percent of insurance sector's capital – which includes share capital, reserves, and retained earnings). At the company level, only two insurance companies would lose over half of its total capital in Adverse Scenario 2, of which only one would lose its entire capital (Figure 10). However, owing to the large amount of deposits held within the overall banking system, potential losses could be larger if a couple of other large banks were to fall in distress.

CONCLUSIONS

52. **Stress tests assessed the financial stability of the banking sector in Bosnia and Herzegovina**. Top-down stress tests, performed jointly by the FSAP team and CBBH staff, assessed the solvency and liquidity stance of the entire banking system. These stress tests were complemented by bottom-up stress tests coordinated by both banking agencies, and carried out by all 27 banks operating in BiH, using their own internal models applied to the macroeconomic scenarios provided by the FSAP team.

[38] Only in one particular case, the hypothetical default of a large bank on its interbank obligations would trigger the undercapitalization (CAR below the minimum requirement) of a small bank in the system.

[39] For instance, when an insurance company wishes to withdraw 5-year term deposit at the end of the second year, then the interest rate on the deposit would be that of a 2-year term deposit instead of the 5-year deposit rate.

53. **The quantitative analysis included macroeconomic scenario-based stress tests, complemented by sensitivity analysis**. Scenario-based stress tests used three full-fledged macroeconomic scenarios (one baseline and two adverse scenarios of varying severity) to assess the solvency of the banking system. These stress tests included very comprehensive risk coverage, analyzing risk factors such as: credit risk on the loan book, issuer default risk on the debt instrument holding and equity investment portfolios, market risk effects on interest income and valuation effects on debt instrument holdings, exchange rate risks related to net open FX positions, and operational risk, among others. Sensitivity analysis to assess potential concentration risks and network analysis of contagion and spillover risks through both the interbank market and cross-border exposures were also performed. Finally, liquidity stress tests were carried out based on proxies of the Basel III liquidity ratios (LCR and NSFR) to assess the liquidity positions of the banks.

54. **The mains results from these stress tests are as follows:**

- Credit risk in the loan book is by far the most significant risk factor on the balance sheet of the banks. In particular, asset quality seems to be highly sensitive to macroeconomic conditions. In addition, although difficult to quantify owing to lack of data, the presence of "unhedged borrowers" represents a significant inherent risk.

- Interest rate risk on interest income seems to be limited. Several loans are essentially floating rate loans, and the resulting gaps between assets and liabilities (based on time-to-repricing buckets) are small.

- The direct effects of exchange rate risk seem to be contained, due to the relatively small net open FX positions reported by the banks. The same applies to other sources of market risks. For instance, risks related to holdings of securities and trading portfolios are quite small, owing to the limited amount of such holdings in the banks' balance sheet.

- Concentration risks are extremely high in a few (mainly domestically-owned) banks, where the default by just a few of their largest exposures would render these banks insolvent. Concentration risks in the rest of the system appear more muted.

- System-wide liquidity appears to be broadly appropriate. Nevertheless, a few banks in both entities, present relatively low liquidity ratios. That said, the potential system-wide liquidity shortfalls appear to be manageable.

- Contagion risks through domestic interbank exposures appear to be contained. However, most banks present significant cross-border exposures. The largest share of these exposures is due to funding lines from parent companies (in the case of foreign-owned banks), and deposits for FX transactions in corresponding accounts abroad. Nevertheless, a couple of small banks exhibit "round-trip" investments, mainly with neighboring countries.

- Several domestically-owned banks seem to rely on public sector support. This includes both funding and capital support, either directly or indirectly (e.g., through the IRBRS).

55. **In conclusion, system-wide solvency and liquidity indicators appear broadly adequate, but significant vulnerabilities remain in specific segments.** On the basis of the supervisory data used, stress tests suggest that aggregate stress losses, mainly related to increased provisions in the loan book remain manageable, although non-negligible. Similarly, system-wide liquidity ratios appear broadly adequate. Nevertheless, there are several banks within the system—mainly small domestically-owned banks—with a wide range of significant vulnerabilities. These include: low liquidity ratios, large concentration risks, risky cross-border exposures, and questionable quality of some of their assets, among others. While these banks are somewhat interconnected among themselves, they present low direct linkages with other domestic banks, and therefore any potential losses are likely to have limited direct spillovers to the rest of the banking system. However, indirect contagion risks (through e.g., reputational risks), not assessed in the stress tests, could pose significant risks to the stability of the system.

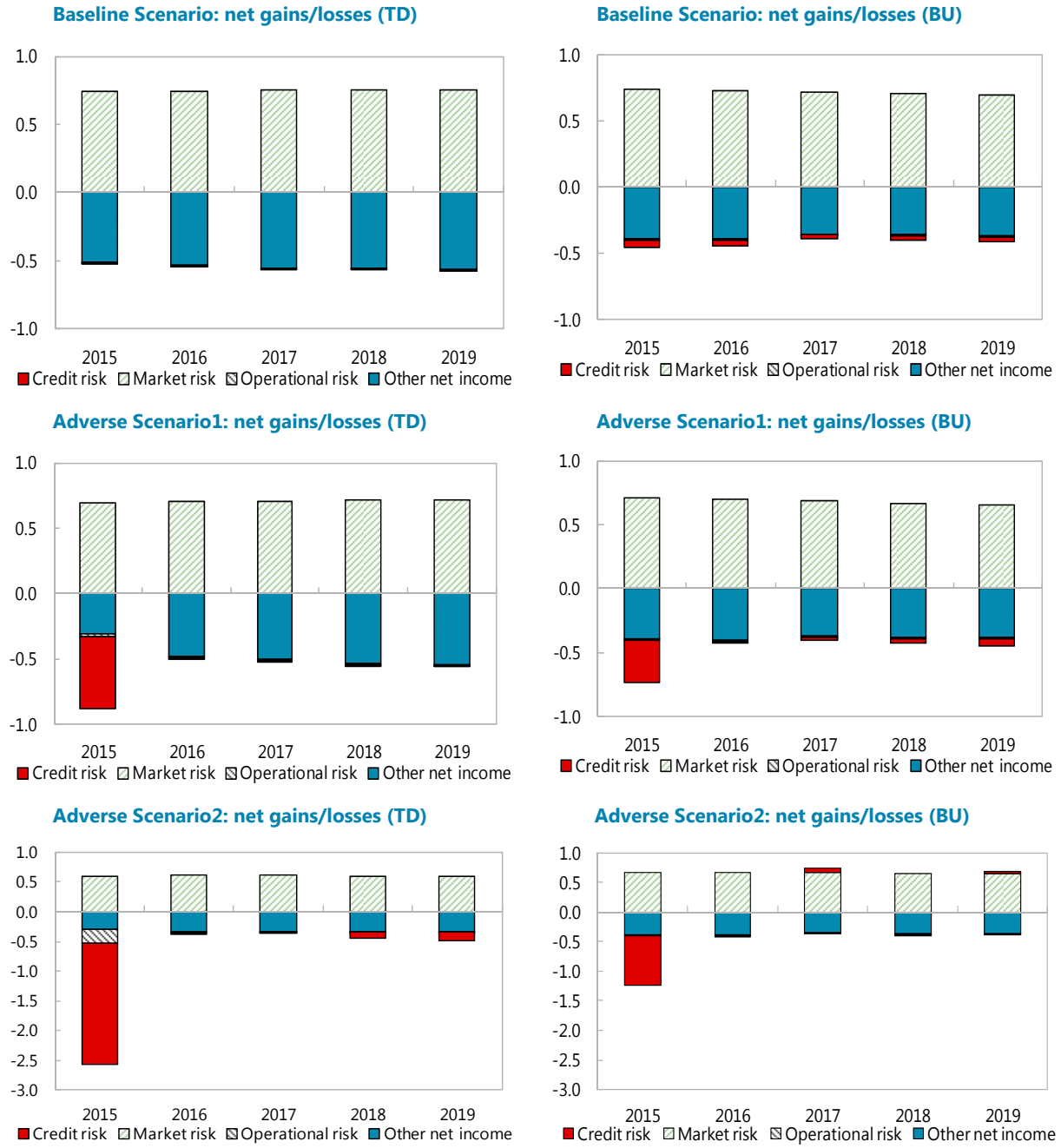
56. **On the basis of the stress test analysis, a number of recommendations are warranted (Table 1)**. Our recommendations are mainly related to the largest sources of risk in the system: credit risk in the loan book; inherent risk from "unhedged borrowers;" potential liquidity shortfalls (including in FX); asset quality of weak banks; etc. Furthermore, these recommendations are mostly aimed at addressing the limitations of the existing off-site supervisory framework in terms of monitoring these risks.

