Financial Stability Report

2023

May 2024

The Financial Stability Report is released biannually by the Central Bank of Uzbekistan. Its purpose is to evaluate macro-financial vulnerabilities and risks, analyze the stability of the domestic financial system, and propose policies and measures to promote financial stability.

This report is based on data as of January 1, 2024.

This is a translation of the original Uzbek version, which is the only official text.

This report was prepared by the Financial Stability Department of the Central Bank of Uzbekistan. If you have any comments, please send them to rmakhammadiev@cbu.uz.

Acronyms

AEs	Advanced economies
AUROC	Area under the receiver operating characteristic curve
CAB	Current account balance
CAR	Capital adequacy ratio
CBU	Central Bank of Uzbekistan
CCA	Caucasus and Central Asia
CCoB	Capital conservation buffer
CCyB	Countercyclical capital buffer
CET1	Common Equity Tier 1
CoVaR	Conditional value at risk
D-SIB	Domestic systemically important bank
DSR	Debt service ratio
EMs	Emerging markets
FCI	Financial conditions index
FSI	Financial stress index
FX	Foreign exchange
GDP	Gross domestic product
HHI	Herfindahl-Hirschman index
HP	Hodrick-Prescott
HQLA	High-quality liquid assets
IMF	International Monetary Fund
JSC	Joint-stock company
LGD	Loss-given default
LCR	Liquidity coverage ratio
LTV	Loan-to-value
MSCI	Morgan Stanley Capital International
NPLs	Non-performing loans
NSFR	Net stable funding rate ratio
PCA	Principal component analysis
PTI	Payment-to-income
ROA	Return on assets
ROE	Return on equity
RWA	Risk-weighted assets
SSM	State-space model
UCI	Uzbekistan Composite Index
USD	United States dollar
UZS	Uzbek soum
VIX	Volatility Index
WUI	World Uncertainty Index

Financial Stability Report for 2023

Contents

Executive Summary

Relatively tight financial conditions persisted in Uzbekistan in 2023. Financial conditions tightened due to worsening expectations regarding external sector risks and high volatility in the international financial markets.

The banking system maintained financial stability. Despite a decline in both the total and Tier I capital adequacy ratios, these metrics stayed above the minimum requirements. The relatively high level of stress that had built up in the banking system in recent years significantly decreased by the end of 2023. The financial stress index, gauging weaknesses in the banking system, displayed a downward trajectory. This decline was supported by positive shifts in the money market and the banking sector, despite trends in the global financial markets.

In 2023, liquidity indicators showed a downward trend, particularly in the net stable funding ratio (NSFR) and liquidity coverage ratio (LCR) of the banking system. Although the minimum requirements were met, this situation increases the risk of the banking system's limited ability to finance long-term assets from stable sources and weakens its tolerance to liquidity shocks.

The share of non-performing loans (NPLs) in total loans stayed nearly constant at 3.5%. In this context, the share of NPLs in Uzbekistan is slightly higher than the 25th percentile boundary in the Caucasus and Central Asia (CCA) countries, maintaining a close alignment with the median.

In 2023, the financial situation in the corporate sector worsened slightly. Leverage of selected large enterprises increased, with a rise in the cost of bank debt servicing in foreign currency, and a decrease in interest coverage ratio and profitability indicators. Persistent changes in these indicators could cause significant losses in the financial system if shocks occur in the corporate sector.

The population's overall debt burden is on the rise. While there was some improvement by year-end 2023, this indicator has nonetheless grown year-over-year. Concerns persist regarding the ability of people to meet their mortgage loan obligations. A survey further underscores this concern, finding that the average debt burden ratio among bank loan borrowers stood at a high 87%.

The real estate market continues to grapple with overvalued housing prices. Market values, already inflated by recent strong growth, are further buoyed by high demand. The significant lag in supply behind high demand tends to drive housing prices up, regardless of fundamental factors, particularly household income. Additionally, despite declining rental yields, speculation has fueled continued high activity and demand in the market. In 2023, the average market price of houses was estimated to be 24% above their fundamental value.

Tightened macroprudential measures led to a slowdown in car loan growth rates in H2 2023. Macroprudential measures enable commercial banks to build provisions for potential car loan losses during significant car price declines, mitigating the impact of potential risks on the banking system's financial stability.

A 2024–2026 macro stress test revealed the banking system's resilience to macroeconomic shocks under the baseline scenario, but also highlighted potential for significant losses under the adverse scenario. The capital adequacy ratio (CAR) and leverage ratio would likely exceed minimum requirements in the baseline scenario, but could fall below them in the adverse scenario. Under the adverse scenario, decreased economic activity and the depreciation of the Uzbek soum (UZS) may lead to difficulties for borrowers' debt servicing in foreign currency, increasing the number of NPLs and potential loan losses.

