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BANK CRISIS RESOLUTION—STRESS TESTING

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TECHNICAL NOTE

STRESS TESTING

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This Technical Note was prepared in the context of a joint IMF-World Bank Financial Sector Assessment Program (FSAP) mission in the Republic of Moldova during February 17 to March 5, 2014 led by Simon Gray, IMF, and Brett Coleman, World Bank, and overseen by the Monetary and Capital Markets Department, IMF, and the Finance Markets Global Practice, World Bank. The note contains the technical analysis and detailed information underpinning the FSAP assessment's findings and recommendations. Further information on the FSAP program can be found at http://www.imf.org/external/np/fsap/fssa.aspx.

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Glossary

AFS	Available For Sale
BCBS	Basel Committee on Banking Supervision
CAR	Capital Adequacy Ratio
EAD	Exposure at Default
FX	Foreign Exchange
GDP	Gross Domestic Product
GRAM	Global Risk Assessment Matrix
HQLA	High Quality Liquid Assets
HFT	Hold For Trading
HTM	Hold To Maturity
LCR	Liquidity Coverage Ratio
LGD	Loss Given Default
MDL	Moldovan lei
NBM	National Bank of Moldova
NEER	Nominal Effective Exchange Rate
NPL	Nonperforming Loan
PD	Probability of Default
REER	Real Effective Exchange Rate
RWA	Risk Weighted Assets

EXECUTIVE SUMMARY[1]

This note discusses the stress tests that were carried out on Moldova's banking system as part of the 2014 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 National Bank of Moldova (NBM), and complement other approaches, such as the analysis of financial indicators and the assessment of the quality of supervision.

The stress tests focused on the banking system and covered all 14 banks operating in the country. Top-down solvency stress tests were conducted jointly by the FSAP team and staff from NBM, using supervisory data. These stress tests were complemented by bottom-up stress tests, conducted by individual banks using their own internal models, but applied to the macroeconomic scenarios provided by the FSAP team. In addition, liquidity stress tests, together with complementary sensitivity analysis were also carried out on all banks in the system.

Four macroeconomic scenarios were considered in the financial stability assessment. In addition to a baseline scenario, based on the latest IMF staff projections, three alternative scenarios were designed to assess the stability of the banking system. Full-fledged macroeconomic projections were quantified for each of these scenarios. These scenarios are:

- *A deeper than expected slowdown in major emerging markets*, combined with the implied lower oil prices, result in a moderate slowdown of the Russian economy, with consequences on Moldova's trade, remittances, and capital inflows.

- *A severe global shock*, caused by the disorderly unwinding of unconventional monetary policies. The global economy is adversely affected in tandem with global financial markets, triggering an increase in sovereign spreads and re-intensification of stress in the euro area periphery. This is also accompanied by fall in global oil prices, causing Russia's real gross domestic product (GDP) growth to fall sharply owing to linkages to advanced markets and oil price dependency. Overall, this scenario has severe consequences for Moldova's economy due to the combined trade, remittances and capital inflow shocks.

- *A severe drought in Moldova, in combination with restrictions on Moldovan exports to Russia*, adversely affecting agriculture output and exports. Overall GDP growth falls due to the share of agriculture on the economy and its secondary effects on other economic sectors. The domestic currency depreciates and interest rates rise.

The stress tests include a comprehensive assessment of risk factors. The assessment of credit risk in the loan book was carried out for the different currencies in which loans are extended. Although this type of credit risk is the prevailing risk factor on the banks' balance sheet, credit risks in other

[1] This Technical Note has been prepared by Carlos Caceres, IMF.

portfolios were also analyzed, including issuer default risk on all debt instrument holdings, and also equity investment risks stemming from potential bankruptcies of the companies in which banks might hold some participation. Similarly, several market risk-related factors were also covered in the stress tests. These include, net gains (losses) on interest income from interest rate sensitive assets and liabilities, valuation net gains (losses) on fixed income instruments, and exchange rate risks from the banks' open Foreign Exchange (FX) positions (in different currencies). The analysis of credit risk also included the indirect effects of market risk. In addition, the scenario-based stress tests were complemented with sensitivity analysis to assess other risks, such as concentration risk and contagion risks from the interbank market. Finally, liquidity stress tests were conducted to assess the system's overall liquidity; these tests also assessed FX liquidity separately.

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 more generally) are sensitive to macroeconomic conditions. In particular, asset quality for foreign currency denominated loans is highly dependent on exchange rate developments.[2] Potential loan losses due to credit risk were estimated to range from MDL 1.7 billion (1.7 percent of GDP) in our first adverse scenario to MDL 5 billion (5.1 percent of GDP) in our most severe scenario. Other sources of credit risk remain contained, owing to the banks' relatively small exposure and risk involved in their holdings of government and corporate bonds, and limited amounts of equity investments.

Top-down and bottom-up stress test results are broadly aligned, except for credit risk losses on the loan portfolio. Overall, the aggregate increases in non-performing loans from the top-down stress test are noticeably larger than those of the bottom-up stress tests. The main differences relate to loans denominated in foreign currencies (EUR and USD), where top-down results call for significantly larger amount of provisions for impaired loans. 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 (in a few cases, surprisingly, none) to the macroeconomic conditions depicted in these macroeconomic scenarios, thus biasing the aggregate results.

Risks related to changes in interest rates are limited. Owing to the fact that most loans in Moldova are issued at a floating rate, the gap between assets and liabilities according to their time to-repricing is quite small. In terms of potential valuation gains or losses on debt instruments holdings, the amounts involved are relatively small and most of these instruments are held-to-maturity. Indeed, none of the banks holds any securities for trading purposes. Thus, valuation gains or losses on these instruments remain relatively small.

[2] These sensitivities were estimated based on an empirical analysis using data over the period 1998-2012. Future sensitivities could be lower as banks have attempted to reduce their exposures to unhedged borrowers following large losses during the global financial crisis (2008–09).

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. Moreover, given the absence of trading instruments, and the limited amount of securities on the banks' investment portfolios, other sources of market risk are contained.

Concentration risks are high in specific segments of the banking sector. Although the average large exposure share at the system level remains relatively moderate, a few banks present large single name exposures, posing significant concentration risks to these institutions. In one particular case, 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 manageable at the system level, but a couple of banks could become insolvent if a small number of their largest exposures were to default.

Contagion risks through the domestic interbank market are small, but some banks present sizeable foreign exposures. Based on reported data, and owing to the limited amount of domestic interbank transactions among banks, the hypothetical default of any bank in the system would not have any "cascade effects" on the rest of the system. However, a few domestic banks exhibit significantly large interbank exposures to foreign banks. If these foreign banks were to renege on these interbank obligations or the funds were otherwise to be blocked, a couple of domestic banks could become insolvent. Nevertheless, these losses would be contained within the banks in question, and are not likely to have a direct impact on the overall domestic banking system.

With a few exceptions, most bank liquidity positions appear to be sound. Liquidity stress tests, based on Basel III LCR-type proxies, show that the banking system as a whole has ample liquidity, with the system-wide liquidity coverage ratio exceeding 100 percent. The stress tests also assessed the liquidity in foreign currency, and yielded similar results. However, there are a couple of banks whose ability to meet the liquidity norms is based on relatively large-scale cross-border interbank placements, and there are some doubts about the genuine liquidity of these positions. Overall, the potential liquidity shortfall could be around MDL 1.6 billion (1.6 percent of GDP). In terms of FX liquidity, this figure would be MDL 1.2 billion (USD 89mn), which represents only a small portion (3 percent) of central bank FX reserves.

Overall, the banking system appears to be well-capitalized and liquid, but significant vulnerabilities remain in some 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, although non-negligible, remain manageable. Similarly, system-wide liquidity ratios appear broadly adequate, in both local and foreign currencies. Nevertheless, there are three banks within the system with a wide range of significant vulnerabilities. These include: large concentration risks, significant cross-border interbank exposures, and questionable quality of some of their liquid assets, among others. While these three banks are highly interconnected among themselves, they present low identified 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, non-transparent

relationships as well as 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.

This note is structured as follows: Section II presents a brief description of the banking sector in Moldova 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 concludes.