Figure 7. Top-Down (lhs) and Bottom-Up (rhs) Estimated Capital Adequacy Ratios

(In percent of risk-weighted assets)

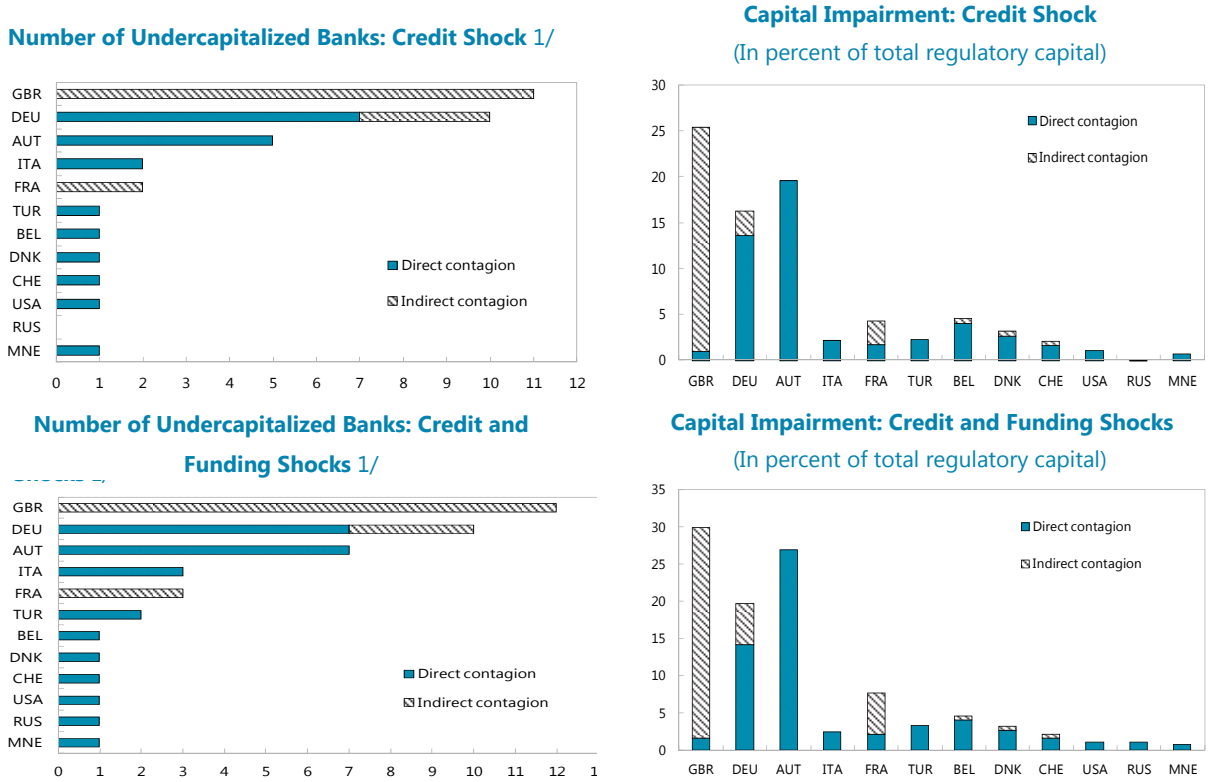
Sources: Individual banks (bottom-up stress tests); IMF and CBBH staff calculations (top-down stress tests).

Figure 8. Top-Down (lhs) and Bottom-Up (rhs) Estimated Potential Losses for the Entire Banking System (27 banks) (In billions of KM)



Sources: individual banks (bottom-up stress tests); IMF and CBBH staff calculations (top-down stress tests).

Figure 9. Cross-Border Financial Spillovers to BiH's Banking System [2/]



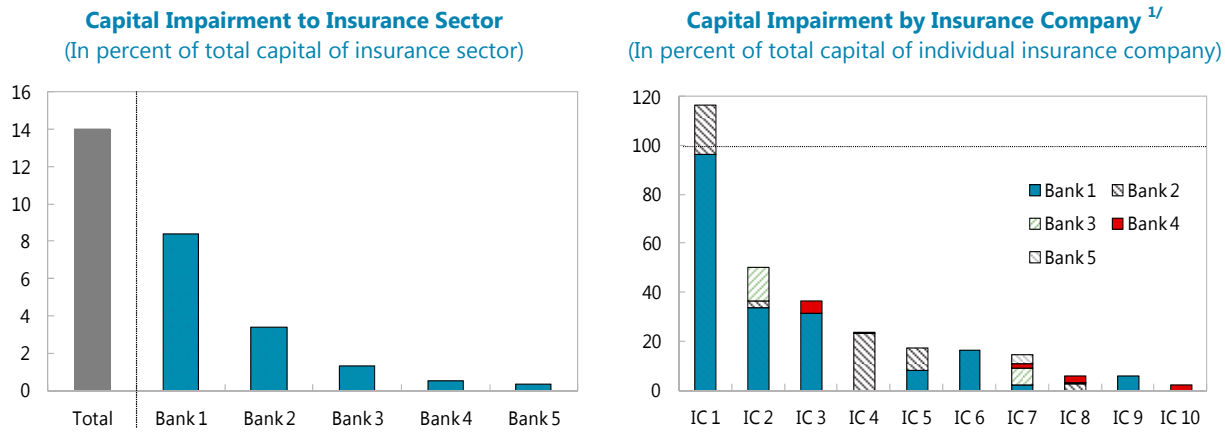
Sources: Authorities supervisory data; BIS Locational Statistics Database; IMF Financial Soundness Indicators Database; and IMF staff calculations.

