

Executive Summary

This mission of technical assistance (TA) reviewed the solvency stress testing tool used at the Central Bank of Uzbekistan (CBU). The work was conducted in August 2023. It focused on the solvency stress-tool that the CBU has been using since 2022. It also reviewed the process to design adverse macroeconomic scenarios.

During the mission, satellite models for credit risk as well as for the main profit and loss (P&L) positions have been reviewed or constructed. The credit risk model has been replaced and tentative to increase the level of granularity has been made, however unsuccessful due to the short time series available. Models for the projection of net interest income and net non-interest income have been developed.

Most of the parameters used in the CBU stress-testing framework have been reviewed and, where necessary, recalibrated. The projection for business expenses has been calibrated and the main parameters used to transform provisions into losses have been assessed and calibrated, where possible. Prudential credit risk add-ons for given segments could be considered if vulnerabilities increase on the corresponding markets.

A procedure has been put in place to build and design adverse scenarios. A working procedure between the CBU's financial stability and monetary policy departments has been discussed. A simple procedure to build adverse macroeconomic scenario, based on anchor variables had been developed. A scenario has been constructed on that basis and other could be built following the same principles in the future.

The inclusion of property price shock into the approach has been reviewed, as well as the contagion and concentration risk modules. In its last financial stability report, the CBU has analysed the impact of a property price shock on banks as a sensitivity analysis. This approach appears appropriate and could be included in regular stress-testing exercises. Given the low materiality of contagion risk for Uzbek banks, there is no urgent need to develop further the approaches covering the risk of contagion.

In the short term, a few technical aspects of the framework should be modified or developed. The scenario horizon should be three years, regardless of the quarter taken as a starting point. The visualization of the results, including at individual banks level, should be enhanced.

Going forward, the stress testing framework can be further developed. If material for Uzbek banks, stress-testing approaches covering liquidity and interest rate risks should be developed. Foreign exchange (FX) risk should be mechanically included in credit risk models once the data base becomes sufficient.

Recommendations

Table 1. Recommendations

Recommendations for FSD	Priority	Timeframe 1/
General		
Fix the horizon issue when simulating at a date other than the end of the year, in order to consider three-year projection, regardless of the quarter taken as a starting point.	High	Short-term
Enrich the documentation with a full description of the calculation process with the help of equations and add a description of the new features. This would help to understand the Excel Master file better, especially for new users.	Low	Medium-term
Perform systematic sensitivity analysis of the results on the main assumptions, in particular the main parameters that cannot be empirically calibrated.	Low	Medium-term
Improve the visualization of the results. Create new charts that show the P&L projection, introduce a dashboard to visualize the results for individual banks or groups of banks.	High	Short-term
Consider assessing the resilience of banks also from the leverage ratio point of view as the 6% minimum could be binding for some banks.	High	Medium-term
Recalibrate dividends assumptions or use fix assumption for all banks.	Low	Short-term
Develop and approach for liquidity stress-tests.	High	Medium-term
Monitor contagion risk and invest resource to develop the approach only if it becomes material enough.	Low	Long-term
Credit risk		
Consider introducing a scaling approach for economic sector if NPL ratios become significantly different than the average ratio for corporates (positive or negative add-on). This could be the case for households with “other” loans, for instance.	High	Medium-term
Consider forward looking positive add-on in case of increasing vulnerabilities (risk) in certain sectors (for instance in the construction sector or for car loans and mortgages for households).	High	Medium-term
Calibrate empirically the parameters for the write-off rates on NPL for corporates and households. If the data are unavailable, ask the banks to provide the information.	Middle	Short-term
Recalibrate the credit model once new data become available (for example in 2 years, no need to do it quarterly). Check if the FX variable could be integrated in a panel or aggregated approach (in that case remove the ad-hoc FX add-on). Alternatively, model FC and NC loans separately.	Middle	Medium-term

Income & expense modules		
Assess interest rate risk in the banking book for the Uzbek banks. If material, consider modifying the approach to include this risk, for instance by considering credit spread shock between the interest rates on loans and deposits (funding costs).	High	Medium-term
Recalibrate the NIM and non-interest income models once new data become available (for example in 2 years, no need to do it quarterly).	Middle	Medium-term
Scenario-related		
Develop narrative for the new designed scenario, based on the country risk assessment, that could then be included in the financial stability report.	High	Short-term
Consider expanding the set of scenarios. For example, a (domestic) scenario in which inflation rises sharply and asset prices (RE) fall sharply.	Middle	Medium-term
RE price evolution should be included in the scenario with appropriate narrative (like for FX for instance). If this is not possible, sensitivity analysis as in the last FSR is a minimum.	Low	Short-term

1/ Short-term is within 6 months; medium-term is within 12 months; long-term is between 12 and 24 months.

Introduction

1. **The 2021 FSSR diagnostic identified several areas where the CBU's stress testing framework could be improved.** At that time, stress tests were not sufficiently integrated within a broader macro-financial framework and there were no consistent linkages between macro-financial variables and banks' key balance sheet and profit and loss items. No stress tests for interbank contagion risk nor liquidity risk were implemented.
2. **In early 2022, a remote TA mission was delivered to assist the authorities in enhancing the solvency stress tests.** The mission developed a new tailor-made macro stress-testing tool for the CBU with a simple end-of-horizon interbank contagion module. The new tool was built based on explicit macroeconomic scenarios, a credit risk satellite model for non-performing loans, a multi-period horizon for the exercise, and taking fully into account the existing regulatory framework.
3. **In 2023, a follow-up TA mission has been planned with the objectives to further strengthen the capacity of the Financial Stability Department (FSD) staff to carry out stress tests and thus assess the resilience of the Uzbek banking system.** At the end of the mission, the FSD staff should have a good understanding of key vulnerabilities and tail risks for the financial sector, design a severe macroeconomic scenario, model bank credit and other risks and estimate P&L components in order to determine the overall and period-by-period impact on bank capital adequacy.
4. **In line with these objectives, the TA mission, which took place in August 2023, focused on the following points:**
 - The revision and development of satellite models for credit risk as well as for the main P&L positions.
 - The revision (re-estimation) of most of the parameters used in the CBU stress-testing framework.
 - The set-up of a procedure to construct adverse scenario within the FSD with collaboration of the Monetary Policy Department (MPD).
 - The design of a new adverse scenario.
 - An illustrative stress-test run in order to test all procedures and new features.
 - The inclusion of real-estate price downturn in the stress-testing framework.
 - The assessment of the tools to measure contagion risk.
5. **Due to time constraint, liquidity stress-test has not been covered.** The mission was not able to assess the materiality of liquidity risk and feasibility of introducing a dedicated stress-test module. Nevertheless, IMF guidelines and tools have been provided to the authorities for follow-up discussions on that topic in order to determine the scope of technical assistance that can potentially be delivered in the future.

I. Macro and Financial Sector Background

6. **Uzbekistan has weathered the pandemic relatively well.**¹ Economic activity rebounded sharply in 2021 with growth accelerating to 7.4 percent from 1.9 percent in 2020 and continuing at 5.7 percent in 2022. Inflation increased to around 12 percent and became more broad-based in 2022 after falling slightly to 10 percent in 2021. With trade and remittances recovering in 2021, the pace of the depreciation of the sum slowed, helping to dampen inflation that year. Downside risks stem particularly from a possible further escalation of the war and the sanctions regime related to Russia's war in Ukraine. Uzbekistan could also be adversely affected by slower growth in its other key trading partners, China, Turkey, and Kazakhstan, and further volatility in commodity prices and tighter global financial conditions.