BANKING SYSTEM AND STRESS TEST COVERAGE

1. The banking sector in Moldova is mainly domestically oriented, and based in traditional lending activities. In 2013, there were 14 licensed banks operating in Moldova, with total assets close to MDL 70 billion, roughly equivalent to 72 percent of GDP. Together the assets of largest five banks account for almost 70 percent of the system (Table 1). Loans to the economy represent the largest share of total assets (56 percent), most of which are directed to the corporate sector. However, a couple of banks exhibit sizeable interbank exposures vis-à-vis other banks, both domestic and cross-border. Finally, assets and liabilities denominated in foreign currency represent an important share of the banks' balance sheet.[3]

Table 1. Balance Sheet Summary of the Banking Sector in Moldova (In millions of MDL unless indicated otherwise)

	All banks	5 largest	All other
Total assets	69,094	47,298	21,796
Total loans	38,457	26,664	11,793
Total deposits	48,033	33,739	14,294
Total regulatory capital	7,766	4,821	2,945
Total risk-weighted assets (RWAs)	33,376	21,695	11,681
Capital adequacy ratio (in percent of RWAs)	**23.3**	**22.2**	**25.2**

Source: Authorities supervisory data and IMF staff calculations.

2. The stress tests covered all 14 banks in the banking system. Top-down stress tests were conducted jointly by the FSAP team and the authorities 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, as of September 30, 2013. In addition, top-down stress tests were complemented by individual bottom-up stress tests conducted by all 14 banks, using their own internal models and based on the macroeconomic scenarios provided by the FSAP team. Finally, liquidity stress tests were also conducted for all the banks operating in Moldova.

MACROECONOMIC SCENARIOS

3. Stress tests were based on the use of full-fledged macroeconomic scenarios. To assess the solvency of the banking sector, four different macroeconomic scenarios were considered, each involving the projections of a large number of macroeconomic and financial variables. The baseline

[3] FX-denominated loans represent 43 percent of the banking sector's lending book.

scenario used the projections generated by the IMF's Area Department team,[4] established as part of their continuous monitoring of the Moldovan economy. Three alternative scenarios were then developed by the FSAP team, and agreed with the authorities, to test the resilience of the banking sector in the presence of adverse shocks. The projections under each of these scenarios were based on satellite models, and their quantification is presented in Table 6. These three adverse scenarios include:[5]

- ***Adverse Scenario 1*:** A deeper than expected slowdown in major emerging markets, combined with implied lower oil prices, result in a moderate slowdown of the Russian economy, with consequences on Moldova's trade, remittances, and capital inflows.

- ***Adverse Scenario 2*:** Severe global shock, caused by the disorderly unwinding of unconventional monetary policies. The global economy is adversely affected in tandem with global financial markets, triggering an increase in sovereign spreads and re-intensification of stress in the euro area periphery. This is also accompanied by fall in global oil prices. This causes Russia's real GDP growth to fall sharply owing to linkages to advanced markets and oil price dependency. Overall, this scenario has severe consequences for Moldova's economy due to the combined trade, remittances and capital inflow shocks. In terms of economic losses, this scenario entails a fall in Moldovan output larger than that observed in the country during both the Russian crisis (1998-99) and the global financial crisis of 2008-09 (Figure 1).[6]

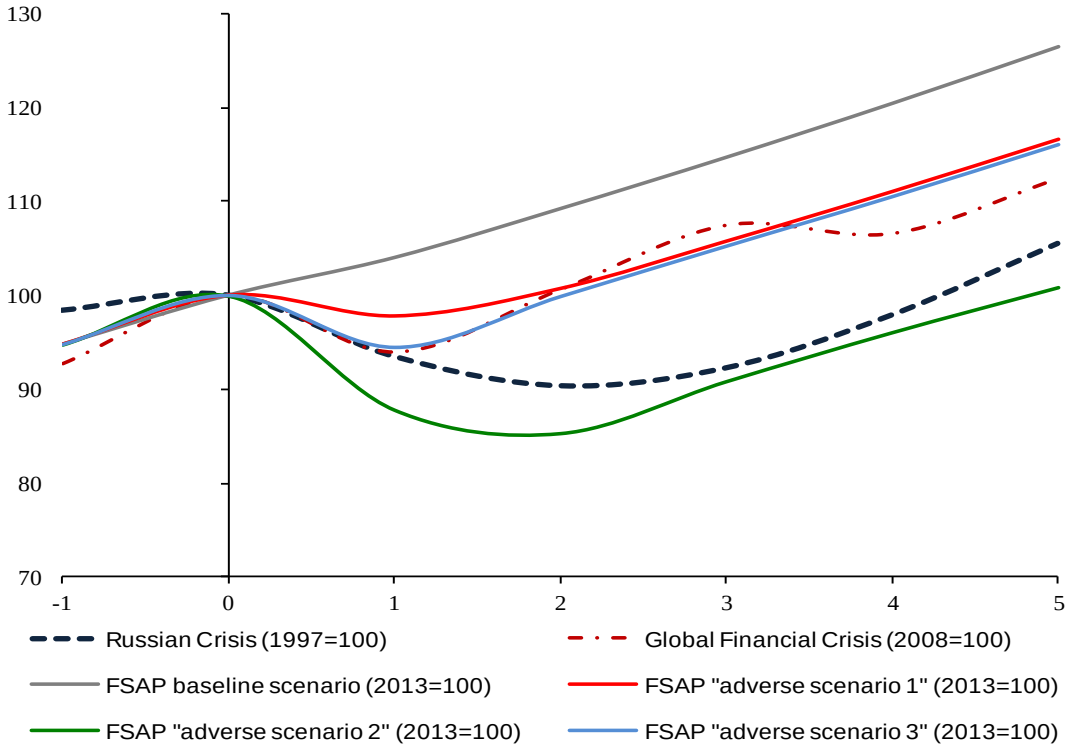
- ***Adverse Scenario 3*:** a severe drought in Moldova, in combination with restrictions on Moldovan exports to Russia, adversely affecting agriculture output and exports. Overall GDP growth falls due to the share of agriculture on the economy and its secondary effects on other economic sectors. The domestic currency depreciates and interest rates rise.

[4] This baseline scenario consists of projections provided by IMF Area Department team as of December 2, 2013, and their latest projections might be slightly different now.

[5] Adverse scenario 1 is based on Risks #1 and #5 in the GRAM of September 2013, whereas adverse scenario 2 is based on Risks #2 and #10.

[6] 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.

Figure 1. Evolution of the Level of Real Gross Domestic Product in the Stress Test Scenarios



Source: IMF staff calculations.

4. Banking sector losses were based on "instantaneous shocks". Although the macroeconomic scenarios generated for the FSAP include multiyear projections, for the period 2014–18, stress tests were conducted based on single point-in-time shocks. Given data limitations, capacity constraints,[7] and the fact that banks operate under Basel I, the assessment of the banks solvency and liquidity was conducted for a single period.[8] Nonetheless, it is worth mentioning that the envisaged "instantaneous shocks" do not necessarily correspond to a single year in the macroeconomic projections (e.g. 2014), but rather attempt to encompass the cumulative and lagged effects usually exhibited by several of the macroeconomic variables included in the scenarios (c.f. last column on Table 6).[9] Furthermore, as risk weights under Basel I remain constant throughout the simulation horizon, the evolution of the CAR under the constant balance sheet assumption derive mainly from changes in capital (the numerator), owing to increased provisions and net income losses,

[7] This is the first time that Moldovan banks conduct bottom-up stress tests, which rely on their own internal methodologies. This, together with the extensive risk coverage of the envisaged stress tests, represented serious challenges for some of the banks, even within a single period ("instantaneous shock") stress testing framework.

[8] See Appendix III for a discussion of the necessary preconditions to conduct adequate multi-period stress tests.

[9] Essentially, the "instantaneous shocks" aim at capturing the larger variation, in terms of the magnitude of the macroeconomic shocks, than that embedded in the changes of these macroeconomic variables in any single year.

rather than changes in risk-weighted assets. Thus, in a multi-period setting, the resulting CAR would simply reflect the cumulative expected net losses over the five year horizon, which can be smaller than those implied by the "instantaneous shocks" considered in these stress tests.

Behavioral assumptions

5. 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. Some of the main behavioral assumptions include: RWAs will remain constant at their pre-shock level; balance sheet composition will remain unchanged; income items such as net fees and commission, operating costs (wages, bonuses, etc), taxes and dividends, are not taken into consideration.

SOLVENCY STRESS TEST

6. 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 (Appendix I), 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;[10] risks related to equity instrument holdings; concentration risk; and contagion risk through interbank exposures, both domestic and foreign.