Notes:

[1/] A bank is considered as "undercapitalized" when its CAR falls below the 12 percent minimum requirement.

[2/] Vakufska bank (FBiH) and Pavlovic international bank (RS) were excluded from this exercise because their pre-shock CARs are already below the minimum requirement.

Figure 10. Spillovers from Banks to Insurance Sector under Adverse Scenario 2



Sources: Authorities supervisory data and IMF staff calculations.

Notes: [1/] An insurance company loses all its capital when capital impairment is larger than 100 percent.

Table 3. Banking Sector Summary by Entity
(As of March 31, 2014)

Bank Name	Total Assets *(Percent of total banking assets in BiH)*	Total Assets *(Percent of total banking assets in the Entity)*	Ownership
Federation of Bosnia and Herzegovina (FBiH)			
Raiffeisen bank d.d. Bosna i Hercegovina	17.4	24.9	Foreign bank (Austria)
UniCredit bank d.d.	16.7	24.0	Mostly foreign bank (Italy)
Intesa Sanpaolo banka d.d. Sarajevo	6.1	8.8	Mostly foreign bank (Italy)
Hypo Alpe-Adria bank d.d. Mostar	5.0	7.2	Foreign bank (Austria)
Sparkasse bank d.d.	4.6	6.5	Mostly foreign bank (Austria)
Sberbank BH d.d.	4.0	5.7	Foreign bank (Russia)
NLB banka d.d.	3.8	5.5	Mostly foreign bank (Slovenia)
Bosnia bank international d.d. Sarajevo	2.5	3.6	Foreign bank (UA Emirates and Dubai, 54.5%; and Saudi Arabia, 45.5%)
Ziraatbank BH d.d.	1.8	2.6	Foreign bank (Turkey)
ProCredit bank d.d.	1.6	2.4	Foreign bank (Germany)
Vakufska banka d.d. Sarajevo	1.3	1.9	Mostly domestic private bank
BOR banka d.d.	1.1	1.5	Mostly domestic private bank
UNION banka d.d.	1.0	1.5	State-owned bank
Investiciono Komercijalna banka d.d.	0.9	1.3	Mostly domestic private bank
Moja banka d.d.	0.8	1.2	Mostly domestic private bank
Privredna banka d.d	0.7	1.0	Mostly domestic private bank
Komercijalno Investiciona banka d.d.	0.3	0.5	Mostly domestic private bank
Republika Srpske (RS)			
Nova banka a.d.	6.9	22.8	Mostly domestic private bank 1/
NLB Razvojna banka a.d.	5.5	18.2	Mostly foreign bank (Slovenia)
Hypo Alpe-Adria bank a.d.	5.2	17.3	Mostly foreign bank (Austria)
UniCredit bank a.d.	4.1	13.5	Mostly foreign bank (Austria)
Sberbank a.d.	2.8	9.2	Mostly foreign bank (Russia)
Bobar banka a.d.	1.6	5.2	Mostly domestic private bank
Komercijalna banka a.d.	1.2	3.8	Foreign bank (Serbia)
Pavlovic international bank a.d.	1.2	3.8	Mostly domestic private bank 2/
Banka Srpske a.d.	1.1	3.5	State-owned bank
MF banka a.d.	0.8	2.6	Domestic private bank

Sources: Banking Agency of FBiH; Banking Agency of RS; and IMF staff calculations.

1/ The ownership of this bank changed in Q3 2014 from a mostly foreign bank to a mostly domestic private bank.

2/ The major owners of this bank have dual citizenship (BiH and the U.S.), and hence the bank is classified as a mostly domestic private bank.

Table 4. Summary of the Banking Sector Loan Book in Bosnia and Herzegovina

	Share of total loans (percent)			Non-performing loans (percent of total loans)		
	BiH (27 banks)	**FBiH (17 banks)**	**RS (10 banks)**	**BiH (27 banks)**	**FBiH (17 banks)**	**RS (10 banks)**
Total loans	**100.0**	**100.0**	**100.0**	**14.9**	**14.5**	**15.7**
Corporate loans	**55.6**	**52.3**	**62.8**	**18.3**	**18.6**	**17.7**
Agriculture	1.5	1.0	2.4	21.8	26.5	17.3
Industrial production	14.7	14.2	15.9	21.3	21.1	21.6
Construction	4.2	3.6	5.4	23.6	31.1	12.6
Trade	19.5	21.6	14.9	19.4	16.7	28.1
Tourism	1.4	1.4	1.1	18.0	19.0	15.2
Transport & communications	2.6	2.8	2.1	14.0	12.2	19.3
Financial intermediation	0.8	0.7	1.0	12.1	9.4	16.3
Commercial real estate	3.5	3.4	3.7	25.5	21.9	32.8
Government & government institutions	5.6	1.8	14.1	2.0	7.2	0.6
Other corporate loans	1.9	1.7	2.1	13.2	11.3	16.6
Retail loans	**44.4**	**47.7**	**37.2**	**10.6**	**10.0**	**12.3**
Consumer loans	32.2	36.1	23.8	9.0	7.9	12.5
Mortgage loans	10.4	10.4	10.6	13.0	15.0	8.7
Small business (craftsman) loans	1.8	1.3	2.8	26.5	28.9	24.1

Sources: Authorities supervisory data and IMF staff calculations.