Financial Vulnerabilities Heatmap for Uzbekistan's Banking System

The financial vulnerabilities heatmap for 2023 indicates persistent vulnerabilities related to household debt, the real estate market, and banking system liquidity. Credit activity in the household sector has seen significant growth. A rise in mortgage and retail loan burdens, coupled with accumulating risks in the real estate market, could threaten the stability of the financial system. Consequently, the resilience of financial system participants to potential shocks may be weakened.

Mounting anxieties surround the real estate market. The sustained rise in real housing prices and their rapid growth compared to the population's disposable income can lead to market housing prices being overestimated relative to their fundamental value. If this trend persists in the medium term, it could exacerbate the risk of a sharp correction in housing prices during an economic downturn, leading to substantial losses on mortgage loans.

Household mortgage debt burdens are on the rise, with debt service ratios (DSR) and leverage indicators for allocated mortgages trending upwards. This persistent increase in mortgage debt levels exposes borrowers to greater risks, making them more vulnerable to income and other shocks.

There has been a slight decline in the liquidity of bank assets. Reductions in claims on other banks and the Central Bank of Uzbekistan (CBU) excluding required reserves have affected the amount of high-quality liquid assets (HQLA). A decrease in the share of HQLA in total bank assets could potentially hinder banks' ability to meet their obligations on time.

Changes in international financial markets are increasing the likelihood of potential losses in banks. The net open currency position of commercial banks has grown due to a widening gap between foreign currency assets and liabilities. As a result, significant fluctuations in exchange rates could potentially expose banks to losses.

I. Macrofinancial Conditions in Global and Uzbekistan's Economy

In 2023, global financial conditions eased. Despite heightened volatility in financial markets due to ongoing geopolitical conflicts and uncertainties in advanced economies (AEs), the global financial conditions index maintained a positive trajectory. This easing trend was further supported by positive developments in the stock market, which exhibited remarkably low price fluctuations.

Figure 1. Global Financial Conditions Index (standard deviation from the average)

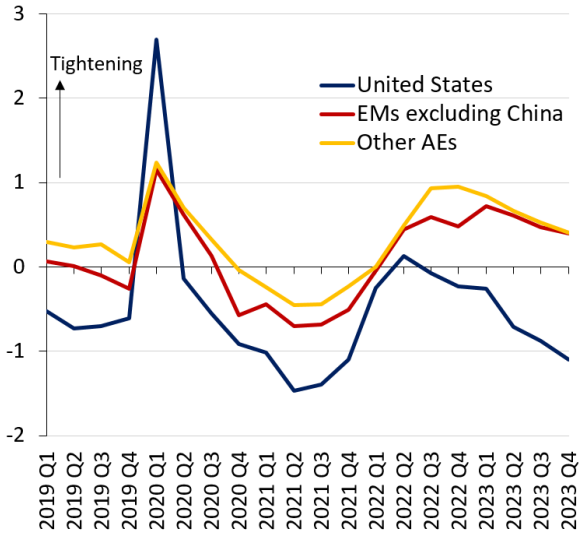
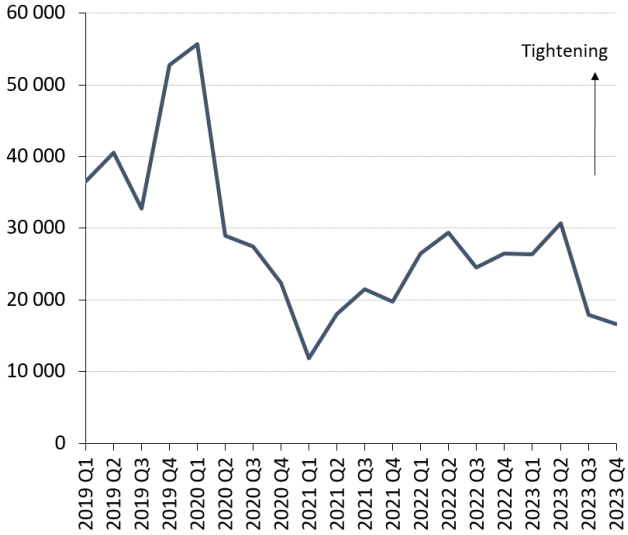


Figure 2. World Uncertainty Index (WUI)



Sources: IMF and WUI.