A. Credit Risk

Credit risk in the loan book

7. Credit risk in the loan book represents the most important risk factor for the banking system. Loans to the economy represent more than half of total banking sector assets, of which a large share is directed towards the corporate sector. Given the relatively large share of FX denominated loans, stress tests also take into account the *indirect effects* of FX risk (that is, through credit risk).

8. 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), the ratio of nonperforming loans (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

[10] Moldovan banks do not hold any securities for trading purposes, thus other market risks (such as the effect of changes in stock prices and volatilities) are not relevant.

implied by the loan migration associated to the increase in NPLs under stress.[11] 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, μ_i is the individual banks fixed effects,[12] $\epsilon_{i,t}$ is a well-behaved error-term, and α and the vector $\boldsymbol{\beta}$ are parameters to be estimated. The above model was estimated separately for each type of currency. Overall, the NPL-ratio under stress was computed as:

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

9. Equation [2] was estimated using annual data over the period 1998-2012. Data on NPLs were available at an annual frequency, and were disaggregated along 20 different economic sectors, and by type of currency (MDL, USD, EUR and other currencies). Among the main macroeconomic variables, real GDP growth, the exchange rate, and - to a lesser extent – interest rates were found to be the main drivers of NPLs. The resulting coefficients for the effects of these three macroeconomic variables on the logit transform of the NPL-ratio are summarized in Table 2. Real GDP growth is found to have a negative and significant effect on credit risk, that is, when economic activity increases, the NPL-ratio decreases as expected. Similarly, an appreciation of the MDL exchange rate lowers the NPL-ratio. Similar results were obtained using slightly different specifications of equation [2]. Specification [3] was used for modeling NPLs thereafter.

10. 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 exchange rate changes in addition to economic conditions, owing to the relatively large share of FX denominated loans. These credit risk losses on the loan book range from MDL 1.7billion in "adverse scenario 1" to MDL 5.0 billion in "adverse scenario 2," equivalent to 1.7 and 5.1 percent of total banking system assets, respectively (Table 7).

[11] This framework explicitly models the behavior of NPLs, i.e., loans classified in categories 3, 4, and 5 ("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.

[12] Owing to data limitations, no bank specific variables were included in these regressions. Instead, fixed effects were used to control for bank specific characteristics.

11. Top-down credit risk losses on the loan book are larger than the bottom-up losses estimated by the banks (Figure 2). In general, the implied increases in aggregate NPLs from the top-down stress test are noticeably larger than those of the bottom-up stress tests (Table 8). The main differences relate to those loans denominated in foreign currencies (EUR and USD), where top-down results call for a significantly larger amount of provisions for impaired loans. In several cases, 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 almost no reaction—or even none—to the macroeconomic conditions depicted in the stress tests scenarios, which seems less plausible.

Table 2. Results from the Estimation of Equation [2]
(Dependent variable: logit transform of nonperforming loan ratio)

Loan currency denomination:	MDL	USD	EUR
Real GDP growth	-0.0671 * * *	-0.0609	-0.0782 *
	(0.0237)	(0.0442)	(0.0468)
Lending interest rate	-0.0021	-0.0317	-
	(0.0252)	(0.0488)	
Changes in NEER 1/	-0.0080	-	-0.0579 * *
	(0.0124)		(0.0289)
Changes in USD/MDL exchange rate 1/	-	-0.0280 * *	-
		(0.0141)	

Source: IMF staff calculations

Notes:

1/ An increase in these variables denote an appreciation of the MDL.

* Denotes significance at the 10 percent level; ** at the 5 percent level; and *** at the 1 percent level.

Issuer default risk

12. 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 entailed the computation of expected losses on debt instrument holdings in the banks' balance sheet. Credit risk losses on these holdings derive from the potential default by the issuer of these instruments (i.e., "issuer default risk") in the stress scenarios. Box 1 describes the methodology used in the top-down stress tests to estimate such losses. These debt instrument holdings include domestic government bonds, corporate bonds and other debts instruments (such as foreign sovereign bonds), in all three available-for-sale (AFS), hold-for-trading (HFT), and hold-to-maturity

(HTM) portfolios. Overall, these exposures remain relatively small, representing altogether less than 8 percent of total assets. Note that expected losses on these holdings related to other risk factors (such as valuation changes due to interest or exchange rate movements) are treated separately, and are described in the "Market Risk" section.

13. 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 (Table 7). Government bonds represent around 95 percent of these holdings. 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.

B. Market Risk

14. 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, exchange rates, interest rates, 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 Moldovan banks do not hold any securities for trading purposes, interest and exchange rate risks were 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

15. Part of the impact of interest rate risk was assessed using time-to-repricing buckets. Different interest rate sensitive assets and liabilities are 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 simply computed as the product of this gap and the changes in the interest rate.[14] 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.

[13] Data were available for the following time-to-repricing buckets: less than 1 month; 1 to 3 months; 3 to 6 months; 6 to 12 months; and more than 12 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.

[14] The envisaged interest rate shocks represent an increase of 0.7, 1.5 and 1.1 standard deviations (in historical terms over the period 1997–12) under Adverse Scenarios 1, 2, and 3, respectively.

Box 1: Computation of Potential Losses due to Issuer Default Risk

For sovereign bond holdings (AFS, HFT, 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.

According to Moody's, Moldova's current sovereign rating is in the "B level" category, with a corresponding default probability of 3.391 percent over a 12-month period. This is the level taken as a starting point in the FSAP stress test (i.e. $PD_0 = 0.03391$).

Based on panel regression analysis,[15] 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 was computed. In addition, following Moldova's (technical) default experience in 2002, a recovery rate of 90 percent was assumed in the stress tests.

Regarding expected losses due to issuer risk for corporate bond holdings, the same methodology was used. The stress tests assume that Moldova's corporate sector rating is the same as that of the sovereign, implying an initial corporate default probability of 4.466 percent. Using the same elasticity γ above, the corporate default probabilities were obtained for the different scenarios. In terms of LGD, based on the World Bank doing business report, the recovery rate in Moldova is 32.8 percent, which was then used in the computation of expected losses in the stress tests.

16. Potential losses on interest income are small owing to the widespread use of floating rate loans. Given that the vast majority of the banks' lending book is made of floating (i.e., variable) rate loans, the time-to-repricing gaps are fairly small. Moreover, 79 percent of interest rate sensitive assets and 68 percent of interest sensitive liabilities exhibit a time-to-repricing lower than one month. Indeed, most banks present 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 (Table 7).

17. Interest rate risk through valuation effects on debt instrument holding was also assessed. The other potential source of gains or losses related to changes in interest rates are

[15] 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.

valuation changes on government and corporate bond holdings. 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 MDL) of each individual bond holding. Finally, 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.

18. Potential valuation losses on fixed income instruments remain limited. Owing to their limited exposure regarding debt instruments and the fact that banks hold mostly government bonds at HTM, the implied valuation changes in the adverse scenarios are fairly small. Banks do not hold any debt instrument for trading purposes, and just a few government and corporate bonds are held on an AFS basis.

Exchange rate risk

19. 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 four categories: USD, EUR, RUB, and "other currencies".[17] 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.[18] 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) were analyzed within the credit risk section, and were found to be rather significant for the loan book.

20. Most banks tend to exhibit fairly small net open FX positions, limiting potential losses. In addition to the existing regulatory limits,[19] bank risk managers in Moldova tend to aim at keeping their net open FX positions close to "zero". Therefore, the implied gains or losses due to exchange rate risk remain small, despite the sharp generalized depreciations of the local currency in the adverse stress test scenarios.

21. 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. Most of the differences in the estimated losses are mainly explained by the way in which individual banks translated the macroeconomic scenarios into effective risk parameters used in their stress tests.

[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).

[17] The amounts included in the "other currencies" category is minimal, with the corresponding position representing less than 0.5 percent of the banks' total FX positions.

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

[19] Net open FX positions are capped at 10 percent of capital for each individual currency, and 20 percent of capital for the aggregate (i.e., all currencies) net open position.

C. Risks Associated to Equity Investments

22. Expected losses on equity instruments relate mainly to potential bankruptcies of the companies in which banks have invested. In theory, potential losses on equity instruments held by banks can arise from two main sources of risk: credit risk and market risk. Credit risk losses on these equity investments could materialize, for instance, when one of the (non-financial) companies in which a bank has invested goes bankrupt. Whereas, market risk losses on equity instruments 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. However, in the case of Moldova, equity investments on the banks portfolios are not for trading purposes (all equity investments are reported as AFS), and usually the companies where these participations are held are not listed in the stock exchange. Therefore, risks associated to equity investments can be considered as credit risk, related to the potential corporate bankruptcies arising in each of the stress test scenarios.