Table 5. Macroeconomic Projections in the Stress Test Scenarios[1/]

	Historical							Projection					
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Baseline scenario:													
Real GDP growth (%)	6.0	5.6	-2.7	0.8	1.0	-1.2	2.1	0.7	3.5	3.7	4.0	4.0	4.0
CPI inflation (%)	1.5	7.4	-0.4	2.2	3.7	2.0	-0.1	1.1	1.5	1.8	2.0	2.1	2.1
Interest rates:													
Short-term interest rate (%)	7.2	7.1	8.1	7.9	7.5	6.9	7.0	6.7	7.2	7.4	7.6	7.7	7.7
Long-term interest rate (%)	7.0	6.9	7.0	8.4	7.5	7.8	7.1	7.3	7.5	7.7	7.8	7.8	7.8
Exchange rates:													
BAM/USD	1.43	1.34	1.41	1.48	1.41	1.52	1.47	1.42	1.42	1.42	1.42	1.42	1.42
BAM/EUR	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
BAM/HRK	26.65	27.07	26.64	26.84	26.30	26.00	25.81	25.62	25.62	25.62	25.62	25.62	25.62
BAM/RSD	2.45	2.41	2.08	1.90	1.92	1.73	1.73	1.69	1.62	1.56	1.50	1.44	1.38
NEER (increase = appreciation)	99.5	100.6	102.5	100.0	100.5	99.5	101.6	109.2	109.8	110.5	111.2	111.8	112.5
REER (increase = appreciation)	98.7	102.4	102.6	100.0	100.8	98.9	99.9	100.62	100.1	99.8	99.6	99.6	99.5
House price index (2007=100):	100.0	127.4	121.3	116.2	111.7	110.7	113.0	110.4	117.8	124.4	130.6	135.3	138.7
House price growth (%)	33.1	27.4	-4.8	-4.2	-3.8	-0.9	2.1	-2.3	6.7	5.6	5.0	3.6	2.6
Stock price index:													
Sarajevo stock exchange index (2007=100)	100.0	51.7	23.8	21.9	22.5	17.0	17.7	16.5	17.2	18.5	20.7	23.2	26.2
Sarajevo stock exchange index growth (%)	130.6	-48.3	-53.9	-8.1	2.7	-24.6	4.3	-6.6	3.8	8.0	11.5	12.4	12.6
Banja Luka stock exchange index (2007=100)	100.0	48.8	27.7	25.0	28.2	23.3	21.8	20.3	21.1	23.0	25.9	29.4	33.5
Banja Luka stock exchange index growth (%)	89.4	-51.2	-43.3	-9.6	12.6	-17.3	-6.5	-7.1	4.2	8.8	12.7	13.6	13.9
Unemployment rate (%)	44.2	41.4	43.4	44.4	44.9	45.5	44.6	44.5	43.2	41.8	40.4	39.0	37.8
Alternative scenario 1:													
Real GDP growth (%)	6.0	5.6	-2.7	0.8	1.0	-1.2	2.1	0.7	-2.0	0.0	0.5	0.8	1.0
CPI inflation (%)	1.5	7.4	-0.4	2.2	3.7	2.0	-0.1	1.1	2.2	2.4	2.7	2.7	2.8
Interest rates:													
Short-term interest rate (%)	7.2	7.1	8.1	7.9	7.5	6.9	7.0	6.7	7.4	7.6	7.8	7.8	7.9
Long-term interest rate (%)	7.0	6.9	7.0	8.4	7.5	7.8	7.1	7.3	7.6	7.7	7.9	7.9	7.9
Exchange rates:													
BAM/USD	1.43	1.34	1.41	1.48	1.41	1.52	1.47	1.42	1.54	1.50	1.46	1.42	1.42
BAM/EUR	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
BAM/HRK	26.65	27.07	26.64	26.84	26.30	26.00	25.81	25.62	25.97	26.21	26.44	26.65	26.85
BAM/RSD	2.45	2.41	2.08	1.90	1.92	1.73	1.73	1.69	1.67	1.63	1.60	1.56	1.52
NEER (increase = appreciation)	99.5	100.6	102.5	100.0	100.5	99.5	101.6	109.2	108.0	107.9	107.9	107.9	107.8
REER (increase = appreciation)	98.7	102.4	102.6	100.0	100.8	98.9	99.9	100.6	98.9	98.4	98.1	97.9	97.7
House price index (2007=100):	100.0	127.4	121.3	116.2	111.7	110.7	113.0	110.4	105.0	99.9	95.8	91.1	86.4
House price growth (%)	33.1	27.4	-4.8	-4.2	-3.8	-0.9	2.1	-2.3	-4.8	-4.9	-4.1	-4.8	-5.2
Stock price index:													
Sarajevo stock exchange index (2007=100)	100.0	51.7	23.8	21.9	22.5	17.0	17.7	16.5	11.0	9.3	8.5	8.0	7.7
Sarajevo stock exchange index growth (%)	130.6	-48.3	-53.9	-8.1	2.7	-24.6	4.3	-6.6	-33.7	-14.7	-9.2	-6.2	-3.8
Banja Luka stock exchange index (2007=100)	100.0	48.8	27.7	25.0	28.2	23.3	21.8	20.3	12.5	10.4	9.3	8.6	8.1
Banja Luka stock exchange index growth (%)	89.4	-51.2	-43.3	-9.6	12.6	-17.3	-6.5	-7.1	-38.2	-17.0	-10.9	-7.6	-5.0
Unemployment rate (%)	44.2	41.4	43.4	44.4	44.9	45.5	44.6	44.5	45.1	44.2	43.1	41.4	39.9
Alternative scenario 2:													
Real GDP growth (%)	6.0	5.6	-2.7	0.8	1.0	-1.2	2.1	0.7	-7.1	-1.5	5.0	4.5	4.0
CPI inflation (%)	1.5	7.4	-0.4	2.2	3.7	2.0	-0.1	1.1	3.6	3.6	2.8	2.1	2.0
Interest rates:													
Short-term interest rate (%)	7.2	7.1	8.1	7.9	7.5	6.9	7.0	6.7	8.1	8.2	8.1	7.7	7.6
Long-term interest rate (%)	7.0	6.9	7.0	8.4	7.5	7.8	7.1	7.3	8.1	8.1	8.0	7.8	7.8
Exchange rates:													
BAM/USD	1.43	1.34	1.41	1.48	1.41	1.52	1.47	1.42	1.54	1.50	1.46	1.42	1.42
BAM/EUR	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
BAM/HRK	26.65	27.07	26.64	26.84	26.30	26.00	25.81	25.62	26.84	27.47	27.35	27.29	27.29
BAM/RSD	2.45	2.41	2.08	1.90	1.92	1.73	1.73	1.69	1.71	1.69	1.61	1.54	1.48
NEER (increase = appreciation)	99.5	100.6	102.5	100.0	100.5	99.5	101.6	109.2	105.4	104.2	105.4	106.3	107.0
REER (increase = appreciation)	98.7	102.4	102.6	100.0	100.8	98.9	99.9	100.6	97.6	96.9	97.8	98.0	97.9
House price index (2007=100):	100.0	127.4	121.3	116.2	111.7	110.7	113.0	110.4	93.6	84.4	88.9	93.8	96.4
House price growth (%)	33.1	27.4	-4.8	-4.2	-3.8	-0.9	2.1	-2.3	-15.2	-9.8	5.4	5.5	2.7
Stock price index:													
Sarajevo stock exchange index (2007=100)	100.0	51.7	23.8	21.9	22.5	17.0	17.7	16.5	4.2	3.2	4.0	5.0	5.9
Sarajevo stock exchange index growth (%)	130.6	-48.3	-53.9	-8.1	2.7	-24.6	4.3	-6.6	-74.3	-25.7	27.5	23.8	19.6
Banja Luka stock exchange index (2007=100)	100.0	48.8	27.7	25.0	28.2	23.3	21.8	20.3	3.3	2.3	3.0	3.8	4.6
Banja Luka stock exchange index growth (%)	89.4	-51.2	-43.3	-9.6	12.6	-17.3	-6.5	-7.1	-84.0	-29.5	30.3	26.1	21.5
Unemployment rate (%)	44.2	41.4	43.4	44.4	44.9	45.5	44.6	44.5	48.6	48.0	45.2	41.8	39.8

Sources: Authorities historical data and IMF staff calculations.