7. **Uzbek banking system appears resilient.** As emphasised in the latest Financial Stability Report (FSR) the capital adequacy ratio of the Uzbek banks remained above the minimum of 13% set by the CBU and banks appeared to have sufficient capital for lending and absorbing potential losses.²

8. **Even though the share of non-performing loans (NPL) has decreased by the end of 2022, vulnerabilities remain present.** Loans to household, for financing real estate and cars, have increased significantly. The debt-service ratio for consumer loans (including car loans) remains elevated. The share of mortgage loans with high LTV has increased notably.

9. **The Uzbek banking system comprises 35 banks, mainly focusing on domestic activities.** The Uzbek banking system is composed of 7 state-own banks (SOBs) and 28 private banks. The SOBs, some of which are systemically-important banks (SIBs), are generally large banks used by the government to finance various public programmes, for example in the industrial sector. Those banks grant loans in foreign currency and receive funding in general from international development banks. Private commercial banks are universal or specialized (digital) banks that offers service to households and corporates. In Uzbekistan, households are only allowed to borrow in local currency.

¹ The information in this paragraph reflects the assessment published on 2022 IMF Staff Report for the Republic of Uzbekistan with updated figures from October 2023 WEO.

² Financial Stability Report 2022, CBU, May 2023,

II. CBU's Stress Testing Framework

10. **The CBU stress-testing framework has been developed by an IMF expert and the CBU staff in a previous TA mission in 2022**, following the recommendations of the 2021 Financial Sector Stability Review (FSSR). It consists of a satellite model for NPL ratio (EViews file), a new Excel tool for macro stress testing, and a Stress Testing User Manual.

11. **By projecting the main P&L and capital items, the CBU ST framework allows for assessing the resilience of the Uzbek banking system.** It can analyze macroeconomic scenarios calibrated in-house in the CBU. It is based on credit risk satellite model for NPL, and the main P&L income positions are projected based on expert judgment. The CBU published stress-test results in their two first editions of the financial stability report. In the most recent one, the CBU has introduced sensitivity analysis in addition to regular stress-test results.

12. **During the first stage of the mission, room for improvements of the stress-testing framework has been identified and emphasized by the FSD staff.** The statistical performance of the satellite credit model appeared less than satisfactory. For instance, adding new observations to the time-series data significantly changed the elasticity of the NPL ratio to macro variables. The main P&L positions were not mechanically linked to macro variables. Calibration of a number of parameters needed a careful reassessment and potential revision. The macro scenario used for the last ST exercise (FSR 2022) seemed not adverse enough compared to the baseline to assess the resilience of the Uzbek banking system to potential shocks. The presentation and graphical depiction of the results lacked sufficient in-depth assessment to provide a full description of the ST results, including the underlying drivers.

III. Review of the Stress-Testing Framework and Adaptations

A. General

13. **The current ST framework allows scenarios to be considered over a three- -year horizon, but by taking the end of the calendar year as the reference, some of the impact of the scenario may be lost.** Running the stress-tests in any quarter other than the end-of year dilutes, by design, the adverse impact in the first year of the scenario. For example, only half of the shock of the first year would be considered if the cut-off is Q2. This design choice is not desirable, and the scenarios should be considered over three years on a rolling basis from the cut-off date onwards.

14. **The current ST framework needs to be revised in order to capture a full three-year projection regardless of the quarter considered as a starting point.** This would imply modifying the Excel file structure and to put less emphasis on end of calendar year results. Instead, results after one to three years should be considered.

15. **An important constraint for the development of econometric models is the unavailability of sufficiently long time-series data.** Individual bank data are available since 2014Q4, or even since 2018Q2 for some sub-positions. Before this date, some data are available but with lower quality. In addition, older data may not adequately reflect the phase of economic liberalization that the country has been going through since 2015. Hence, their usefulness to develop models is questionable.

16. **In the future, the underlying satellite models would need to be periodically assessed and possibly recalibrated as new data becomes available, possibly incorporating data from the credit register.** The model for NNII, in particular, deserves special attention due to the very short time-series considered. The exchange rate could be taken into account in the credit risk model because it should be correlated with credit losses, at least theoretically. The credit register, which is available since 2018, could also be used going forward to develop or benchmark credit risk models.

B. Credit risk: Satellite Models

17. **The current satellite model used to project the aggregated NPL ratio needs to be revised.** The model seems particularly unstable when new data are added, possibly due to short-time series. In particular, in a recent update, the explanatory variables (real GDP growth and the one-quarter lag of IR on loans) did not show any statistical significance and somewhat compensated each other. The results were difficult to interpret and appeared not related to the scenario projections.

18. **Aggregate or bank-specific data were considered in order to establish a link between different measures of credit risk (NPL ratios, proxies for PD) and macroeconomic variables.** NPL and credit data are available at the aggregated level since 2013 Q4. Bank

specific NPL and credit are available since 2014 Q4 (unbalanced panel). Proxies for PD are from Hardy and Schmieder (2013) and from the IMF guidance note on stress-testing.^{3,4}

19. **Models were considered at the total loan level as well as at sub-portfolio levels (e.g., households, corporates in foreign/national currency loans).** Bank level and aggregated NPL data for credit sub-portfolio are available since 2018 Q2. The sub-segments available for corporates are industry, agriculture, transport, construction, technical work, communal services and other sectors. For household, the breakdown is given according to the type of loans: mortgages, micro loans, consumer loans, car loans, other loans.

20. **Aggregated and panel models for banks' NPL ratios as a function of real GDP growth and IR on loans perform best statistically.** PD models perform less well, in particular, because they depend heavily on the proportion of NPL that are written off yearly, which cannot be calibrated empirically. Beside real GDP growth and IR on loans, other macroeconomic variables such as the UZS/USD exchange rate, inflation, remittances, have also been tested, but showed little statistical significance. Despite good explanatory power, unemployment rate has not been included in the models due to the low representativeness of the unemployment statistics in the country (i.e., many unemployed do not declare themselves).

21. **The aggregated model for banks' total NPL ratio as a function of real GDP growth and IR on loans show better in-sample results and has therefore been selected.** The retained model hence has the form (see appendix for estimation results):

$$\ln(NPLr_t/(1 - NPLr_t)) = \beta_0 + \beta_1 \ln(NPLr_{t-1}/(1 - NPLr_{t-1})) + \beta_2 GDP_{t-2} + \beta_3 IR_{t-1} + \epsilon_t$$

A panel model with the same form (with banks fixed effect in addition) seemed less reactive in-sample than the aggregated model and has therefore been rejected.

22. **Models for households and corporates have been rejected due to the short time-series and poor statistical performance.** Reliable NPL data for households and corporates are only available since 2018 Q2. Aggregated and panel models with different regressors and lags showed no better statistical performance than the model for total NPL ratio.

23. **In the future, models for PD and LGD could also be developed based on the Uzbek credit register, but this needs to be carefully considered.** The credit register was implemented in 2018 and collects a number of important borrower characteristics (type of credit, contractual maturity, interest rate, collateral type, etc.). However, it is debatable to what extent a very granular model is desirable, due to the inherent complexity of such models, possibly including data standardization issues. In general, developing this type of model requires a significant investment in terms of resources, and therefore can be pursued in the long-term.

³ Hardy, D.C., and C. Schmieder, 2013, "Rules of Thumb for Bank Solvency Stress Testing," IMF Working Paper 13/232 (Washington: International Monetary Fund).