Note: The World Uncertainty Index (WUI) is a measure that tracks uncertainty around the world, covering 143 countries. It's constructed by text-mining country reports from the Economist Intelligence Unit (EIU). The WUI is calculated by counting the percentage of the word "uncertain" (or its variants) in the EIU country reports. The WUI is then rescaled by multiplying by 1,000,000 and weight averaged by the countries' GDP. A higher number means higher uncertainty.

Financial vulnerabilities persist across many countries. The high yield levels observed in the sovereign bonds of AEs have led to a reduction in investments in the assets of EMs in the international market. Additionally, high interest rates in 2023 dampened loan demand. Furthermore, defaults among certain borrower segments have continued to rise, diminishing banks' appetite for credit risk. Financial conditions in a high interest rate environment can pose challenges for the economies of weaker EMs[1].

Economists' concerns about global risks have lessened. This is evidenced by a decline in WUI, which reflects economists' concerns about global uncertainties[2]. A decline in the WUI value by the end of 2023 points to a slight reduction of uncertainties from recent geopolitical instability.

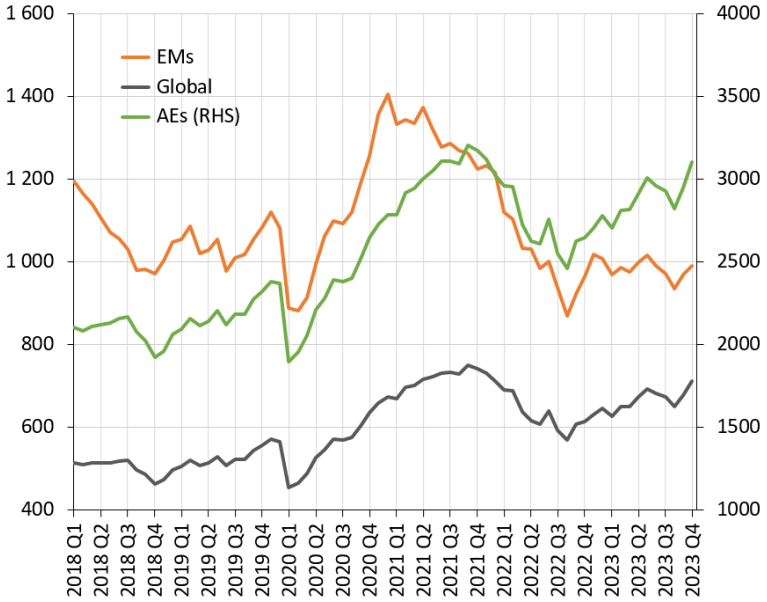
[1] International Monetary Fund. (2024, January). World Economic Outlook.

[2] World Uncertainty Index. (2024). World Uncertainty Index (WUI): Global.

After the spring 2023 banking turmoil in US and European banks, the global capital markets stabilized. The adverse effects of the US federal funds rate hike in response to high inflation moderated slightly in 2023. Moderate global economic growth and a slowdown in inflation indicators contributed to a modest recovery in investor confidence by the year's end.

The Morgan Stanley Capital International (MSCI) indexes, which reflect global stock market dynamics, showed an upward trend for both global and advanced economies. In 2023, the MSCI index for AEs rose by 22% from 2022, reaching approximately 3,200 USD by the end of the year. The global MSCI index also increased by 17% during the same period. However, there was no notable positive change in the stock markets of EMs.