[1/] These scenarios are based on projections made in July 2014. Therefore, these numbers (in particular the projections for 2014) need to be interpreted in that context. In addition, the latest baseline projections from the IMF's Area Department team might differ slightly from those presented here. All numbers are period averages.

Table 6. Summary of the Solvency Stress Test Results—Entire Banking System (27 banks)
(In thousands of KM unless indicated otherwise)

	Baseline Scenario		Adverse Scenario 1		Adverse Scenario 2	
	Top-Down	Bottom-Up	Top-Down	Bottom-Up	Top-Down	Bottom-Up
Actual data as of 31-March-2014 - before any shock:						
Total regulatory capital - before shock	2,938,843	2,938,843	2,938,843	2,938,843	2,938,843	2,938,843
Tier 1 capital	2,624,308	2,624,308	2,624,308	2,624,308	2,624,308	2,624,308
Total risk-weighted assets (RWAs)	16,942,976	16,942,976	16,942,976	16,942,976	16,942,976	16,942,976
Total assets	21,783,153	21,783,153	21,783,153	21,783,153	21,783,153	21,783,153
Total regulatory capital-ratio (CAR; in percent of RWAs) - before shock	**17.3**	**17.3**	**17.3**	**17.3**	**17.3**	**17.3**
Stress test estimated losses after shock (2015):						
Credit risk:						
Increase in provisions due to loan migration	(4,067)	(55,062)	(545,431)	(326,040)	(2,019,179)	(829,554)
Expected net losses on BIH government bond holding (HTM) - "issuer default risk"	(1,267)	(230)	(2,025)	(537)	(3,127)	(1,071)
Expected net losses on BIH corporate bond holding (HTM) - "issuer default risk"	(2)	-	(4)	(2)	(6)	(5)
Risk related to equity instruments:						
Expected net losses on equity instruments	656	238	(3,161)	(4,001)	(7,349)	(8,717)
Market risk:						
Expected net interest income	743,575	733,660	703,600	709,078	601,218	679,485
Expected gains/losses on BIH government bond holding (AFS & HFT)	(4,102)	(1,579)	(5,604)	(3,688)	(11,829)	(8,645)
Expected gains/losses on BIH corporate bond holding (AFS & HFT)	-	-	-	-	-	-
Expected gains/losses on foreign bond holding (AFS, HFT & HTM)	(2,220)	303	(3,033)	120	(6,401)	(519)
Expected gains/losses on net open FX positions	(39)	217	551	935	728	1,076
Operational risk:						
Expected operational risk losses	(1,810)	(9,221)	(22,343)	(10,454)	(238,144)	(11,651)
Total net expected "stress losses"	730,724	668,328	122,551	365,411	(1,684,089)	(179,600)
Other net income after shock (2015):						
Total "other net income"	(512,265)	(390,860)	(307,845)	(387,684)	(303,081)	(384,748)
Stress test estimated capitalization after shock (2015):						
Total regulatory capital - after shock	3,157,302	3,216,311	2,753,549	2,916,570	951,673	2,374,494
Total regulatory capital-ratio (CAR; in percent of RWAs) - after shock	**18.6**	**19.0**	**16.3**	**17.2**	**5.6**	**14.0**
Implied capital shorfall (if any) 1/	-	144	26,147	2,941	1,147,991	122,731
Number of banks with a CAR below 12 percent	-	1	5	2	22	13
Number of banks with a CAR below "zero"	-	-	-	-	5	-

Sources: Authorities supervisory data; individual banks (bottom-up stress tests); IMF and CBBH staff calculations (top-down stress tests).

Notes:
1/ The “implied capital shortfall” is the amount of system wide recapitalization needs so that the CAR of each bank is equal or above 12 percent.

Table 7. Summary of the Top-Down Solvency Stress Test Results—Entity Level
(In thousands of KM unless indicated otherwise)

	Baseline Scenario		Adverse Scenario 1		Adverse Scenario 2	
	FBiH (17 banks)	RS (10 banks)	FBiH (17 banks)	RS (10 banks)	FBiH (17 banks)	RS (10 banks)
Actual data as of 31-March-2014 - before any shock:						
Total regulatory capital - before shock	2,100,981	837,862	2,100,981	837,862	2,100,981	837,862
Tier 1 capital	1,890,552	733,756	1,890,552	733,756	1,890,552	733,756
Total risk-weighted assets (RWAs)	12,002,921	4,940,055	12,002,921	4,940,055	12,002,921	4,940,055
Total assets	15,159,500	6,623,653	15,159,500	6,623,653	15,159,500	6,623,653
Total regulatory capital-ratio (CAR; in percent of RWAs) - before shock	**17.5**	**17.0**	**17.5**	**17.0**	**17.5**	**17.0**
Stress test estimated losses after shock (2015):						
Credit risk:						
Increase in provisions due to loan migration	55	(4,122)	(399,074)	(146,357)	(1,508,994)	(510,186)
Expected net losses on BIH government bond holding (HTM) - "issuer default risk"	(1,215)	(52)	(1,942)	(84)	(2,997)	(129)
Expected net losses on BIH corporate bond holding (HTM) - "issuer default risk"	-	(2)	-	(4)	-	(6)
Risk related to equity instruments:						
Expected net losses on equity instruments	5	652	(585)	(2,575)	(1,252)	(6,097)
Market risk:						
Expected net interest income	544,071	199,504	516,014	187,586	445,167	156,051
Expected gains/losses on BIH government bond holding (AFS & HFT)	(975)	(3,126)	(1,332)	(4,271)	(2,812)	(9,016)
Expected gains/losses on BIH corporate bond holding (AFS & HFT)	-	-	-	-	-	-
Expected gains/losses on foreign bond holding (AFS, HFT & HTM)	(1,673)	(547)	(2,286)	(747)	(4,825)	(1,577)
Expected gains/losses on net open FX positions	(12)	(27)	425	127	492	236
Operational risk:						
Expected operational risk losses	(1,259)	(550)	(15,549)	(6,794)	(165,731)	(72,413)
Total net expected "stress losses"	538,995	191,728	95,671	26,880	(1,240,953)	(443,136)
Other net income after shock (2015):						
Total "other net income"	(388,745)	(123,520)	(222,888)	(84,957)	(218,042)	(85,039)
Stress test estimated capitalization after shock (2015):						
Total regulatory capital - after shock	2,251,232	906,070	1,973,764	779,785	641,986	309,686
Total regulatory capital-ratio (CAR; in percent of RWAs) - after shock	**18.8**	**18.3**	**16.4**	**15.8**	**5.3**	**6.3**
Implied capital shorfall (if any) 1/	-	-	20,893	5,254	859,457	289,948
Number of banks with a CAR below 12 percent	-	-	3	2	13	9
Number of banks with a CAR below "zero"	-	-	-	-	5	-