23. 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 (Table 7).

D. Concentration Risk

24. 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 32.8 percent (based on the latest World Bank "Doing Business" report), but alternative assumptions were also used (Table 3).

Table 3. Stress Test Results on Name Concentration Risk

	Default of the largest borrower			Default of the largest 5 borrowers		
Assumed recovery rate (in percent)	**0.0**	**32.8**	**65.0**	**0.0**	**32.8**	**65.0**
System-wide CAR (in percent of RWAs)	18.6	21.5	24.3	7.0	17.9	28.6
Implied capital shortfall (in millions of MDL) 1/	421	231	125	3,181	898	210
Number of banks with a CAR less than 16 percent	3	2	1	11	4	1
Number of insolvent banks 2/	0	0	0	2	1	0

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 16 percent of risk-weighted assets.
2/ The number of insolvent banks is the number of banks with a negative CAR.

25. 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 largest exposure is around 20 percent of total regulatory capital. However, there is a wide dispersion among different banks, where the largest exposure ranges from as low as 7 percent to as high as 68 percent of capital. Therefore, these risks seem to be concentrated within a couple of banks, as confirmed by the stress test results. Overall, the losses at the system level seem to be manageable. The default by the largest exposure of each bank in the system would imply a capital shortfall of around MDL 231m (0.2 percent of GDP). Even under the most extreme case scenario, with a simultaneous default by the five largest exposures in each bank and assuming a "zero" recovery rate, only two banks would become insolvent, and the total capital shortfall would be around MDL 3 billion (3.1 percent of GDP).

E. Interbank Contagion Risk

26. Contagion risks were assessed using the matrix of interbank exposures. This matrix contains, for each bank, the net domestic interbank exposure to every other bank in the system.[20] The stress test assumes the hypothetical default of each bank, one at a time, on all its interbank obligations, and assesses the impact on other banks. If the default of any given bank on its interbank obligations implies the default of another bank in the system, a subsequent round must be calculated to assess the impact of the second bank's default on all other banks, and so on (i.e., "cascade effects"). In addition, and given the relatively large amount of interbank exposures to foreign (cross-border) banks, the analysis was complemented by the assessment of interbank exposures of Moldovan banks to foreign banks. This analysis assesses the impact that a hypothetical default by a foreign bank on these interbank obligations would have on the domestic bank in question and on the rest of the domestic banking system in turn.

27. Contagion risks stemming from domestic interbank exposures remain limited. The domestic interbank market is thin, characterized by small interbank exposures. Using data as of end-September 2013, it was found that no significant "cascade effects"—that is, the subsequent defaults of banks when any of the banks in the system defaults on its interbank obligations—would take place through the interbank market. Indeed, only one small bank would be in distress if one of the large banks defaults on its interbank obligations; the default of that small bank would have no significant effects on the rest of the system.[21]

28. However, some domestic banks appear to be highly exposed to foreign (cross-border) banks. Despite the limited domestic interbank exposures among Moldovan banks, some banks in the system exhibit significant interbank exposures to foreign banks. Indeed, it was found that for a few domestic banks, their interbank exposure to a single foreign bank is large enough that, if that

[20] In a system with 14 banks, the interbank exposure matrix is a square matrix of size 14 x 14.

[21] These conclusions remain the same when using interbank data as of end-December 2013. In fact, these data would suggest that the default of any bank in the system on its interbank obligations would not trigger the default of any other bank in the system due to their interbank exposures.

bank were to renege on this interbank obligation, or this obligation become impaired in some other way, then the domestic bank would be insolvent.[22] Nevertheless, owing to their limited domestic interbank linkages, the potential stress in these banks is not likely to affect directly other banks in the system. However, other sources of contagion not analyzed here (for instance, through confidence and reputational factors) might represent additional risks to the stability of the overall financial system.

LIQUIDITY STRESS TEST

29. Liquidity stress tests were based on Basel III LCR-type proxies (Appendix II). The main liquidity indicators are based on the "stressed LCR" embedded in Basel III.[23] The LCR measures the banks' potential net outflows over the next 30 days, and the counterbalancing capacity of the banks—i.e. the amount of available high quality liquid assets (HQLA) - to be able to cover these potential outflows. Banks should maintain an LCR above 100 percent. Specific deposit run-off rates and asset haircuts are included to emulate stress conditions. LCR-type proxies can also be computed to assess banks' liquidity position in different currencies.

30. Top-down liquidity stress tests were conducted jointly by the FSAP team and NBM staff. The assessment of liquidity was conducted using slight variants of the framework currently in place at the NBM, used in their quarterly liquidity stress test. The framework currently employed at the NBM follows the methodology proposed during a recent technical assistance mission by the World Bank.[24] The banks were not required to conduct a bottom-up liquidity stress test. Since these liquidity stress tests are based on LCR proxies using supervisory data reported by the banks, with predetermined deposit run-off rates and asset haircuts, results from top-down and bottom-up stress tests would have yielded—by construction—identical results. Thus, in this case, bottom-up liquidity stress test would have represented a duplication of efforts with virtually no value added.

A. Overall Liquidity

31. Liquidity stress tests assumed various deposit run-off rates and asset haircuts. The assumptions embedded in the LCR proxy within the NBM's existing liquidity framework were calibrated based on historically observed deposit run-off rates in Moldova. These run-off rates, together with the assumed asset haircuts, are presented in Table 4. One of the main differences between the assumptions in the NBM framework with those suggested in Basel III LCR documentation is that NBM haircut on interbank claims with maturity less than 1 month is

[22] A couple of Moldovan banks exhibit single interbank exposures to individual foreign banks whose amounts are larger than their total reported capital.

[23] See "International framework for liquidity risk measurement, standards and monitoring" by the BCBS, 2010, The Bank for International Settlements (BIS).

[24] See Technical Note on "Stress Testing Banking Sector Liquidity, Republic of Moldova" by Attila Csajbok, 2013, The World Bank.

50 percent—compared to 100 percent under Basel III. Thus, FSAP liquidity stress tests were carried out using both Moldova specific and Basel III assumptions.

Table 4. Liquidity Stress Test Assumptions on Haircuts and Run-off Rates (In percent)

	LCR - BNM methodology	LCR - Basel III assumptions
Liquidity *buffer*		
Cash	**0**	**0**
Central bank instruments (2-week CBNs)	**0**	**0**
Government securities eligible as collateral RM<35 days	**5**	**15**
Government securities eligible as collateral RM>35 days	**20**	**15**
Required reserves on deposits (FX+MDL) (eligible collateral)	**20**	**0**
Interbank claims with less than 1 month maturity	**50**	**100**
Loans (performing) maturing in 1 month	**20**	**50**
Monthly repayments on loans with maturities greater than 1 month	**20**	**50**
Other assets maturing in 1 month	**30**	**50**
Excess reserves on deposits in MDL	**0**	**0**
Potential *outflows*		
Deposits: Interbank	**69**	**100**
Deposits: Households	**26**	**5 - 10**
Deposits: Corporates	**16**	**5 - 75**
Non-deposit liabilities maturing in 1 month	**100**	**25 - 100**
Total contingent engagements	**10**	**10**

Sources: BCBS (2010), IMF staff calculations.

32. Overall, system-wide liquidity appears to be broadly appropriate. Liquidity stress test results suggest that aggregate LCR using the NBM methodology is around 167 percent, whilst that under Basel III assumptions is 110 percent (Table 9). Indeed, under the domestic methodology all banks in the system exceed the LCR threshold of 100 percent, and thus none of the banks presents any liquidity shortfall. Nevertheless, the results of the LCR under Basel III assumptions suggest that the potential liquidity shortfall could be around MDL 1.6 billion (1.6 percent of GDP), and this shortfall would be concentrated in four banks.

33. However, a few banks meet their liquidity requirements based on interbank claims. Indeed, the main difference between the results obtained from the LCR based on the NBM methodology and that using Basel III assumptions is due to some banks which present very large amounts of interbank claims. Under Basel III, these assets are considered to be "illiquid" under stress conditions. In one particular bank, these interbank claims represent over 80 percent of that bank's HQLA (compared to an average of 32 percent for the system as a whole): this is a serious liquidity risk.