Figure 3. MSCI Indexes*, USD

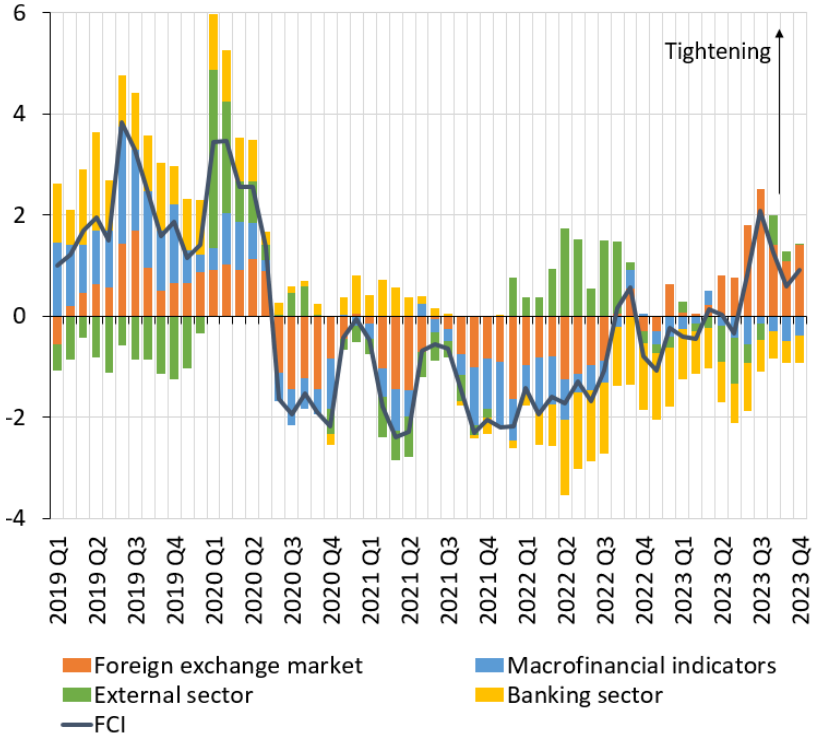


Source: Bloomberg.

Note: *MSCI indexes provide an overview of the global stock market by tracking the large companies' stock prices in 23 AEs and 24 EMs. If the index values increase, it means that the stock prices of the companies in the index have increased.

In 2023, financial conditions in Uzbekistan tightened. It was driven by deteriorating external risk expectations and high volatility in international financial markets. A deficit in the current account balance (CAB), particularly a negative trade balance, further exacerbated UZS depreciation (see Appendix 1).

Figure 4. Uzbekistan's Financial Conditions Index (FCI)



Source: CBU staff calculations.

Note: Positive values of the FCI indicate a tightening of financial conditions, while negative values indicate a softening of financial conditions (see Appendix 2).

Uzbekistan has seen a substantial rise in domestic demand. The country's economic growth in 2023 reached 6%, with domestic demand contributing a significant 9.2 percentage points to this increase. However, this positive impact was partially offset by a negative net export balance of 3.3 percentage points. Consumption constitutes the largest portion of domestic demand, accounting for roughly 64% as of January 1, 2024.

In 2023, the service and industrial sectors significantly boosted GDP growth, contributing 2.6 and 1.5 percentage points, respectively. Agriculture also made a positive impact, adding 1 percentage point[3]. However, the construction sector's limited contribution to GDP growth raises concerns about a potential imbalance between supply and demand in the real estate market.

[3] Statistics Agency under the President of the Republic of Uzbekistan. (2023). National accounts.

Figure 5. Annual GDP Growth Decomposition*, percentage point

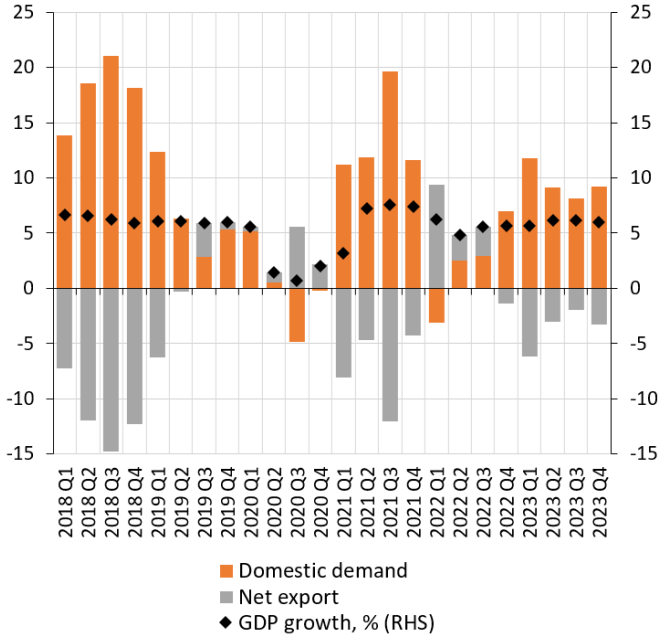
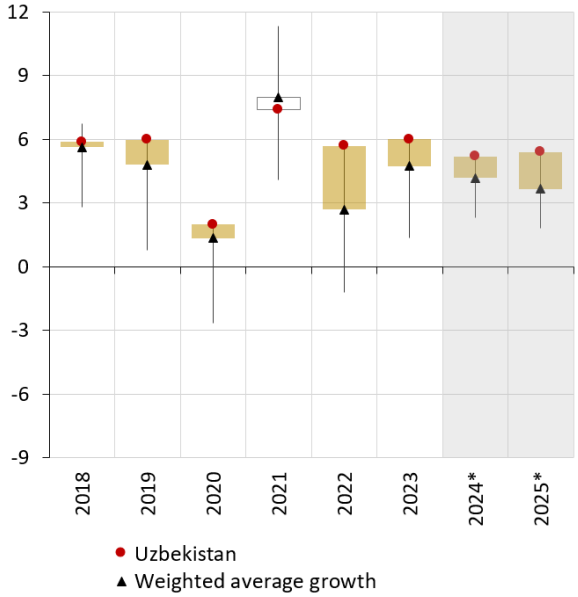


Figure 6. Growth Distribution of Uzbekistan's Main Trading Partners, %**



Sources: Statistics Agency, IMF, and CBU staff calculations.