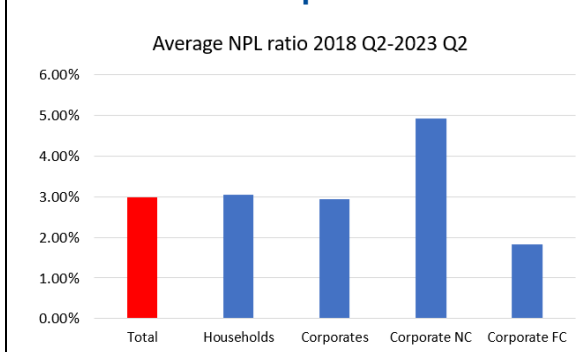
⁴ $PD_t = \frac{NPLr_t * loans_t + (1 - \alpha)NPLr_{t-1} * loans_{t-1}}{average\ loans_{t|t-1}}$ where: α is the portion of NPLs that are written-off in period t-1.

C. Credit risk: Scaling Approach

24. **Households and businesses have similar levels of risk, but the risk varies depending on whether the corporate loans are denominated in foreign or domestic currency.**

Average non-performing loans for households and banks since Q2 2018 have been around 3% of total loans (Figure 1). For households, car loans appear less risky than mortgages, micro loans and consumer loans, which show similar NPL levels, while “other loans” present the higher risk loans (Figure 2). For corporates, national currency (NC) loans appear significantly riskier than foreign currency (FC) loans (Figure 1). In terms of economic activities, construction and communal services are the riskiest segments but their overall volumes remain low (Figure 2).

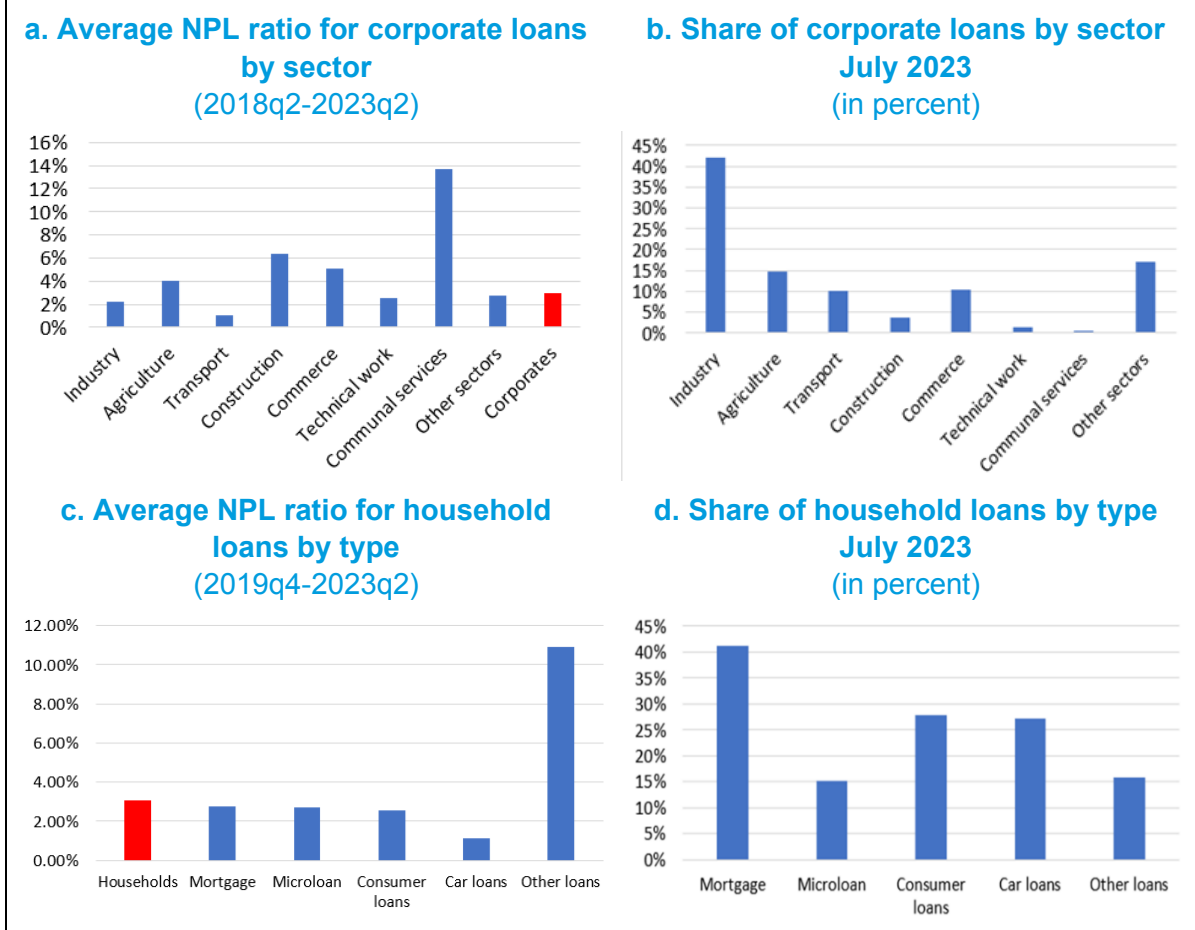
Figure 1. NPL Ratios for Household and Corporates



25. **To differentiate NC loans from FC loans in terms of risk, a scaling approach has been introduced.** Hence the total provisions for loans in NC are scaled up by a risk factor (around 1.67) while the total provisions for loans in FC are scaled down by a risk factor (around 0.62). These parameters are calibrated based on the NPL ratios for NC and FC loans compared to the NPL ratio for all loans (Figure 1). Overall, this adjustment is neutral but penalizes banks that only grant loans in national currency.

26. **A similar scaling approach could be introduced for other credit sub-segments, in particular, on a forward-looking basis, for segments showing an increasing level of vulnerability.** Based on current observations, scaling risk factors (or NPL add-ons) for “other loans” for households as well as construction and communal services for corporates could be advisable. Going forward, depending on the evolution of the vulnerabilities in these segments, car loans and mortgages for households as well as FC loans for corporates could also be candidates. In the latter case, one possibility would be to set back the FC loans risk factor to one.

Figure 2. NPL Ratios and Exposures for Sub-credit Segments



D. Net Interest Income: Satellite Model

27. **The approach to project net interest income (NII) needs to be revised in order to reflect the scenario dynamics and severity.** The elasticities of the net interest margin (NIM) to macroeconomic adverse scenario are set by expert judgment. The macro-micro relationship needs to be strengthened on the basis of empirical data.

28. **Aggregate and bank-specific data were considered to establish a link between the net interest margin (NIM) and macroeconomic variables.** NIM is computed as banks' net interest income divided by total interest-bearing assets. It is important to note that total interest-bearing assets are being projected proportionally to total assets (TAS), hence it depends on the scenario projections for credit growth and UZS/USD exchange rate (see the 2022 TA report).