B. Foreign Exchange Liquidity

34. Liquidity stress tests also assessed the banks' FX liquidity stance separately. The assumed deposit run-off rates, asset haircuts and other parameters used in the computation of the LCR proxy for testing FX liquidity are presented in Table 5. Similarly to the overall LCR, the LCR in FX compares the possible FX-denominated outflows (over the next 30 days) to the HQLA in FX held by the banks.

35. FX liquidity stress tests suggest that potential liquidity shortfalls appear to be manageable. At 160 percent, the system-wide LCR in FX is well above the 100 percent threshold, suggesting that the banking sector as a whole has enough FX liquidity (Table 9). Nonetheless, 4 banks exhibit an LCR in FX below 100 percent, implying an overall liquidity shortfall of around MDL 1.2 billion (USD 89mn).[25] Moreover, a couple of these banks cover their FX liquidity requirement mainly through HQLA concentrated in overnight FX claims, which represents a significant risk to their liquidity stance. However, the estimated amount of potential liquidity shortfall is relatively small compared to the amount of FX reserves at the central bank. The central bank does not provide emergency lending in FX; but if the bank in question were able to borrow MDL from the central bank, it could in principle then sell the MDL to obtain FX as necessary. Thus the FX liquidity risk for the banking sector as a whole appears to be currently manageable.

Table 5. Assumptions on Haircuts and Run-off Rates for the Liquidity Coverage Ratio in Foreign Exchange
(In percent)

	LCR - FX
Liquidity *buffer*	
FX Cash	**0**
Nostro accounts abroad	**0**
Banks FX placements abroad maturing in 1 month	**0**
FX Interbank Placements maturing in 1 month	**50**
Overnight FX	**0**
FX Loans maturing in 1 month	**20**
Monthly repayments on loans with maturities greater than 1 month	**20**
Other FX assets maturing in 1 month	**30**
Potetial *outflows*	
FX Deposits: Interbank	**69**
FX Deposits: Households	**26**
FX Deposits: Corporates	**16**
Non-deposit FX liabilities maturing in 1 month	**100**
Commited FX credit lines	**10**

Source: IMF staff calculations.

[25] This is roughly equivalent to 3 percent of total FX reserves held by the NBM.

C. Liquidity Link to Solvency

36. Liquidity stress tests were also linked to the results from the solvency stress tests. Following the methodology proposed by recent World Bank technical assistance, different deposit run-off rates were assumed for the different banks based on their solvency stance according to solvency stress tests results.[26] Essentially, these run-off rates are directly related to the CAR of each of the banks; the lower the CAR, the higher the run-off rates on deposits. Intuitively, banks which have a weaker solvency stance are more likely to experience larger deposit withdrawals than those banks perceived to be more stable.

37. Similar conclusions are drawn from these additional liquidity tests, which account for solvency stress. The results obtained from this specific analysis are similar to those implied by the other LCR proxies used in the liquidity tests. Overall losses implied by the LCR linked to solvency risk (LCR-CR in Table 9) amount to around MDL 1.2 billion (1.2percent of GDP). Nevertheless, it is worth noting that the same few banks that present potential liquidity shortfalls are those which are found to exhibit highly concentrated portfolios and large foreign interbank exposures.

CONCLUSIONS

38. Stress tests assessed the financial stability of the banking sector in Moldova. Top-down stress tests, performed jointly by the FSAP team and NBM staff, assessed the solvency and liquidity stance of the entire banking system. These stress tests were complemented by bottom-up stress tests, carried out by all 14 banks operating in the country, using their own internal models applied to the macroeconomic scenarios provided by the FSAP team.

39. The quantitative analysis included macroeconomic scenario-based stress tests, complemented by sensitivity analysis. Scenario-based stress tests used four full-fledged macroeconomic scenarios (one baseline and three adverse scenarios of varying severity) to assess the solvency of the banking system. These stress tests included a 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, and exchange rate related risks, among others. Sensitivity analysis to assess potential concentration risks and risk of contagion through the interbank market were also performed. Finally, liquidity stress tests were carried out to assess both the overall and FX liquidity positions of the banks.

40. 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 in loans denominated in foreign currency seems to be highly

[26] See Technical Note on "Stress Testing Banking Sector Liquidity, Republic of Moldova" by Attila Csajbok, 2013, The World Bank.

sensitive to exchange rate development (though possibly less so now than in the past), in addition to overall economic activity.

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

- Risks related to debt instrument holdings and equity investments are quite small, owing to the limited amount of such holdings in the banks' balance sheet. Most debt instruments are hold-to-maturity, and banks do not hold securities for trading purposes.

- The direct effects of exchange rate risk seem to be contained, due to the relatively small net open FX positions reported by the banks.

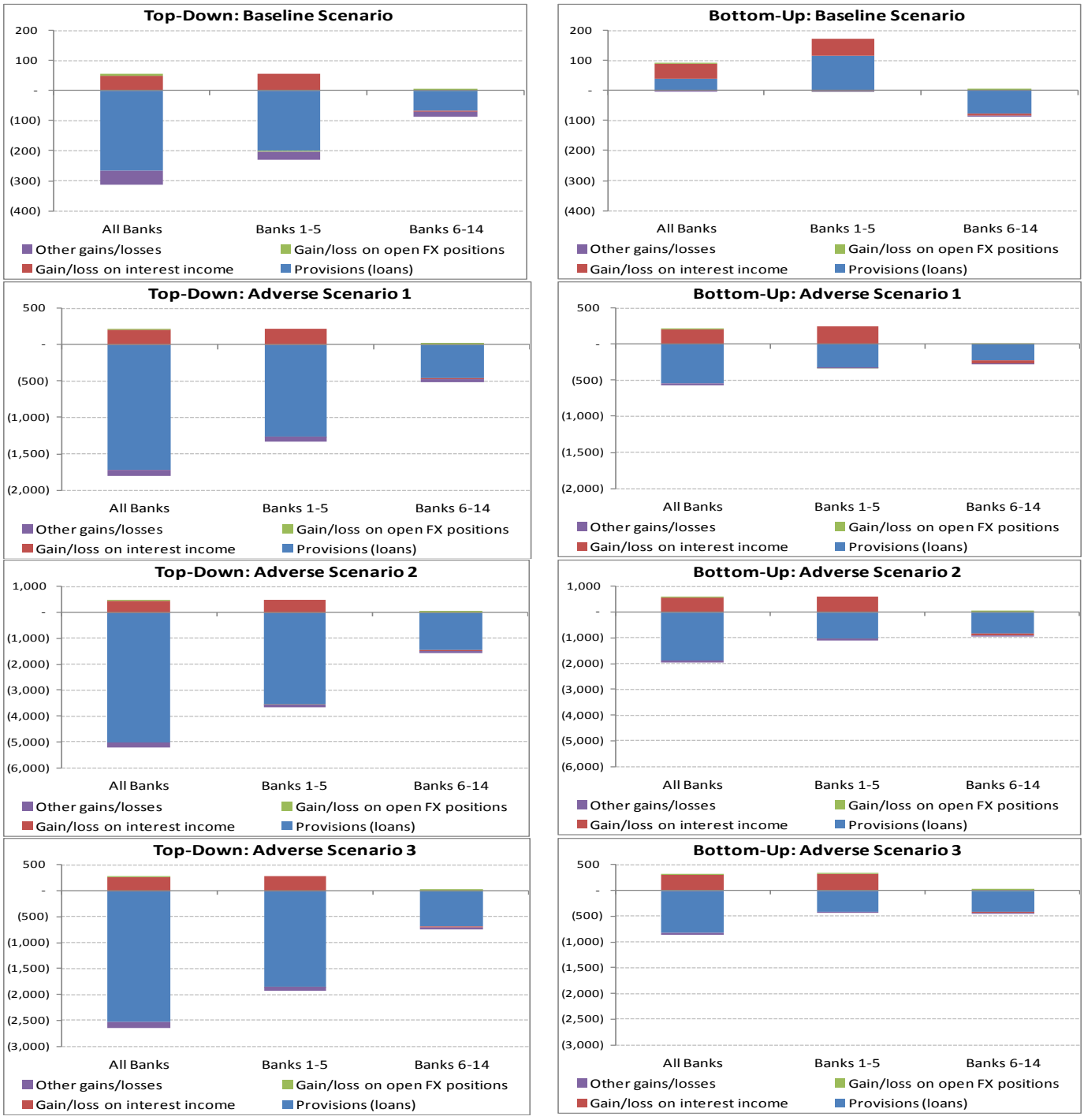
- Concentration risks are extremely high in a couple of banks, where the default by just a few of their largest exposures would render these banks insolvent. Concentration risks in the rest of the system appear more muted.