Source: Authorities supervisory data; IMF and CBBH staff calculations.

Notes:
1/ The "implied capital shortfall" is the amount of system wide recapitalization needs so that the CAR of each bank is equal or above 12 percent.

Table 8. Implied Non-Performing Loan Ratios under Adverse Scenario 2
(In percent of total loans)

	Top-Down						Bottom-Up					
	2014	2015	2016	2017	2018	2019	2014	2015	2016	2017	2018	2019
Federation of Bosnia and Herzegovina (FBiH)												
Minimum	5.5	16.7	16.7	16.7	17.5	18.6	5.5	12.0	6.3	2.0	2.2	3.5
Median	12.2	31.1	31.1	31.1	32.2	33.7	12.2	29.3	25.2	22.2	21.8	20.8
Maximum	58.0	82.7	82.7	82.7	83.5	84.5	58.0	63.6	64.6	60.8	57.3	61.6
Republika Srpska (RS)												
Minimum	6.0	18.0	18.0	18.0	18.8	19.9	6.0	7.7	9.0	10.4	9.1	7.6
Median	13.7	34.8	34.8	34.8	36.0	37.6	13.7	21.7	23.3	21.8	21.4	20.3
Maximum	52.0	77.8	77.8	77.8	78.7	79.9	52.0	59.0	54.0	48.2	48.7	49.1

Sources: individual banks (bottom-up stress tests); IMF and CBBH staff calculations (top-down stress tests).

Table 9. Stress Test Results on Credit Concentration Risk

	Default of the largest borrower			Default of the largest 5 borrowers		
	BiH (27 banks)	FBiH (17 banks)	RS (10 banks)	BiH (27 banks)	FBiH (17 banks)	RS (10 banks)
Assumed recovery rate of 36 percent						
System-wide CAR (in percent of RWAs)	15.3	16.1	13.5	10.3	12.5	4.8
Implied capital shortfall (in millions of BAM) 1/	91	28	63	516	168	348
Number of banks with a CAR less than 12 percent	9	4	5	19	9	10
Number of banks with a CAR below "zero"	1	-	1	4	1	3
Assumed recovery rate of "zero" percent						
System-wide CAR (in percent of RWAs)	13.9	14.7	12.0	5.7	7.6	1.0
Implied capital shortfall (in millions of BAM) 1/	166	60	106	1,094	566	529
Number of banks with a CAR less than 12 percent	10	5	5	24	14	10
Number of banks with a CAR below "zero"	2	1	1	7	4	3
Assumed recovery rate of 70 percent						
System-wide CAR (in percent of RWAs)	16.3	16.8	14.9	13.2	15.2	8.3
Implied capital shortfall (in millions of BAM) 1/	39	14	25	249	46	203
Number of banks with a CAR less than 12 percent	6	3	3	11	4	7
Number of banks with a CAR below "zero"	-	-	-	2	-	2

Source: IMF staff calculations.

Notes:

1/ The "implied capital shortfall" is the amount of system wide recapitalization needs so that the CAR of each bank is at least 12 percent of risk-weighted assets.

Table 10. Summary of the Liquidity Stress Test Results

	BiH (27 banks)	FBiH (17 banks)	RS (10 banks)
LCR (including "required reserves"):			
System-wide LCR (in percent)	291.7	348.6	205.2
Implied liquidity shortfall (in millions of BAM) 1/	70.2	49.7	20.4
Number of banks with a LCR below 100 percent	5	2	3
LCR (excluding "required reserves"):			
System-wide LCR (in percent)	200.5	241.5	138.1
Implied liquidity shortfall (in millions of BAM) 1/	324.6	142.7	181.9
Number of banks with a LCR below 100 percent	11	6	5
NSFR:			
System-wide NSFR (in percent)	123.0	127.4	114.0
Implied liquidity shortfall (in millions of BAM) 2/	322.8	209.9	112.9
Number of banks with a NSFR below 100 percent	7	4	3

Source: IMF staff calculations.

Notes:

1/ The LCR "implied liquidity shortfall" is the amount of system wide liquidity needs (in terms of HQLA) so that the LCR of each bank is at least 100 percent.

2/ The NSFR "implied liquidity shortfall" is the amount of system wide liquidity needs (in terms of ASF) so that the NSFR of each bank is at least 100 percent.

Table 11. Summary of FSAP Team Access to Supervisory Data [1/]

	Fully available	Partially available	Not available
Data at the individual bank level	✓		
Data aggregated along groups of banks	✓		
Data aggregated at the banking system level	✓		

Source: IMF staff calculations.

Notes:

[1/] This table only describes the availability of supervisory data for the top-down stress tests conducted by the FSAP team, but is not related to data quality issues.

Appendix I. Preliminary Risk Assessment Matrix

Nature/Source of Main Threats	Overall Level of Concern	
	Likelihood of Severe Realization of Threat in the Next 1–3 Years (high, medium, or low)	**Expected Impact on Financial Stability if Threat is Realized** (high, medium, or low)
1. Bond market stress from a reassessment in sovereign risk in the euro area[1]	**Staff assessment: Low** • Financial stress in the euro area could re-emerge and bank-sovereign-real economy links could re-intensify as a result of stalled or incomplete delivery of policy commitments. • Euro area corporate and bank deleveraging as well as fiscal drag could affect the growth outlook for the euro and lead to heightened turmoil in financial markets.	**Staff assessment: Medium** • Euro area countries are BiH's largest trading partners. Export activity and revenues will be severely disrupted. • Remittances from euro area countries are sizeable and a large source of foreign exchange and banks' liquidity and deposits. • FDI and other capital flows may also come to a halt, further deteriorating BiH's growth outlook. • Given currency board arrangement, lower availability of FX will constrain base money. • Banks will likely suffer from funding retrenchment and asset quality deterioration due to the increase in NPLs. *(These risks are incorporated through an adverse macroeconomic scenario in the solvency stress test*
2. Geopolitical tensions surrounding Russia/Ukraine. 2	**Staff assessment: Medium** • These geopolitical tensions create significant disruptions in global financial, trade and commodity markets.	**Staff assessment: Low** • Russian banks own subsidiaries in European countries, which themselves are the parent companies for banks in BiH.