29. **A simple aggregated model that links the NIM with the level of IR on loans as well as with the yearly growth rate of UZS/USD exchange rate has been selected.** The retained model hence has the form (see appendix for estimation results):

$$NIM_t = \beta_0 + \beta_1 IR_{t-1} + \beta_2 FX_t + \epsilon_t$$

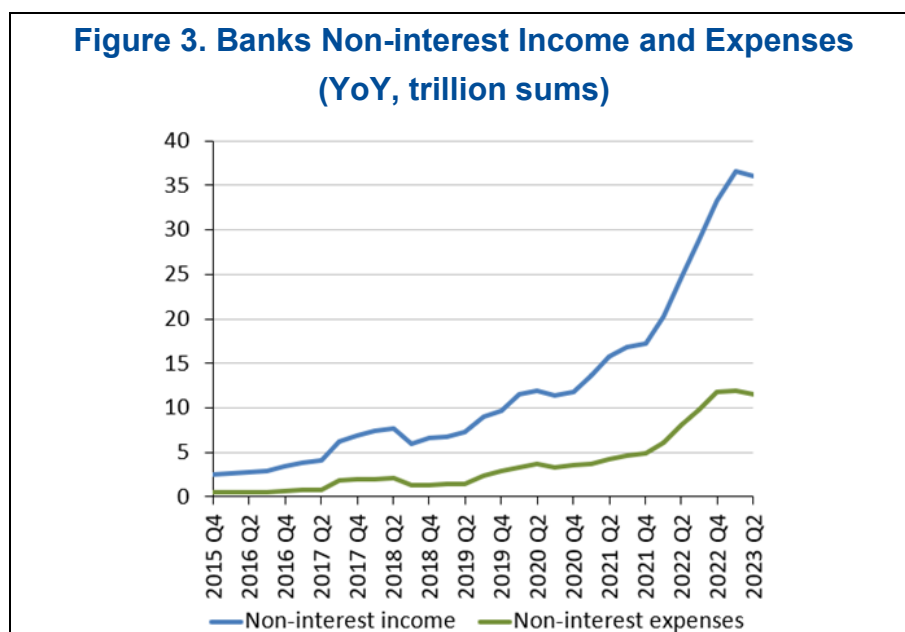
30. **Modelling the NIM as a function of IR does not allow to capture properly interest rate risk in the banking book (IRRBB).** IRRBB could materialize for banks if funding costs increase faster than average interest income. The stronger the banks rely on maturity transformation, the more pronounced this effect would be, possibly resulting in a reduction of NII.

31. **If IRRBB is material for Uzbek banks, the NII could be modelled differently.** A simple approach would be to shock the interest rate spreads between asset and liability in case of a positive IR shock for instance. To model IRRBB is in general a non-trivial task. If this risk is assessed as significant, specific data should be requested from the banks (e.g., cash flow and notional information from asset and liability positions) in order to simulate NII.

E. Net Non-Interest Income: Satellite Model

32. **The approach to project net non-interest income (NNII) needed to be revised in order to reflect the scenario dynamics and severity.** Currently, the elasticity of the non-interest income to macroeconomic adverse scenario is set by expert judgment. Non-interest expense is grouped with operational expenses, which is then projected also based on expert judgement. The translation of macro shocks into NNII reaction needs to be strengthened on the basis of empirical data.

33. **As a preliminary step, non-interest income has been netted with non-interest expense, which was previously grouped with operating expenses.** The correlation between non-interest income and expense is close to one and they show very similar dynamic (Figure 3). Hence, it is preferable to estimate the net non-interest income (NNII) and to treat operating expenses separately (see next section).



34. **Aggregate or bank-specific data were considered to establish a link between NNII over TAS and macroeconomic variables.** The estimation of NNII as a ratio over TAS primarily depends on the scenario projections for credit growth and UZS/USD exchange rate.

35. **A simple panel model with bank-specific fixed effects that links the NNII-to-TAS ratio with the real GDP growth as well as with the yearly rate of change in UZS/USD exchange rate has been selected.** In Uzbekistan, NNII is generated essentially by fees on transactions, including lending fees. The overall level of economic activity as well as, to a lesser extent, the UZS/USD exchange rate are good proxies for the number of transactions that generate fees. The retained model hence has the form (see appendix for estimation results):

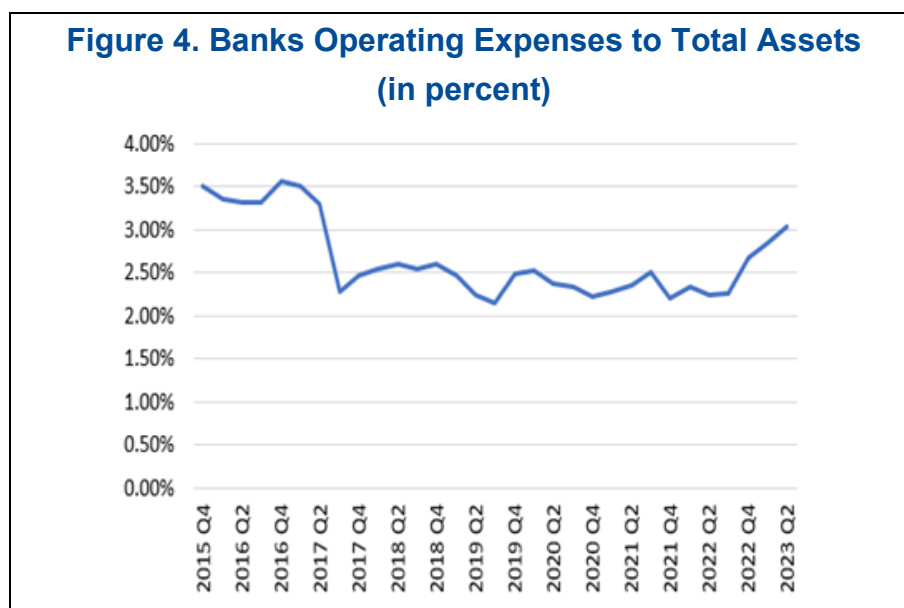
$$\frac{NNII_{i,t}}{TOTA_{i,t}} = \alpha_i + \beta_0 + \beta_1 GDP r_t + \beta_2 FX_t + \epsilon_{i,t}$$

F. Operating Expenses

36. **The approach to project operating expenses needed to be revised in order to reflect the scenario dynamics and severity.** As aforementioned, operating expenses were projected together with the non-interest expense based on expert judgment. As discussed in the previous section, operating expenses are considered without non-interest expenses.

37. **Operating expenses over total assets have remained broadly constant over the last few years.** Operating expenses have evolved in line with the banks' total assets except in 2017 due to a strong Sum depreciation, and in 2023, when operating expenses have risen faster than banks' total assets (Figure 4).

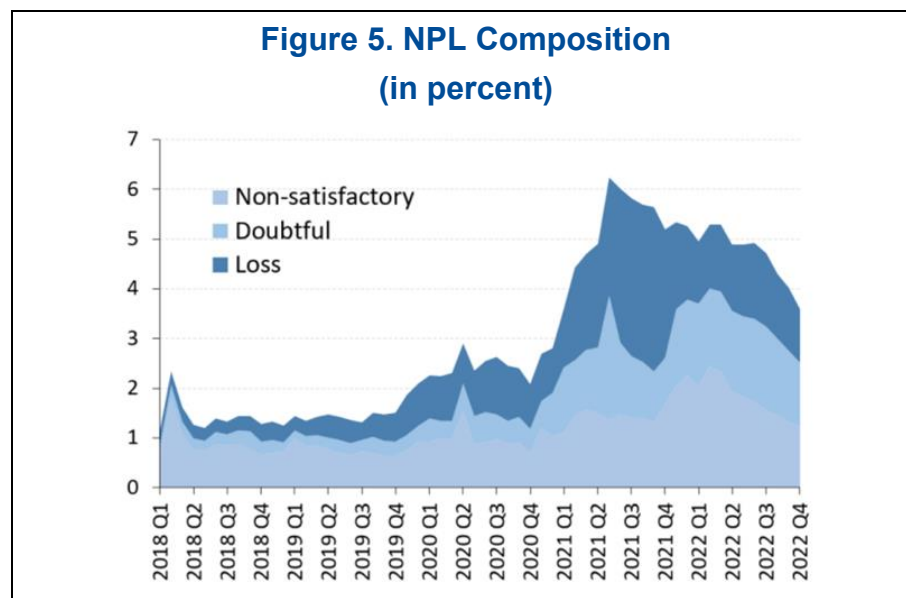
38. **Individual banks' operating expenses are projected using the total asset growth.** In the absence of clear links between operating expenses and the main macro variables, the ratio of operating expenses to total asset is kept constant in the projection. That implies that a bank's operating expenses evolves like its assets, which depends on the credit growth and exchange rate projections.