- Contagion risks through domestic interbank exposures appear to be contained. The hypothetical default by any bank in the system would not trigger any "cascade effects". However, a few banks present significant interbank exposures to foreign banks.

- System-wide liquidity appears to be broadly appropriate, both in domestic currency and in FX. Nevertheless, a couple of banks meet their liquidity requirements with relatively large amounts of cross-border interbank claims, some of which are of questionable quality. Nevertheless, the potential system-wide liquidity shortfalls appear to be manageable.

41. In conclusion, the banking system appears to be well-capitalized and liquid, 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, in both local and foreign currencies. Nevertheless, there are three banks within the system with a wide range of significant vulnerabilities. These include: large concentration risks, significant cross-border interbank exposures, and questionable quality of some of their liquid assets, among others. While these banks are highly 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.

Figure 2. Top-down (lhs) and Bottom-up (rhs) Estimated Potential Losses
(In millions of MDL)



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

Table 6. Macroeconomic Projections in the Stress Test Scenarios[27]

	mean*	s.d.*	Historical 2007	2008	2009	2010	2011	2012	Projection 2013	2014	2015	2016	2017	2018	instantaneous shock
Baseline scenario:															
Real GDP growth (%)	**3.2**	**5.0**	3.0	7.8	-6.0	7.1	6.8	-0.8	5.5	4.0	5.0	5.0	5.0	5.0	**4.0**
Agriculture GDP growth (%)	**0.6**	**17.3**	-35.0	41.1	-9.9	7.4	5.2	-23.3	*23.0*	1.8	5.0	5.0	5.0	5.0	**1.8**
Non-agriculture GDP growth (%)	**4.1**	**5.9**	12.8	2.8	-5.2	7.0	7.1	3.5	3.3	4.3	5.0	5.0	5.0	5.0	**4.3**
CPI inflation (%)	**12.0**	**9.6**	12.4	12.8	-0.1	7.5	7.7	4.5	4.5	4.6	5.6	5.8	5.0	5.0	**5.6**
Interest rates:															
Short-term money market rate (%)	**14.2**	**9.1**	12.4	16.0	10.9	5.6	8.4	5.4	6.8	6.9	7.8	8.0	7.3	7.3	**7.8**
Long-term lending rate (%)	**23.0**	**7.1**	18.8	21.1	20.5	16.4	14.4	13.4	12.3	12.8	13.4	13.8	13.3	13.1	**13.4**
Exchange rates:															
MDL/USD	**11.35**	**2.62**	12.09	10.37	11.19	12.38	11.71	12.13	12.60	13.10	13.50	13.80	14.00	14.30	**13.50**
MDL/EUR	**13.61**	**3.58**	16.55	15.25	15.61	16.42	16.30	15.59	16.68	17.34	17.87	18.27	18.54	18.93	**17.87**
MDL/RUB	**0.46**	**0.11**	0.47	0.42	0.35	0.41	0.40	0.39	0.39	0.40	0.40	0.40	0.40	0.41	**0.40**
NEER (increase = appreciation)	**115.5**	**26.0**	95.8	108.1	113.9	103.2	106.4	109.8	107.2	104.4	102.2	100.7	99.8	98.4	**102.2**
REER (increase = appreciation)	**108.4**	**19.7**	111.5	132.8	135.4	127.2	134.7	140.0	137.5	134.3	131.7	131.7	131.7	131.7	**131.7**
Real estate prices:															
NIKA index growth (%)	**18.8**	**23.5**	15.6	14.9	-13.1	-4.1	0.2	-7.4	3.9	1.0	3.4	3.5	2.6	2.1	**1.0**
Unemployment rate (%)	**6.5**	**2.4**	5.2	4.0	6.5	7.6	6.7	5.6	5.9	5.7	5.3	5.0	5.0	5.0	**5.7**
Domestic credit growth (%)	**24.0**	**16.9**	51.7	20.3	-4.9	12.7	15.0	16.1	13.6	12.7	10.9	11.1	10.3	10.3	**12.7**
Alternative scenario 1 - External (I):															
Real GDP growth (%)	**3.2**	**5.0**	3.0	7.8	-6.0	7.1	6.8	-0.8	5.5	-2.2	3.0	5.0	5.0	5.0	**-2.2**
Agriculture GDP growth (%)	**0.6**	**17.3**	-35.0	41.1	-9.9	7.4	5.2	-23.3	23.0	-1.0	3.0	5.0	5.0	5.0	**-1.0**
Non-agriculture GDP growth (%)	**4.1**	**5.9**	12.8	2.8	-5.2	7.0	7.1	3.5	3.3	-2.4	3.0	5.0	5.0	5.0	**-2.4**
CPI inflation (%)	**12.0**	**9.6**	12.4	12.8	-0.1	7.5	7.7	4.5	4.5	5.4	8.9	6.8	5.0	5.0	**8.9**
Interest rates:															
Short-term money market rate (%)	**14.2**	**9.1**	12.4	16.0	10.9	5.6	8.4	5.4	6.8	7.6	10.6	8.8	7.3	7.3	**10.6**
Long-term lending rate (%)	**23.0**	**7.1**	18.8	21.1	20.5	16.4	14.4	13.4	12.3	11.9	17.3	15.1	13.3	13.1	**17.3**
Exchange rates:															
MDL/USD	**11.35**	**2.62**	12.09	10.37	11.19	12.38	11.71	12.13	12.60	14.62	15.63	15.98	16.21	16.56	**15.63**
MDL/EUR	**13.61**	**3.58**	16.55	15.25	15.61	16.42	16.30	15.59	16.68	19.36	20.70	21.16	21.46	21.92	**20.70**
MDL/RUB	**0.46**	**0.11**	0.47	0.42	0.35	0.41	0.40	0.39	0.39	0.41	0.42	0.42	0.42	0.42	**0.42**
NEER (increase = appreciation)	**84.9**	**22.5**	95.8	108.1	113.9	103.2	106.4	109.8	107.2	95.8	91.4	90.1	89.2	87.9	**91.4**
REER (increase = appreciation)	**108.4**	**19.7**	111.5	132.8	135.4	127.2	134.7	140.0	137.5	123.8	119.9	120.4	120.4	120.4	**119.9**
Real estate prices:															
NIKA index growth (%)	**18.8**	**23.5**	15.6	14.9	-13.1	-4.1	0.2	-7.4	3.9	-7.2	0.9	4.4	2.9	2.1	**-7.2**
Unemployment rate (%)	**6.5**	**2.4**	5.2	4.0	6.5	7.6	6.7	5.6	5.9	7.2	7.3	7.0	7.0	7.0	**7.3**
Domestic credit growth (%)	**24.0**	**16.9**	51.7	20.3	-4.9	12.7	15.0	16.1	13.6	3.1	12.2	12.1	10.3	10.3	**3.1**
Alternative scenario 2 - External (II):															
Real GDP growth (%)	**3.2**	**5.0**	3.0	7.8	-6.0	7.1	6.8	-0.8	5.5	**-12.2**	-2.8	6.5	5.8	5.0	**-12.2**
Agriculture GDP growth (%)	**0.6**	**17.3**	-35.0	41.1	-9.9	7.4	5.2	-23.3	23.0	-5.5	-2.8	6.5	5.8	5.0	**-5.5**
Non-agriculture GDP growth (%)	**4.1**	**5.9**	12.8	2.8	-5.2	7.0	7.1	3.5	3.3	-13.1	-2.8	6.5	5.8	5.0	**-13.1**
CPI inflation (%)	**12.0**	**9.6**	12.4	12.8	-0.1	7.5	7.7	4.5	4.5	6.0	14.1	9.3	4.1	4.5	**14.1**
Interest rates:															
Short-term money market rate (%)	**14.2**	**9.1**	12.4	16.0	10.9	5.6	8.4	5.4	6.8	8.1	15.1	11.0	6.5	6.8	**15.1**
Long-term lending rate (%)	**23.0**	**7.1**	18.8	21.1	20.5	16.4	14.4	13.4	12.3	9.9	22.9	19.2	12.3	12.5	**22.9**
Exchange rates:															
MDL/USD	**11.35**	**2.62**	12.09	10.37	11.19	12.38	11.71	12.13	12.60	17.69	21.35	21.10	21.05	21.50	**21.35**
MDL/EUR	**13.61**	**3.58**	16.55	15.25	15.61	16.42	16.30	15.59	16.68	21.40	24.50	24.30	24.26	24.62	**24.50**
MDL/RUB	**0.46**	**0.11**	0.47	0.42	0.35	0.41	0.40	0.39	0.39	0.43	0.46	0.46	0.45	0.46	**0.46**
NEER (increase = appreciation)	**84.9**	**22.5**	95.8	108.1	113.9	103.2	106.4	109.8	107.2	83.7	74.3	74.8	74.9	74.0	**74.3**
REER (increase = appreciation)	**108.4**	**19.7**	111.5	132.8	135.4	127.2	134.7	140.0	137.5	108.6	100.3	103.9	104.7	104.7	**100.3**
Real estate prices:															
NIKA index growth (%)	**18.8**	**23.5**	15.6	14.9	-13.1	-4.1	0.2	-7.4	3.9	-20.7	-6.9	7.9	4.6	1.8	**-20.7**
Unemployment rate (%)	**6.5**	**2.4**	5.2	4.0	6.5	7.6	6.7	5.6	5.9	9.6	11.0	10.4	10.2	10.2	**11.0**
Domestic credit growth (%)	**24.0**	**16.9**	51.7	20.3	-4.9	12.7	15.0	16.1	13.6	-6.9	10.9	16.5	10.1	9.7	**-6.9**
Alternative scenario 3 - Domestic:															
Real GDP growth (%)	**3.2**	**5.0**	3.0	7.8	-6.0	7.1	6.8	-0.8	5.5	-5.5	5.7	5.4	5.0	5.0	**-5.5**
Agriculture GDP growth (%)	**0.6**	**17.3**	-35.0	41.1	-9.9	7.4	5.2	-23.3	23.0	-37.0	8.0	6.5	5.0	5.0	**-37.0**
Non-agriculture GDP growth (%)	**4.1**	**5.9**	12.8	2.8	-5.2	7.0	7.1	3.5	3.3	2.4	5.2	5.1	5.0	5.0	**2.4**
CPI inflation (%)	**12.0**	**9.6**	12.4	12.8	-0.1	7.5	7.7	4.5	4.5	7.5	10.3	5.5	4.9	5.2	**10.3**
Interest rates:															
Short-term money market rate (%)	**14.2**	**9.1**	12.4	16.0	10.9	5.6	8.4	5.4	6.8	9.5	11.8	7.7	7.2	7.4	**11.8**
Long-term lending rate (%)	**23.0**	**7.1**	18.8	21.1	20.5	16.4	14.4	13.4	12.3	12.9	20.0	13.4	13.2	13.3	**20.0**
Exchange rates:															
MDL/USD	**11.35**	**2.62**	12.09	10.37	11.19	12.38	11.71	12.13	12.60	15.42	15.68	15.92	16.15	16.50	**15.68**
MDL/EUR	**13.61**	**3.58**	16.55	15.25	15.61	16.42	16.30	15.59	16.68	20.42	20.76	21.08	21.38	21.84	**20.76**
MDL/RUB	**0.46**	**0.11**	0.47	0.42	0.35	0.41	0.40	0.39	0.39	0.45	0.45	0.46	0.46	0.47	**0.45**
NEER (increase = appreciation)	**84.9**	**22.5**	95.8	108.1	113.9	103.2	106.4	109.8	107.2	87.5	86.3	85.2	84.2	82.7	**86.3**
REER (increase = appreciation)	**108.4**	**19.7**	111.5	132.8	135.4	127.2	134.7	140.0	137.5	114.4	115.1	115.2	114.9	114.6	**115.1**
Real estate prices:															
NIKA index growth (%)	**18.8**	**23.5**	15.6	14.9	-13.1	-4.1	0.2	-7.4	3.9	-10.3	5.2	5.4	2.6	2.2	**-10.3**
Unemployment rate (%)	**6.5**	**2.4**	5.2	4.0	6.5	7.6	6.7	5.6	5.9	8.0	7.4	7.0	7.0	7.0	**8.0**
Domestic credit growth (%)	**24.0**	**16.9**	51.7	20.3	-4.9	12.7	15.0	16.1	13.6	1.6	16.6	11.2	10.2	10.4	**1.6**