[1] In line with Risk #7 in the September 2014 Global Risk Assessment Matrix (GRAM).

[2] In line with Risk #4 in the September 2014 Global Risk Assessment Matrix (GRAM).

Nature/Source of Main Threats	Overall Level of Concern	
	Likelihood of Severe Realization of Threat in the Next 1–3 Years (high, medium, or low)	**Expected Impact on Financial Stability if Threat is Realized** (high, medium, or low)
	• Disruptions in commodity production or transport raise oil and gas prices in Europe and neighboring countries. • Increased uncertainty and lower confidence could trigger a permanent increase in risk aversion that reduces global equity prices.	• Banks would suffer from a potential funding retrenchment from the "grand-parent" banks. • Demand for BiH exports from Russia and neighboring countries would fall. *(These risks are incorporated through an adverse macroeconomic scenario in the solvency stress test).*
3. External funding: Parent banks remove support of local subs and/or decide to withdraw from BIH market.	**Staff assessment: Medium** • As euro area banks address balance sheet strains they may opt to limit presence in the region as well as BiH. • AQR exercise may result in additional recapitalization needs and further balance sheet strains. • With limited capital available, in the competition for foreign capital and foreign bank funding, BiH banks are at a disadvantage given complex regulatory and institutional system.	**Staff assessment: Medium** • BiH banking sector dominated by foreign banks, accounting for over 90 percent of the sector's assets. • Subsidiaries of foreign banks are still reliant on parent bank support: while banks are becoming more reliant on domestic deposits, parent bank loans and deposits are still sizeable. • Parent bank capital still one of few options to raise fresh capital in BiH. • Repatriation of parent bank deposits may severely constrain liquidity in some large foreign-owned banks. • Confidence effects of foreign banks withdrawing from BiH could be significant. Depositors still trust the foreign bank brand. • Domestic banks too small to compensate for intermediation loss. *(These risks are incorporated through the liquidity stress test.)*
4. Further deterioration in the health of commercial	**Staff assessment: Medium** • Slow economic activity could increase NPLs and require bank recapitalization.	**Staff assessment: High** • Higher NPLs will call for additional provisioning, also negatively affecting banks' profits.

Nature/Source of Main Threats	Overall Level of Concern	
	Likelihood of Severe Realization of Threat in the Next 1–3 Years (high, medium, or low)	**Expected Impact on Financial Stability if Threat is Realized** (high, medium, or low)
banks and confidence loss by bank depositors.	• A depositor confidence loss could lead to banking system liquidity shocks.	• Bank recapitalization could be problematic in the absence of parent bank support.
	• Addressing the ongoing deterioration of asset quality has been challenging, and hopes that growth recovery would restore bank balance sheets have not materialized. At about 15 percent to total loans, the high stock of NPLs constitutes a looming contingent liability for the state/public sector.	• Authorities unlikely to have the resources/framework to deal with problems in a large bank. • Liquidity strains may turn into solvency problems. • Currency Board Arrangement and lack of LOLR facilities limit the range of options available. • *(In the stress tests, these risks are incorporated through (i) and adverse macroeconomic scenario and (ii) a liquidity stress test.)*
5. Unavailability of official budget financing and sovereign debt restructuring.	**Staff assessment: Low** • A challenging political and economic climate and difficult policy coordination could derail progress under the SBA and lead to unavailability of (or delay in) official budget support. • Entity governments have limited sources of alternative financing, already having saturated the domestic market. Pricing and availability of additional budget financing will become an issue. • Political uncertainty surrounding this year's general elections could pose further fiscal policy risks.	**Staff assessment: Low** • Sluggish growth and weak tax revenue may complicate the servicing of domestic debt and a run-up in arrears. This may lead to additional austerity measures and weaker domestic demand, thus impacting banks' credit activity. • Both foreign and domestic banks have accumulated government securities through their purchases of entity debt. A potential restructure (or default) of entity government's debt would somewhat impact banks' balance sheets. • The official sector may be forced to accelerate the withdrawal of their banks' deposits, compromising banks' liquidity position. *(These risks are incorporated mainly through sensitivity analysis.)*

Appendix II. Stress Test Matrix (STeM) for Solvency, Liquidity, and Contagion Risks

Domain		Assumptions		
		Bottom-Up by Banks (if applicable)	Top-Down by Authorities (if applicable)[1]	Top-down by FSAP Team (if applicable)
BANKING SECTOR: SOLVENCY RISK				
1.Institutional Perimeter	Institutions included	• All banks (27 banks)	• All banks (27 banks)	• All banks (27 banks)
	Market share	• Percentage of total sector assets: 100 percent	• Percentage of total sector assets: 100 percent	• Percentage of total sector assets: 100 percent
	Data and baseline date	• Supervisory data • Banks' own data	• Supervisory data	• Supervisory data • Publicly available data
2. Channels of Risk Propagation	Methodology	• Combination of banks' own internal models and pre-defined benchmarks.	• CBBH's stress testing framework supplemented with the IMF balance sheet stress testing framework.	• IMF balance sheet stress testing framework (tailor-made for the Bosnia and Herzegovina FSAP)
	Satellite Models for Macro-Financial linkages	• Banks' own models for credit losses, pre-impairment income; expert judgment.	• CBBH's models supplemented with IMF's econometric models for credit losses, pre-impairment income; expert judgment.	• IMF's econometric models for credit losses, pre-impairment income; expert judgment.
	Stress test horizon	• 5 years (2015–2019)	• 5 years (2015–2019)	• 5 years (2015–2019)
3. Tail shocks	Scenario analysis	• Shocks based on GDP trajectories, and translated in a consistent manner to all other variables in the macro-scenarios. • Three scenarios: baseline scenario; moderate external shock scenario; severe external shock scenario	• Shocks based on GDP trajectories, and translated in a consistent manner to all other variables in the macro-scenarios. • Three scenarios: baseline scenario; moderate external shock scenario; severe external shock scenario	• Shocks based on GDP trajectories, and translated in a consistent manner to all other variables in the macro-scenarios. • Three scenarios: baseline scenario; moderate external shock scenario; severe external shock scenario

[1] Solvency top-down stress tests to be done jointly by the FSAP team and the staff at the CBBH.