Notes: *Domestic demand is the sum of consumption and gross capital formation.

**The rectangle displayed in the chart represents the variation between Uzbekistan's GDP growth rate and the weighted average of GDP growth rates for main trading partners. The length of the rectangle indicates the difference between the growth rates. If Uzbekistan's GDP growth rate exceeds the weighted average, the rectangle is shaded, and if it is the opposite, the rectangle remains blank. The vertical black line on the chart represents the maximum and minimum growth rates among the seven countries for a given year.

Uzbekistan's economic growth is estimated to outpace that of its main trading partners in the coming years. According to the International Monetary Fund (IMF), Uzbekistan's economy is expected to grow by 5.2% in 2024 and 5.4% in 2025[4]. Meanwhile, the World Bank projects growth rates of 5.3% in 2024 and 5.5% in 2025[5]. Based on IMF data, the average economic growth rate of Uzbekistan's main trading partners is anticipated to be 4.2% in 2024 and 3.7% in 2025[6].

A high deficit was observed in the CAB, totaling 7.8 billion USD (8.6% of GDP) by the end of 2023. The negative trade and primary income balances were 17.6 billion USD and 0.8 billion USD, respectively, while the positive secondary income balance amounted to 10.5 billion USD[7].

[4] International Monetary Fund. (2024, April). World Economic Outlook.

[5] World Bank. (2024, Spring). Unleashing the Power of the Private Sector.

[6] International Monetary Fund. (2024, April). World Economic Outlook.

[7] The Central Bank of the Republic of Uzbekistan. (2024). Balance of Payments (analytical presentation).

Figure 7. Quarterly Distribution of Current Account Balance, billion USD

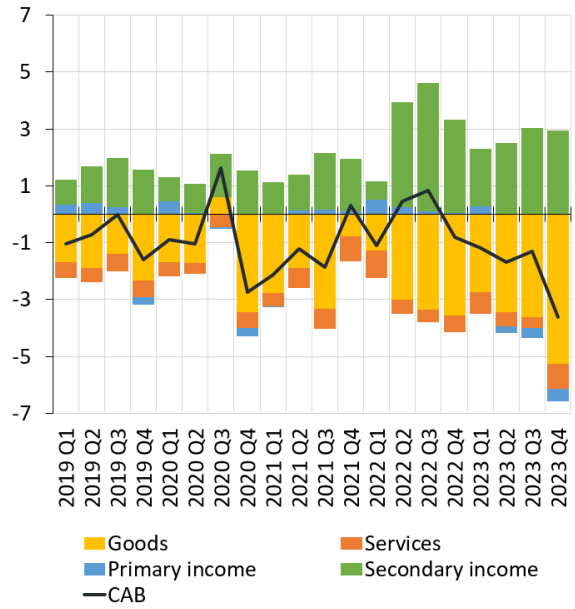
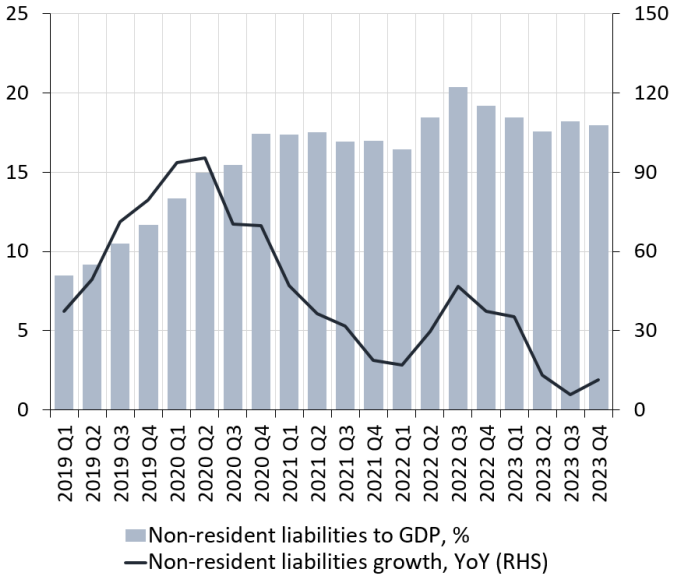


Figure 8. Bank Liabilities to Non-residents-to-GDP Ratio and YoY Growth of These Liabilities, %



Source: CBU.