* Average and standard deviation computed over the period 1997-2012.

[27] These scenarios are based on projections made on December 2, 2013. 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 Area Department team might differ slightly from those presented here. All numbers are period averages.

Table 7. Summary of the Solvency Stress Test Results
(In millions of MDL unless indicated otherwise)

	Baseline Scenario		Averse Scenario 1		Averse Scenario 2		Averse Scenario 3	
	Top-Down	Bottom-Up	Top-Down	Bottom-Up	Top-Down	Bottom-Up	Top-Down	Bottom-Up
Actual data as of 30-Sept-2013 - before any shock:								
Total regulatory capital - before shock	7,766	7,766	7,766	7,766	7,766	7,766	7,766	7,766
Total risk-weighted assets (RWAs)	33,376	33,376	33,376	33,376	33,376	33,376	33,376	33,376
Total assets	69,094	69,094	69,094	69,094	69,094	69,094	69,094	69,094
Total regulatory capital-ratio (CAR) - before shock (in percent of RWAs)	**23.3**	**23.3**	**23.3**	**23.3**	**23.3**	**23.3**	**23.3**	**23.3**
Stress test estimated losses after shock:								
Credit risk:								
Changes in provisions due to loan migration	(267)	41	(1,720)	(550)	(5,021)	(1,892)	(2,527)	(821)
Expected gains/losses on government bond holdings due to issuer default risk	(19)	(4)	(32)	(16)	(72)	(47)	(43)	(36)
Expected gains/losses on corporate bond holdings due to issuer default risk	(9)	(1)	(15)	(3)	(31)	(9)	(19)	(7)
Risk related to equity instruments:								
Expected gains/losses on equity instruments	(13)	1	(22)	(1)	(48)	(12)	(29)	11
Market risk:								
Expected gains/losses on interest income	50	48	198	211	432	544	260	295
Expected gains/losses on government bond holding due to interest rate risk	(4)	1	(19)	1	(39)	(5)	(29)	(3)
Expected gains/losses on corporate bond holding due to interest rate risk	(0)	-	(0)	0	(0)	0	(0)	-
Expected gains/losses on net open FX positions	4	4	14	13	68	50	28	33
Total expected losses:	(257)	89	(1,595)	(345)	(4,712)	(1,370)	(2,358)	(528)
Stress test estimated capitalization after shock:								
Total regulatory capital - after shock	7,509	7,855	6,195	7,445	3,054	6,396	5,408	7,238
Total regulatory capital-ratio (CAR) - after shock (in percent of RWAs)	**22.5**	**23.5**	**18.6**	**22.3**	**9.2**	**19.2**	**16.2**	**21.7**
Implied capital shortfall (if any) 1/	**85**	**81**	**592**	**135**	**2,814**	**510**	**953**	**149**

Source: Individual banks (bottom-up stress tests); NBM and IMF 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 16 percent of risk-weighted assets

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Table 8. Implied Nonperforming Loans under the Different Stress Test Scenarios (In percent of total loans; by currency denomination)

	Top-Down Stress Test:			
	Total loans	MDL	USD	EUR
Actual (as of 30-Sept-2013)	11.6	10.9	10.1	14.3
Baseline Scenario	12.8	11.6	11.3	16.4
Adverse Scenario 1	19.0	15.2	18.2	28.1
Adverse Scenario 2	33.2	22.6	39.9	51.6
Adverse Scenario 3	22.4	17.4	20.3	35.2
	Bottom-Up Stress Test:			
	Total loans	MDL	USD	EUR
Actual (as of 30-Sept-2013)	11.6	10.9	10.1	14.3
Baseline Scenario	11.0	11.0	8.7	13.0
Adverse Scenario 1	13.4	13.1	12.1	15.4
Adverse Scenario 2	19.8	20.7	19.0	20.3
Adverse Scenario 3	14.8	14.8	13.4	16.3

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

Table 9. Summary of the Liquidity Stress Test Results
(In millions of MDL, unless otherwise noted)

	LCR - MDA 1/	LCR - Basel III 2/	LCR - FX 3/	LCR - CR 4/
Liquid assets	21,942	17,770	9,820	17,770
Potential outflows	13,130	16,134	6,119	15,744
System-wide LCR (in percent)	**167.1**	**110.1**	**160.5**	**112.9**
Liquidity shorfall 5/	-	1,631	1,164	1,201
Number of banks with LCR below 100 percent	0	4	4	3

Source: IMF staff and NBM staff calculations.