Domain		Assumptions		
		Bottom-Up by Banks (if applicable)	Top-Down by Authorities (if applicable)[1]	Top-down by FSAP Team (if applicable)
		(implying output losses larger than those recorded in recent relevant historical crisis).	(implying output losses larger than those recorded in recent relevant historical crisis).	(implying output losses larger than those recorded in recent relevant historical crisis).
	Sensitivity analysis	• Single-factor shocks: interest rate; exchange rate; sovereign securities loss/haircut. • Credit concentration risk.	• Single-factor shocks: interest rate; exchange rate; sovereign securities loss/haircut. • Credit concentration risk.	• Single-factor shocks: interest rate; exchange rate; sovereign securities loss/haircut. • Credit concentration risk.
4.Risks and Buffers	Risks/factors assessed (How each element is derived, assumptions.)	• Comprehensive coverage of solvency risks: • *Credit risk*: credit risk on loan book; issuer default risk on government and corporate bond and other debt instrument holdings. • *Market risk*: interest rate risk impact on net interest income, government and corporate bond and other debt instrument holdings; FX risk. • *Equity investment-related risk* (includes both credit and market risk components). • *Operational risk.*	• Comprehensive coverage of solvency risks: • *Credit risk*: credit risk on loan book; issuer default risk on government and corporate bond and other debt instrument holdings. • *Market risk*: interest rate risk impact on net interest income, government and corporate bond and other debt instrument holdings; FX risk. • *Equity investment-related risk* (includes both credit and market risk components). • *Operational risk.*	• Comprehensive coverage of solvency risks: • *Credit risk*: credit risk on loan book; issuer default risk on government and corporate bond and other debt instrument holdings. • *Market risk*: interest rate risk impact on net interest income, government and corporate bond and other debt instrument holdings; FX risk. • *Equity investment-related risk* (includes both credit and market risk components). • *Operational risk.*
	Behavioral adjustments	• Evolution of total assets and RWAs based on constant balance sheet assumption. • No management actions considered. • Other net income items, dividends, and taxes, based on macroeconomic scenarios and pre-determined rules.	• Evolution of total assets and RWAs based on constant balance sheet assumption. • No management actions considered. • Other net income items, dividends, and taxes, based on macroeconomic scenarios and pre-determined rules.)	• Evolution of total assets and RWAs based on constant balance sheet assumption. • No management actions considered. • Other net income items, dividends, and taxes, based on macroeconomic scenarios and pre-determined rules.
5. Regulatory and	Calibration of risk	• Expected losses or loan migration (downgrades) and	• Expected losses or loan migration (downgrades) and	• Expected losses or loan migration (downgrades) and

Domain		Assumptions		
		Bottom-Up by Banks (if applicable)	Top-Down by Authorities (if applicable)[1]	Top-down by FSAP Team (if applicable)
Market-Based Standards and Parameters	parameters	changes in provisions based on banks' internal models. • Estimation of expected gains/losses on government and corporate bond holdings, real estate and equity investments based on banks' internal models.	changes in provisions based on satellite models. • Estimation of expected gains/losses on government and corporate bond holdings, real estate and equity investments based on satellite models (including gap and duration analysis).	changes in provisions based on satellite models. • Estimation of expected gains/losses on government and corporate bond holdings, real estate and equity investments based on satellite models (including gap and duration analysis).
	Regulatory/Accounting and Market-Based Standards	• Hurdle rates based on regulatory minimum for total regulatory capital (i.e., CAR of 12 percent). • Basel I rules.	• Hurdle rates based on regulatory minimum for total regulatory capital (i.e., CAR of 12 percent). • Basel I rules.	• Hurdle rates based on regulatory minimum for total regulatory capital (i.e., CAR of 12 percent). • Basel I rules.
6. Reporting Format for Results	Output presentation	• CAR, shortfall (if applicable). • Pass or fail; number of "undercapitalized" banks (i.e., with a CAR below 12 percent). • System-wide and by entity.	• CAR, shortfall (if applicable). • Pass or fail; number of "undercapitalized" banks (i.e., with a CAR below 12 percent). • System-wide and by entity.	• CAR, shortfall (if applicable). • Pass or fail; number of "undercapitalized" banks (i.e., with a CAR below 12 percent). • System-wide and by entity.
BANKING SECTOR: LIQUIDITY RISK				
1. Institutional Perimeter	Institutions included	• All banks (27 banks)		
	Market share	• Percentage of total sector assets: 100 percent		
	Data and baseline date	• Supervisory data • Banks' own data		
2. Channels of Risk Propagation	Methodology	• Basel III LCR-type proxy • Basel III NSFR-type proxy		
3.Risks and Buffers	Risks	• Market liquidity • Maturity mismatches		

Domain		Assumptions		
		Bottom-Up by Banks (if applicable)	Top-Down by Authorities (if applicable)[1]	Top-down by FSAP Team (if applicable)
	Buffers	• Counterbalancing capacity (HQLA, ASF).		
4. Tail shocks	Size of the shock	• Haircuts and run-off rates as defined in Basel III for LCR and NSFR		
5. Regulatory and Market-Based Standards and Parameters	Regulatory standards	• LCR proxy should exceed 100 percent (not a legal/regulatory requirement). • NFSR proxy should exceed 100 percent (not a legal/regulatory requirement).		
6. Reporting Format for Results	Output presentation	• Pass rate, remaining buffers, and liquidity shortfall (if applicable). • System-wide and by entity.		
BANKING SECTOR: CONTAGION RISK				
1.Institutional Perimeter	Institutions included	• N/A	• N/A	• All banks (27); All insurance companies (25)
	Market share	• N/A	• N/A	• Percentage of total sector assets: 100 percent
	Data and baseline date	• N/A	• N/A	• Supervisory data. • Banks' own data. • Publicly available data.
2. Channels of Risk Propagation	Methodology	• N/A	• N/A	• Network analysis, using Espinosa-Vega and Solé (2010) methodology.
3. Tail shocks	Size of the shock	• N/A	• N/A	• Stress scenario with a credit shock: a severe stress in a bank or a banking system, causing a default on all of its liabilities to domestic institutions or foreign banks. • Stress scenario with a joint

Domain		Assumptions		
		Bottom-Up by Banks (if applicable)	Top-Down by Authorities (if applicable)[1]	Top-down by FSAP Team (if applicable)
				credit and funding shock when the default of a bank or a banking system also leads to a liquidity squeeze for those institutions funded by the defaulting bank or banking system.
4. Reporting Format for Results	Output presentation	• N/A	• N/A	• Capital impairment to domestic banking system, number of failed banks, and remaining buffers (at both banking-system level and bank level) • Capital impairment to domestic insurance sector, number of failed insurance companies, and remaining buffers (at both sector-wide level and company level)

Source: IMF staff.