The growth of gross external liabilities of commercial banks has slowed. The increase in interest rates due to the tightening effect observed in the world financial market has influenced the rising cost of attracting external funds for commercial banks. Consequently, the pace of attracting external funds by banks is decelerating. In particular, in 2023, the liabilities of commercial banks to non-residents increased by 11%, with the growth rate slowing by 26 percentage points compared to 2022. Additionally, as of January 1, 2024, the ratio of commercial banks' liabilities to non-residents to GDP was about 18%, a decrease of 1 percentage point compared to the corresponding period in 2023.

Box 1. Uzbekistan's Financial Conditions Index (FCI)

To develop Uzbekistan's financial conditions index, indicators representing the banking sector, domestic currency market, foreign sector, and overall financial situation were used based on the characteristics of the country's financial system and foreign experience (see Appendix 3).

For the analysis of the banking sector, the spread between bank loan rates[8] and treasury bond rates in the national currency, along with indicators such as the loan-to-deposit ratio, was utilized. The Exchange Market Pressure Index (EMPI)[9] served as a reflection of changes in the domestic currency market. Risk expectations in the external sector were assessed using the Volatility Index (VIX)[10] alongside the G-spread[11] indicators of Uzbekistan's sovereign Eurobonds, which represent the country's risk premium. Finally, indicators such as the inflation rate and the annual real growth of demand deposits in the broad money supply were used to assess the country's overall financial condition.

Because the capital market in Uzbekistan is underdeveloped, market participants exhibit low sensitivity to economic expectations. Consequently, the Uzbekistan Composite Index (UCI) and

[8] Interest rates on preferential loans and microloans are not included.

[9] Balakrishnan, R., Danninger, S., Elekdag, S., & Tytell, I. (2009). The Transmission of Financial Stress from Advanced to Emerging Economies. International Monetary Found.

The Exchange Market Pressure Index (EMPI) measures exchange rate depreciations and declines in international reserves. It is calculated by comparing the ratio of the annual percentage changes in the exchange rate to its standard deviation with the ratio of the annual percentage changes in international reserves (excluding gold) to its standard deviation.

EMPI is calculated using the following formula:

$$EMPI_t = \frac{\Delta e_t}{\sigma_{\Delta e}} - \frac{\Delta Res_t}{\sigma_{\Delta Res}}$$

Where,
Δe_t – year-over-year percentage change in the exchange rate;
ΔRes_t – year-over-year percentage change in total international reserves excluding gold;
σ – standard deviation.

[10] Chicago Board Options Exchange. (2023). Volatility Index Methodology: CBOE Volatility Index.

The VIX index, administered by the CBOE (Chicago Board Options Exchange), serves as a volatility gauge for the stock market, indicating the level of stress and uncertainty. Higher values in the VIX index signify heightened market stress and uncertainty.

VIX is calculated using the following formula:

$$\text{VIX} = \sqrt{\frac{2}{T}\sum_i \frac{\Delta K_i}{K_i^2} e^{RT} Q(K_i) - \frac{1}{T}\left[\frac{F}{K_0} - 1\right]^2} * 100$$

Where,
T – time to expiration;
F – option-implied forward price;
K_0 – first strike equal to or otherwise immediately below the forward index level, F;
K_i – strike price of the i^{th} out-of-the-money option;
ΔK_i – interval between strike prices;
R – risk-free interest rate to expiration;
$Q(K_i)$ – the midpoint of the bid-ask spread for each option with strike K_i.

[11] A G-spread is the difference between the bond yield and its benchmark, the US Treasury bond yield. An increase in the G-spread denotes an increase in the risk level of this bond compared to the benchmark bond.

market capitalization levels, which reflect changes in the capital market, were not included in the FCI calculation. This exclusion was due to the weak correlation between these indicators and changes in the country's real economy.

The determined indicators are presented in a standardized form, with their arithmetic mean value set to zero and their standard deviation set to one using the Z-score method[12].

Sub-indexes representing the banking system, foreign exchange (FX) market, external sector, and financial condition were determined by calculating their arithmetic average, with equal weights assigned to standardized indicators.

The final result of FCI was calculated using the principal component analysis (PCA) model[13], which reduced the size of the sub-indexes through linear replacement while retaining as much available variance of the sub-indexes as possible.