Notes:

1/ LCR-proxy based on haircut on liquid assets and deposit run-off rate assumptions from the existing NBM methodology.

2/ LCR-proxy based on haircut on liquid assets and deposit run-off rate assumptions suggested in Basel III rules.

3/ LCR-proxy based on haircut on liquid assets and deposit run-off rate assumptions from the existing NBM methodology, to assess FX liquidity.

4/ LCR-proxy, where bank specific haircut on liquid assets and deposit run-off rate assumptions are linked to the results from the solvency stress tests.

5/ Liquidity shortfall is the amount required so that the LCR in each bank in the system is equal or above 100 percent.

Appendix I. Stress Test Matrix for Solvency Risk

Domain	Assumptions		
	Bottom-up by Banks (if applicable)	**Top-down by Authorities (if applicable) 1/**	**Top-down by IMF Team (if applicable) 1/**
Institutions included	• All banks (14 banks)	• All banks (14 banks)	
Market share	• Share of total sector assets: 100 percent	• Share of total sector assets: 100 percent	
Data and baseline date	• Supervisory data • Banks' own data	• Supervisory data	
Methodology	• Combination of banks' own models and pre-defined benchmarks.	• IMF stress testing framework (tailor-made for the Moldova FSAP; along the lines of Cihak, 2007); complemented with the NBM's stress testing models (when applicable).	
Stress test horizon 2/	• 1 year/period (instantaneous shocks)	1 year/period (instantaneous shocks)	
Shocks	• Shocks based on GDP trajectories, and translated in a consistent manner to all other variables in the macro-scenarios. • Three adverse scenarios: moderate external shock (1.25 StD in historical terms); severe external shock (3.25 StD in historical terms; larger output losses than those recorded during the "Russian crisis" and the "global financial crisis"); domestic shock to agriculture sector (2.25 StD for agriculture GDP in historical terms).		
Risks/factors assessed	• 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,	• 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). • *Concentration risk* (name concentration risk).	

Domain	Assumptions		
	Bottom-up by Banks (if applicable)	**Top-down by Authorities (if applicable) 1/**	**Top-down by IMF Team (if applicable) 1/**
	government and corporate bond and other debt instrument holdings; FX risk. • *Equity investment-related risk* (includes both credit and market risk components).	• *Contagion risk* (interbank market).	
Calibration of risk parameters	• Loan migration (downgrades) and changes in provisions based on banks' internal models. • Estimation of expected gains/losses on government and corporate bond holdings and equity investments based on banks' internal models.	• Loan migration (downgrades) and changes in provisions based on satellite models. • Estimation of expected gains/losses on government and corporate bond holdings and equity investments based on satellite models (including gap and duration analysis).	
Behavioral adjustments	• Total assets and RWAs assumed constant during "instantaneous shock" (constant balance sheet assumption). • No management actions considered. • No additional income sources, dividends, and taxes are considered.	• Total assets and RWAs assumed constant during "instantaneous shock" (constant balance sheet assumption). • No management actions considered. • No additional income sources, dividends, and taxes are considered.	

Domain	Assumptions		
	Bottom-up by Banks (if applicable)	**Top-down by Authorities (if applicable) 1/**	**Top-down by IMF Team (if applicable) 1/**
Regulatory standards	• Hurdle rates based on regulatory minimum for total capital (minimum CAR of 16 percent). • Basel I rules.	• Hurdle rates based on regulatory minimum for total capital (minimum CAR of 16 percent). • Basel I rules.	
Results	• CAR, shortfall (if applicable). • Pass or fail; percentage of assets that fail.	• CAR, shortfall (if applicable), and buffer changes; system-wide. • Pass or fail (number of banks); percentage of assets that fail.	

Source: IMF staff.

Notes:

1/ Top-down stress tests conducted jointly by the IMF FSAP team and NBM staff.

2/ Full-fledged macroeconomic scenarios were constructed over a five-year horizon (2014–2018). However, stress tests are conducted using a one-year period ("instantaneous shock").

Appendix II. Stress Test Matrix for Liquidity Risk

Domain	Assumptions		
	Bottom-Up by Banks	Top-Down by Authorities	Top-down by IMF
Institutions included	• N/A	• All banks (14 banks)	
Market share		• Percent of total sector assets: 100	
Data and baseline date		• Supervisory data	
Methodology		• Basel III LCR-type proxies, based on NBM existing liquidity stress test framework, following the methodology proposed by Csajbok, A. (2013), World Bank TA report. • Liquidity tests by currency.	
Risks		• Market liquidity • Maturity and currency mismatches.	
Regulatory standards		• Liquidity ratio ("Second Principle of Liquidity"): liquid assets should exceed 20 percent of total assets. • LCR proxy should exceed 100 percent (not a legal requirement).	
Results		• Pass rate, remaining buffers, and liquidity shortfall (if applicable); system-wide.	

Source: IMF staff.

Appendix III. Preconditions for Conducting Multi-period Stress Tests[1]

The proposed stress tests for assessing the financial stability of the banking sector in Moldova represent a "one-period" type of analysis. In this type of stress tests, all shocks are assumed to take place "instantaneously", and their impact is deducted from capital, while all (or most) other items in the balance sheet remain unchanged.

In reality, shocks tend to have an impact on the banks' balance sheet through time (and not necessarily simultaneously). For that, a "multi-period" type of stress test might be more useful, and might depict more closely the economic reality of the banking sector. Of course, the clear trade-off is that such type of analysis increases significantly the complexity of the stress tests, requiring better data (in terms of both quantity and quality) and more advanced modeling capabilities and techniques.

In essence, a "multi-period" type of analysis could be envisaged within the stress test framework in Moldova if the following conditions are satisfied:

(a) Sufficient data on macroeconomic and financial variables are available.[2]

(b) Sufficient data on the different income items of the P&L are available.[3] [4]

(c) Possibility to model *satisfactorily* the evolution of RWAs (allowing for changes both in volumes and "*riskiness*") under the different macroeconomic scenarios.

The last point is particularly crucial in a "multi-year" stress test. Under Basel I, which is the regulatory framework currently in place in Moldova, risk weights are constant for each type of exposure in the balance sheet. This is problematic, as one could envisage a situation in which e.g. credit growth matches nominal GDP growth, and under such condition, the worst macroeconomic scenario is likely to entail the lowest GDP growth. This would then imply the lowest credit growth, and thus the lowest RWAs (as the latter would shrink in volumes, but will remain unchanged in terms of risk weights). In other words, the CAR might be higher in the "worst case" scenario compared to e.g. the baseline scenario.

[1] A "multi-period" stress test was not an integral part of the stress tests conducted during this FSAP update, however it featured in the discussions with the authorities. This was done so with the objective of introducing this type of analysis to their stress test framework in the future.

[2] This is so that the different macroeconomic and financial variables can be modeled in a consistent and fairly accurate way under each of the macro scenarios. This requirement is reasonably satisfied in Moldova.

[3] These different income lines include: net interest income; net fees and commissions; net income from investment and trading; non-interest expenses; and other (non-recurrent) net income. In addition, data on taxes and dividend payments would also be needed.

[4] This is so that the different income items can be linked to the macroeconomic and financial variables that feature in the stress scenarios in a reliable manner.

To overcome this important shortcoming, a "multi-period" stress test would require a mapping from the current Basel I framework into a "quasi-Basel II standardized approach"—i.e., enabling the risk weights of the different items to change when the "rating" associated to that particular item changes. Following the example above, when credit growth equals nominal GDP growth: the worst case scenarios is likely to entail the lowest credit growth (i.e., "volume effect" on RWAs), but the economic deterioration is likely to imply a "rating downgrade" of the different assets (hence implying higher risk weights). Overall, the "increase in risk" effect (through changes in risk weights) might outweigh the "volume effect" (which decreases the actual size of the loan portfolio). In that case, RWA would still be higher (as expected) in the "worst case" scenario relative to e.g., the baseline scenario.