G. Review of Other Parameters

39. **During the TA mission, all parameters entering the CBU stress-testing framework have been analysed and assessed.** The main observations are outlined below:

- a. **Assumed (annual) gross loan growth:** was originally set based on expert judgment; it is now directly linked to credit growth projections derived from the scenarios.
- b. **Assumed NPL write-off rates:** 15% for corporate and 5% for households have been maintained. Going forward, the CBU should try to calibrate these parameters empirically, either by analysing supervisory data or credit register data (not covered during this TA mission), or by periodic bank surveys.
- c. **Change in NPL provisioning rate against previous period:** 10% for a moderate adverse scenario and 20% for a severely adverse scenario have been maintained. This corresponds to the change in NPL provisioning due to the migration within the three NPL classes for which different provisioning rates apply.⁵ In the 2018-2019 period, NPL provisioning rate was about 50% (Figure 5). During the recent stress episode in 2021, this rate rose to about 70-75%). This observation empirically justifies the levels of these parameters for a strong adverse shock (+20pp.) and for a moderate one (+10pp).



- d. **Elasticity of NPL ratio to FX shock:** shock on FX cannot be included mechanically in the NPL model that drives credit losses, essentially due to the exceptional devaluation of the Sum in 2017 that dominates in regressions. Instead, the model assumes an ad-hoc FX NPL add-on if the cumulative change in exchange rate exceeds a given threshold (currently 10% devaluation of the Sum). The ad-hoc FX NPL add-on is set based on the level of the NPL ratio with an elasticity of 10%.

⁵ Loan loss provisioning for NPL is based on regulatory coefficients for individual loan classes (25% non-satisfactory, 50% doubtful, 100% loss).

Given the risk of devaluation of the sum on Uzbek banks, adding a FX NPL add-on to the NPL seems appropriate. Going forward, the FSD should try to calibrate this parameter empirically. The calibration must be conservative and could be forward-looking, depending on how the situation and risks evolve. In particular, the elasticity may well increase as a function of the devaluation past the threshold (an impact of 11% vs 30% devaluation could be rather different). It is therefore important to review the value of these parameters in particular before each stress-testing exercise.

- e. **Proportion of ER changes already included in loan growth projection:** this allows to set what proportion of the “accounting” exchange rate effects is already captured in the loan growth projections and which needs to be added additionally. The “included” proportion is currently set by expert judgment at 60%, leaving 40% of exchange rate changes to be additionally accounted for in the gross loans projections.

Going forward, the FSD should try to calibrate this parameter empirically in close collaboration with the MPD. One possibility would be to explicitly include all exchange rate effects in the loan growth projection and to get rid of this parameter.

- f. **Dividend pay-out rate:** the parameters used could not be reconciled with those of the current dividend pay-out rate. Going forward, the FSD should recalibrate assumptions for dividends per banks or use fix assumption for all banks.
- g. **Securities held, and other asset items parameters:** the other parameters were not analysed in detail during the mission, either because they appear reasonable (e.g., taxes) or because they concern risks that are not material for Uzbek banks (e.g., securities).

H. Integration of Real Estate Price Shock

40. **The current approach for the real property held on-balance sheet by Uzbek banks seems appropriate.** An increase in provisioning of 30% is applied on this type of assets, which represent only a very small proportion of banks’ total assets. They are mainly private property foreclosed from non-performing loans.

41. **Recently, this approach has been complemented by an analysis measuring the impact of a real estate downturn on the mortgage portfolio.** The mortgage portfolio would certainly be the main transmission channel of a real-estate downturn on Uzbek banks. Based on credit register information, the FSD analyses the share of new mortgage-borrowers that would have an LTV larger than 120% in case of given real estate downturns. The main assumption is that the corresponding proportion of mortgage borrowers would default, leading to an increase in NPLs, resulting in an add-on to the model for mortgage loans.

42. **This analysis, which is forward-looking by nature, should be anchored in the CBU stress-testing framework, provided that the scenario includes a narrative for property prices shock.** The very short time series for property prices do not allow to include it in the credit risk model for instance. Instead, the impact of the house price shock on banks should be included by a forward-looking NPL add-on, based on consistent scenario narrative. In doing so, the house price shock might be considered over the first year of the scenario only, in order to obtain the maximum effect.

43. **As a minimum, the impact of real estate price shock on banks should be maintained as sensitivity analysis and developed further.** Given the recent strong increase of property prices in Uzbekistan, the impact on banks of a fall of prices should be captured by stress-testing tools, either directly (preferred) or indirectly in sensitivity analysis. Going forward, the LTV distribution for the stock of mortgages could be estimated based on the credit register in order to capture the full effect of a price correction on the mortgage portfolio. The 120% assumption on the default threshold should be checked as it may not be sufficiently conservative.

I. Contagion and Concentration Risks

44. **The CBU is currently using two approaches to analyse contagion and concentration risks in the Uzbek banking system.** The first tool, developed in the previous TA mission, is a simple approach that measures concentration risk by assuming a failure of selected large borrowers. The second analyses the impact on banks of the cascade effect assuming a default of a major banking counterparty.

45. **The concentration risk tools indicates that this risk for Uzbek banks is high.** As published in the last FSR, the default of the five to ten largest borrowers (mainly non-financial corporates) would have a significant impact on most banks.

46. **The contagion tool, simulating a cascade effect assuming the defaults of banking counterparties, indicates that contagion risk for Uzbek banks is low.** As published in the last FSR, no major cascade effect would take place even with an LGD of 100% due to low interbank exposures.

47. **Sensitivity analysis using the two tools should be maintained but no further development is urgent.** The contagion tool could be extended, including feedback loops, etc. But given the low materiality of the risk, no further development appears urgent. Instead, the development of an approach to liquidity risk may have priority. Indeed, there are prudential regulations regarding large exposures in the banking system of Uzbekistan. There is a limit of interbank exposure to other bank or interrelated banking group, which should not exceed 25 percent of Tier 1 capital of the bank. Furthermore, the maximum exposure of bank to single borrower or a group of interrelated borrowers should not exceed 25 percent of Tier 1 capital of the bank.

IV. Procedure for Designing an Adverse Macro Scenario

48. **In their last financial stability report, the CBU analysed a baseline and an alternate scenario that were very close to each other in terms of trajectory and severity.** Both scenarios were provided by the MPD.

49. **Prior to the mission, it was agreed that the FSD should build in-house capacity to build and calibrate adverse scenarios for the purpose of stress-testing.** So far, an alternate scenario was provided by the MPD. However, this scenario is more of an alternative to the baseline scenario than an adverse scenario, which should describe a tail event. Therefore, the FSD should be able to construct their own adverse scenario for the purpose of a robust stress-testing exercise. Going forward, the baseline and alternate scenarios from the MPD should continue to be provided. MPD's baseline scenario will establish the benchmark in the stress-test exercise, while MPD's alternate scenario could serve as an input to FSD for the calibration of the adverse scenario.

50. **During the mission a simple procedure to design and calibrate an adverse scenario has been developed.** The proposed construction process at the FSD follows simple rules (Figure 6). On that basis, an adverse scenario has been designed, and others could be constructed on the same basis.

51. **The severity of the scenario is imposed by the anchor variables: real GDP growth and inflation.** For the calibration of a severe and plausible real GDP shock, experience in neighbouring countries, or in countries that went through similar financial deepening episodes, could be used, since there has been no recession in Uzbekistan since the fall of the Soviet Union. Inflation could be taken from MPD's alternate scenario or defined based on expert judgement.