Figure 9. AUROC Model: Efficacy of FCI in Providing 2- and 4-Quarter Lagged Crisis Warnings

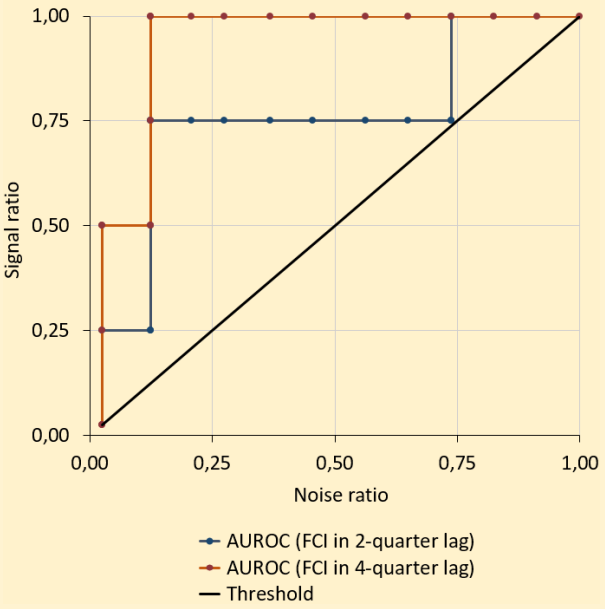
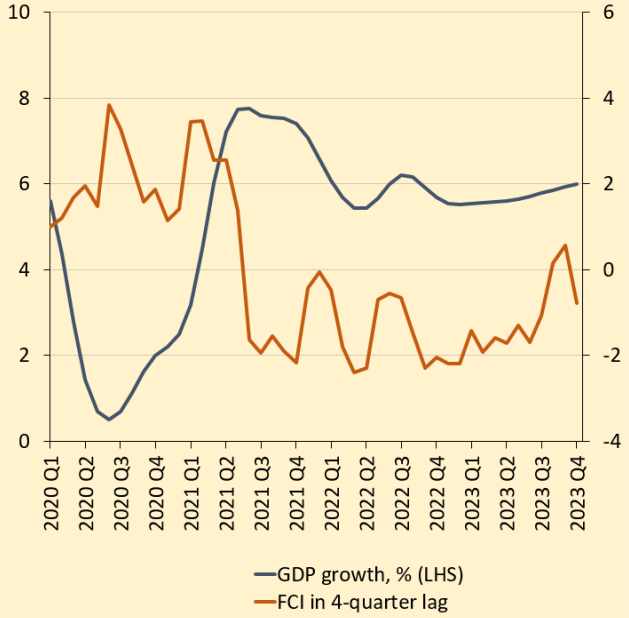


Figure 10. FCI in 2- and 4-Quarter Lags and GDP Growth*



Source: CBU staff calculations.

Note: *Increasing FCI signals tighter financial conditions, which could lead to a decrease in the country's real economic growth rate. Conversely, a decrease in FCI suggests eased financial conditions, signaling expectations of higher real GDP growth rates.

[12] Standardization of indicators is performed using the following formula:

$$y_z = \frac{y_t - y_\mu}{\sigma_{y_t}}$$

Where,
y_z – the standardized value of the indicator;
y_t – the value of the indicator in month t;
y_μ – the arithmetic mean of the indicators;
σ_{y_t} – the standard deviation of the indicator.

[13] The PCA methodology is elaborated upon in the Financial Stability Report for 2022.

The significance level of the final FCI result was evaluated using the AUROC model, assessing its effectiveness in identifying crisis periods with 2- and 4-quarter lags. Additionally, FCI was compared with GDP growth. Considering that FCI is a monthly time series, GDP growth was converted from quarterly to monthly using a cubic spline interpolation model (see Appendix 4).