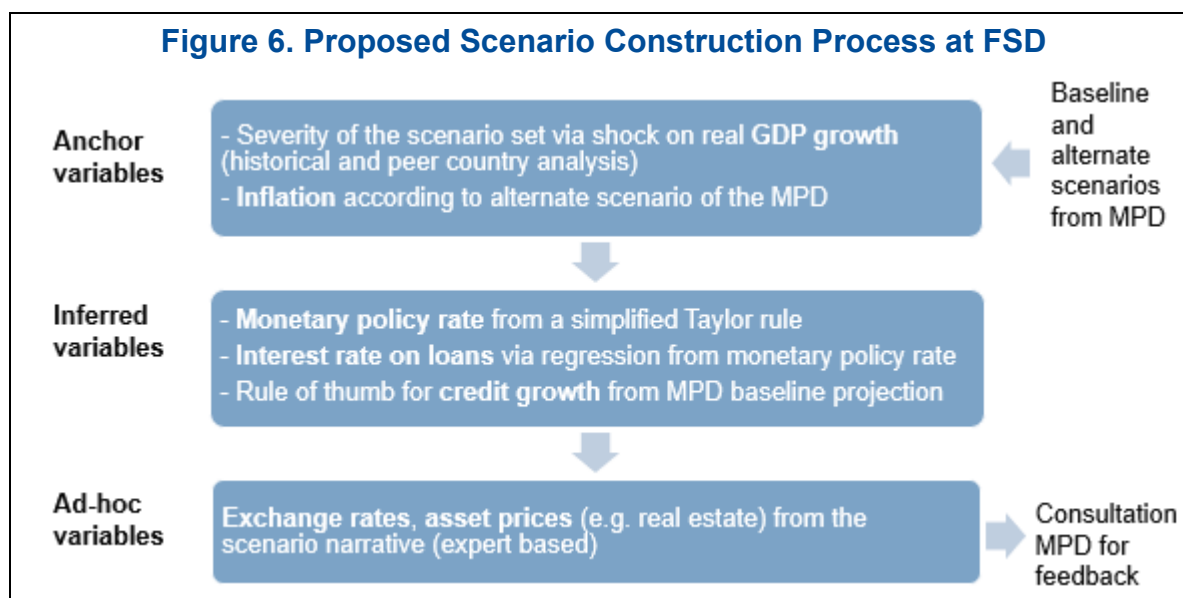
52. **Once the severity of the scenario has been determined, the projection for the monetary policy rate as well as credit growth are obtained based on simple rules.** First, the monetary policy rate is computed using a simplified Taylor rule that depends on real GDP growth and annual inflation rate compared to their baseline paths.⁶ Second, the interest rates on loans are then estimated using a simple OLS regression against the monetary policy rate. Then, the projection for credit growth is obtained by computing the relative difference in lending rate in the baseline and adverse scenarios and applying it to its baseline. Alternatively, the projection for credit growth could also be linked to nominal GDP with a zero lower bound to avoid introducing deleveraging by design.

53. **Projection for other macroeconomic variables should be designed based on the scenario narrative.** Projections, for example for exchange rates and asset prices, should be based on expert judgement in relation to the scenario narrative.

⁶ $MPR_{severe} = MPR_{baseline} + 0.5 * (Inf_{severe} - Inf_{baseline}) + 0.5 * (GDPG_{severe} - GDPG_{baseline})$

54. **In general, the narratives of adverse scenarios should be constructed by the FSD based on the country risk assessment to financial stability, in collaboration with the MPD.** The country risk assessment should help to identify the potential future shocks that can trigger adverse macroeconomic scenarios. The scenario narratives should be built on that basis by the FSD with feedback from the MPD.

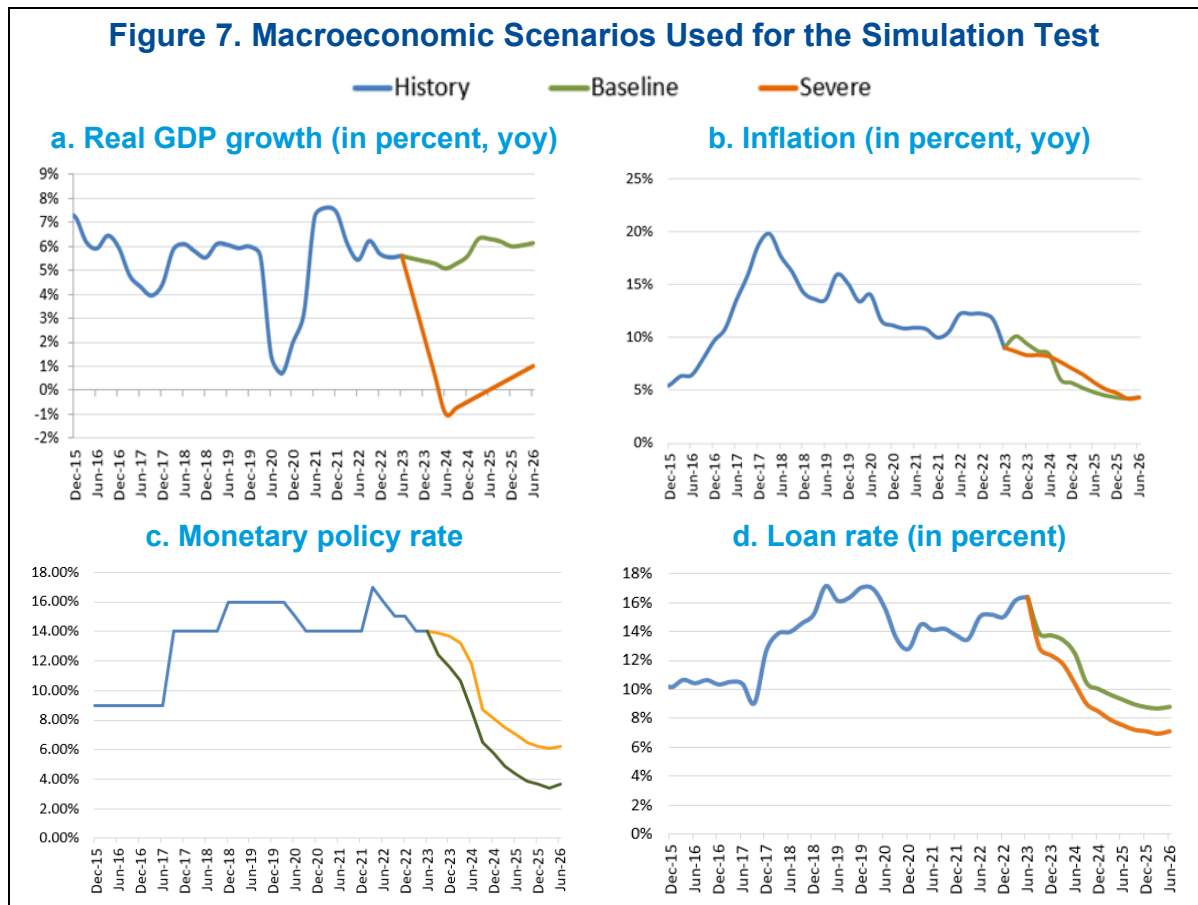
55. **To cover the main risks to financial stability, other adverse scenarios could be considered.** Depending on the risk assessment, scenarios that include structural shocks (regional conflict, FDI contraction, etc.), in combination with cyclical shocks could be designed. For example, instead of a sharp recession and low inflation, a stagflation scenario could be considered. In a recession scenario, the form of the recession (e.g., U-shape, V-shape, L-shape) could be modified.

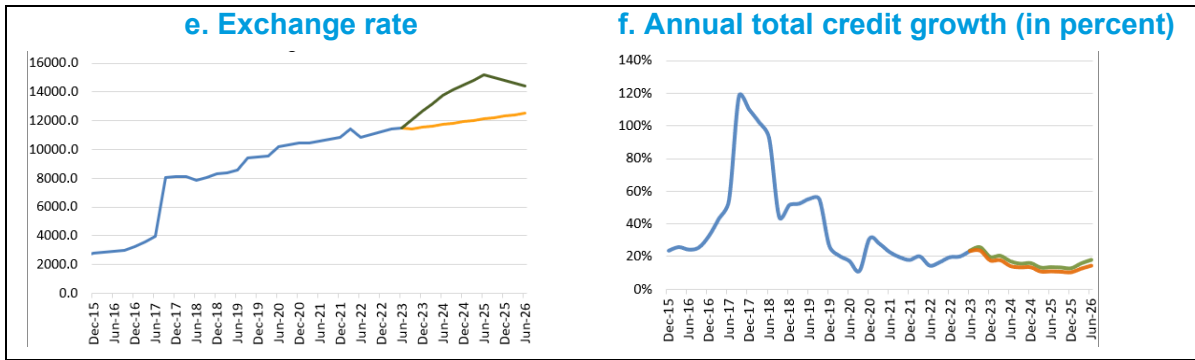


V. Illustrative Stress-test Run

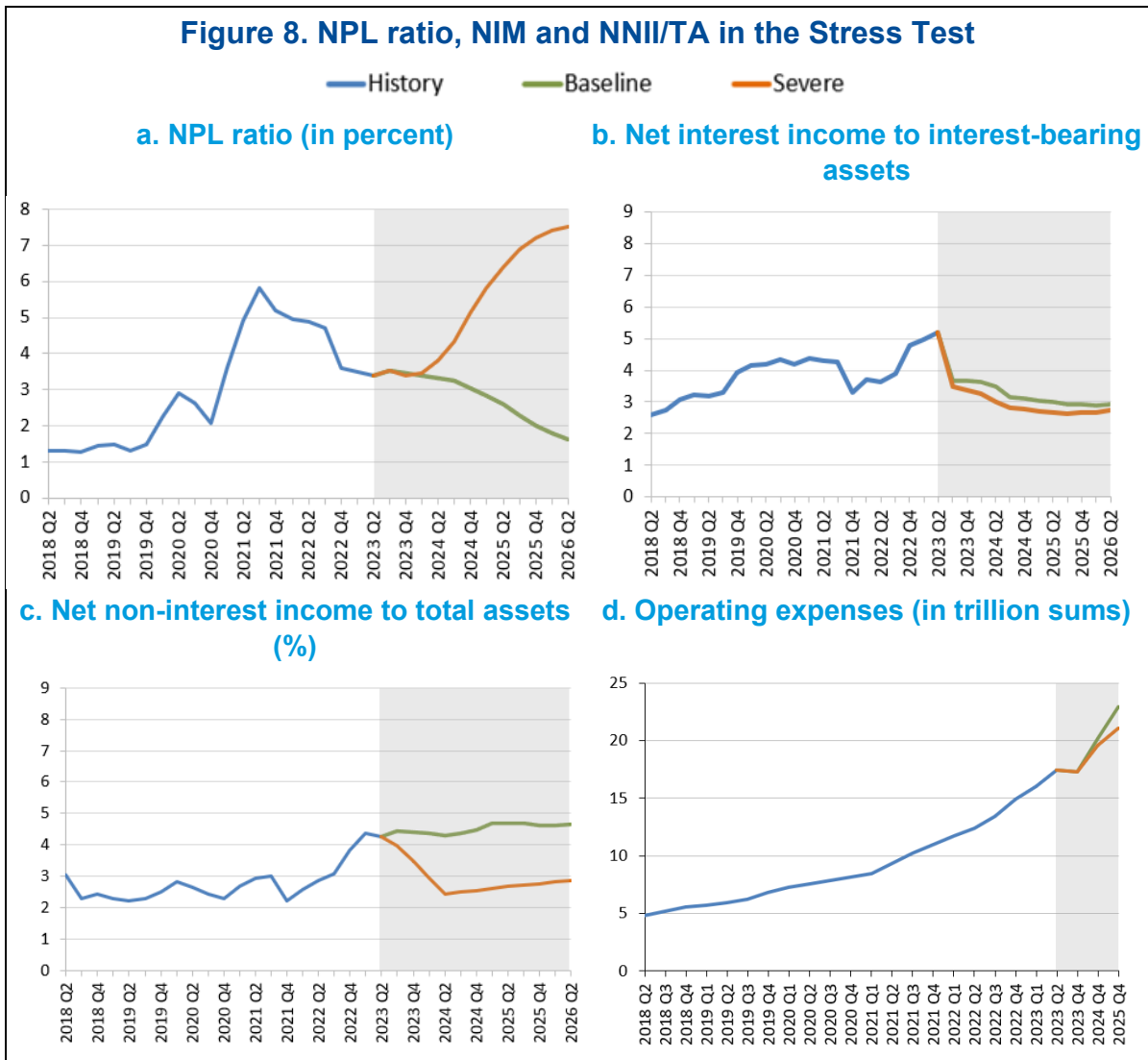
56. **At the end of the mission, a simulation test was performed to verify the functioning of the tool with the updated features and an ad-hoc adverse scenario.** The test was carried out on the basis of an ad-hoc adverse scenario, the aim being to check the performance of the models rather than to construct a perfectly consistent scenario to assess the resilience of the Uzbek banking sector. Going forward the FSD should build a fully consistent adverse scenario based on the current risk assessment for the Uzbek banking system and on the principles described in the previous section.

57. **The scenario used assumes a fall in real GDP, a reduction in inflation and interest rates, and a devaluation of the currency.** The scenario assumes a slightly negative real GDP growth (-1 percent) and a devaluation of the sum (20 percent) over the two first years. Inflation would come down as in the baseline scenario, while interest rate would drop as well (Figure 7). Due to the absence of a recession in Uzbekistan since the early 90s, the calibration of the real GDP downturn has been performed by analysing similar episodes in comparable countries. This results in a slight negative real GDP growth in the first year of the scenario followed by weak growth the next two years (Figure 7). The path for inflation is taken from MPD's "alternate" scenario and would result in a reduction of IR on loans and a stagnation of credit growth. The strong devaluation of the Sum is calibrated on expert basis.





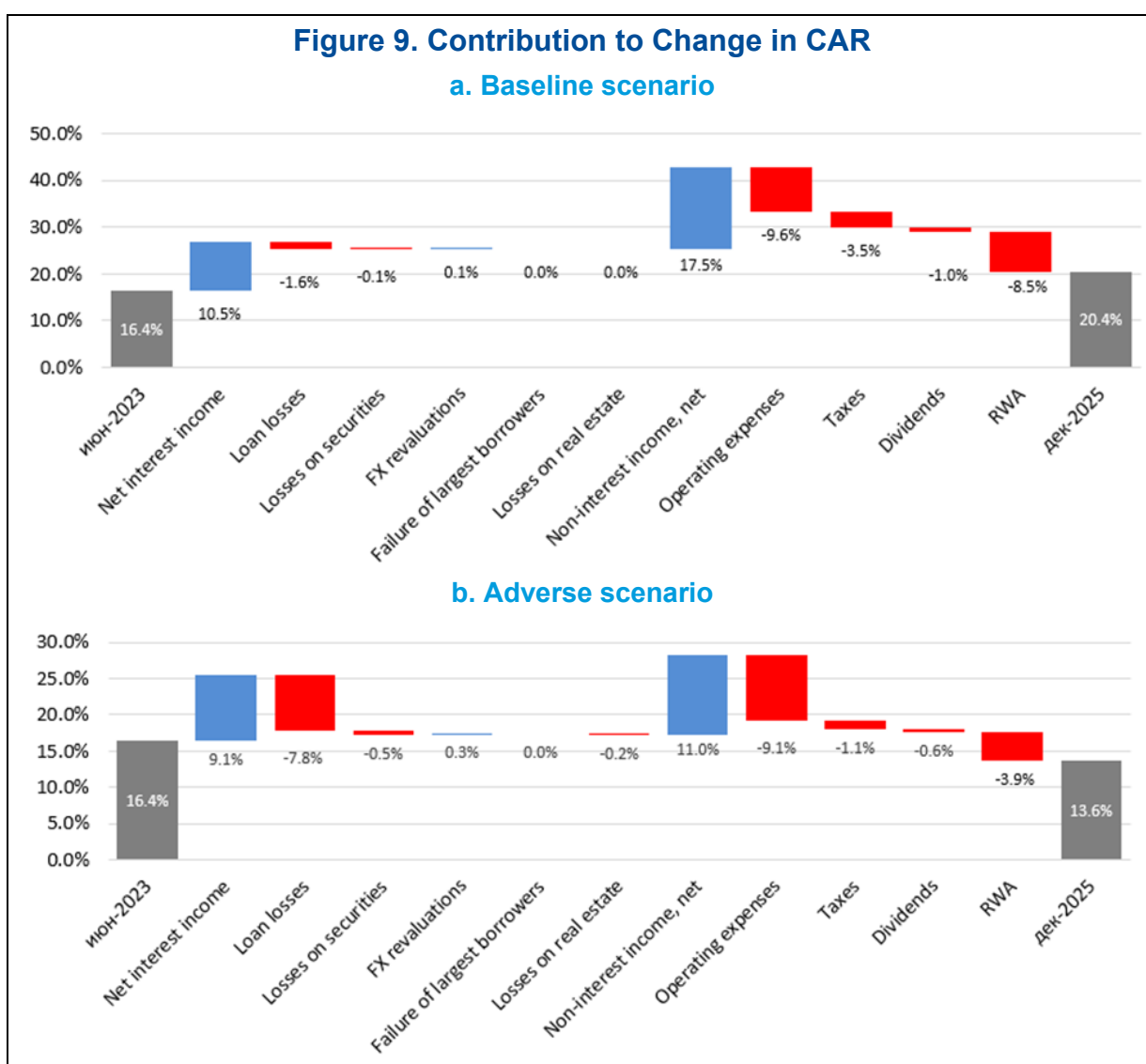
58. Under this adverse scenario, banks' NPL ratio would rise strongly, while NII and NNII would drop significantly. NPL would hike higher than during the Covid crisis but remain below levels reached in comparable countries (Figure 8). NII would drop significantly, but in a similar way to the baseline scenario. NNII would also drop significantly due to the strong shock on real GDP growth.



59. Compared to the baseline scenario, loan losses would be larger while NNII would be lower, explaining most of the difference between the two scenarios. NII and operating income would be similar due to the limited difference in terms of IR on loans and credit growth between the scenarios (Figure 9).

60. Overall, under this scenario, the aggregate bank risk-weighted capital ratio would fall significantly compared to the baseline scenario and approach the minimum requirement of 13%. Uzbek banks would be strongly impacted by this scenario. A number of them would fall below the minimum requirement which could threaten the resilience of the banking system as a whole.

61. In the future, the impact of this scenario on leverage ratio requirements should also be studied. So far, only the risk-weighted perspective is analysed. The resilience of the banking system should also be tested against the 6% minimum leverage ratio requirement.



62. **If this scenario is going to be used going forward, it would need to be more closely related to the country risk assessment and to a corresponding narrative.** This scenario has been built on best principles in order to test the modified stress-testing framework. Should it be used, for instance in the context of the FSR, the projection for the main variables (in particular inflation and the exchange rate) should be calibrated and based on a scenario narrative.

63. **In general, the graphical representations of the results could be extended.** For instance, graphs representing the projection of the main P&L positions should be developed.

64. **The user manual should also be adapted to reflect the new features of the framework.** In general, the user manual should contain the loss calculation process in terms of equations to make the Excel tool more transparent.

Conclusion

65. **The TA mission reviewed the CBU stress-testing framework and developed a set of statistical models that will help further enhance the existing stress testing capacity.**

The team and the FSD staff run a simulation test to verify the functioning of the tool with the updated features and figures.

66. **The TA mission reviewed the CBU scenario construction process and proposed a simple working procedure to construct macro scenario for the purpose of stress-testing.**

Going forward, the FSD should be able to develop adverse macroeconomic scenarios based on simple principles, in collaboration with the MPD.

67. **The CBU should carry on performing regular stress-tests with the help of the Excel tools that have been developed in previously and further strengthened during this mission.**

The CBU is advised to re-estimate satellite models as new data become available and to try to calibrate the model parameters empirically. Moreover, it is also advisable to construct alternative adverse scenarios based on the country risk assessment.

68. **The TA expert also recommends the CBU to:**

- Fix the scenario horizon to three years regardless of the starting quarter.
- Improve the graphical representation of the results, including at the level of individual banks.
- Consider adding prudential add-ons for mortgage loans and car loans, etc., if vulnerabilities increase on these markets.
- Evaluate if interest rate risk is material for Uzbek banks. If yes, a modification of the approach for NII projections is advisable.
- Consider further technical assistance from the IMF in the area of liquidity stress testing as suggested by the 2021 FSSR.

Annex 1. Satellite Models

a. NPL model

```
. reg npl_logit L2.gdpg L1.irl L1.npl_logit
```

Source	SS	df	MS	Number of obs	=	37
Model	11.5416762	3	3.84722541	F(3, 33)	=	125.05
Residual	1.01525367	33	.030765263	Prob > F	=	0.0000
				R-squared	=	0.9191
				Adj R-squared	=	0.9118
Total	12.5569299	36	.348803608	Root MSE	=	.1754

npl_logit	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
gdpg L2.	-4.807258	1.782908	-2.70	0.011	-8.434612 -1.179904
irl L1.	2.172278	1.405007	1.55	0.132	-.6862293 5.030786
npl_logit L1.	.922951	.0544061	16.96	0.000	.812261 1.033641
_cons	-.306751	.3625619	-0.85	0.404	-1.044389 .4308868

b. NIM model

```
. reg nim irl fxgr
```

Source	SS	df	MS	Number of obs	=	31
Model	.001140647	2	.000570324	F(2, 28)	=	15.78
Residual	.00101203	28	.000036144	Prob > F	=	0.0000
				R-squared	=	0.5299
				Adj R-squared	=	0.4963
Total	.002152677	30	.000071756	Root MSE	=	.00601

nim	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
irl	.1535185	.0494034	3.11	0.004	.0523202 .2547169
fxgr	-.0086649	.0026343	-3.29	0.003	-.0140611 -.0032687
_cons	.0159181	.0071476	2.23	0.034	.001277 .0305592

c. NNII/TA model

```
. xtreg netnoninterestincometa gdpgrowth exchangerategrowth, fe
```

Fixed-effects (within) regression

Group variable: id

R-sq:

within = 0.0202
between = 0.0030
overall = 0.0116

Number of obs = 840
Number of groups = 31
Obs per group:
min = 4
avg = 27.1
max = 31

corr(u_i, Xb) = -0.0121

F(2,807) = 8.31
Prob > F = 0.0003

netnoninterestin~a	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
gdpgrowth	.3320889	.092726	3.58	0.000	.1500763 .5141016
exchangerategrowth	.0088663	.003606	2.46	0.014	.0017881 .0159445
_cons	.0258165	.0053797	4.80	0.000	.0152566 .0363764