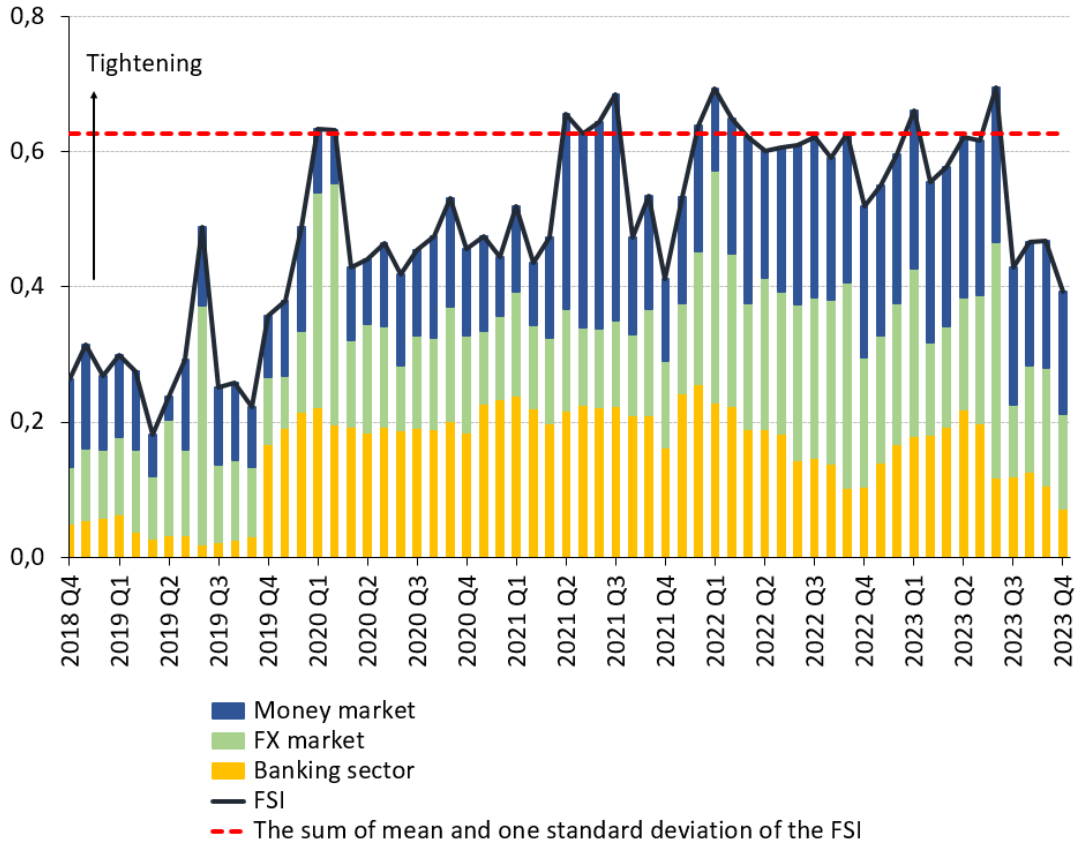
The AUROC model results indicate that the FCI effectively signals crises with a lag of both 2 quarters (AUROC = 0.77) and 4 quarters (AUROC = 0.95). A strong correlation is observed between GDP growth and the index values lagged by 4 quarters (see Appendix 5). This correlation allows for early assessment of changes in the real economy. Specifically, the slight tightening trend in the FCI for 2023 serves as a 4-quarter early warning sign of an anticipated decline in the country's real GDP growth rate.

II. Financial sector

2.1. Banking sector

In 2023, Uzbekistan's banking system maintained financial stability. Despite a decrease observed in the main financial stability indicators, they remained above the established minimum requirements. The relatively high stress level that had been building in recent years decreased significantly by the end of 2023. The Financial Stress Index (FSI)[14], reflecting current vulnerabilities in the system, showed a downward trend. Positive developments in the money market and banking sector, despite high domestic currency market volatility, contributed to the decline in the FSI.

Figure 11. Uzbekistan's Financial Stress Index



Source: CBU staff calculations.

Note: The FSI value close to 1 indicates a high level of stress, while a value near 0 indicates a low level of stress

Strong growth in lending, deposit attraction, and the return on banks' interest-bearing assets has stimulated positive change in the banking sector. By the end of 2023, the total volume of loans and deposits in commercial banks exceeded their potential trends. In 2023, the net interest income surged by 20% compared to 2022,

[14] The FSI methodology is presented in the Financial Stability Report for 2022.

totaling 29 trillion UZS[15]. Consequently, there was a positive change in the ratio of net interest margin to total interest-bearing assets, which reached 5.4% by the end of 2023.

Figure 12. Bank-by-bank ΔCoVaR

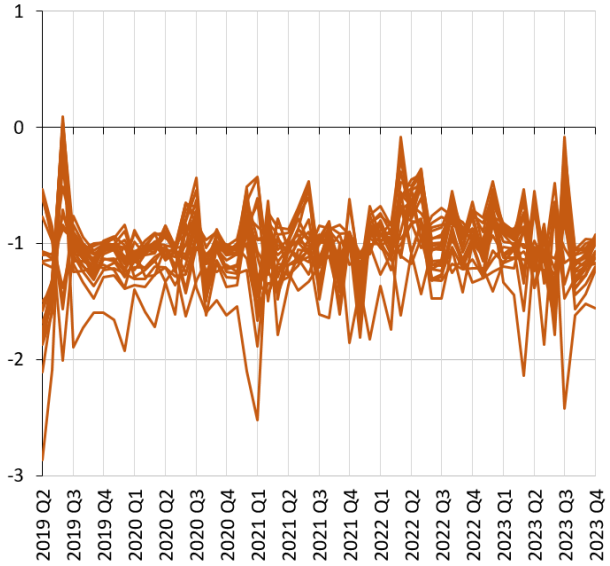
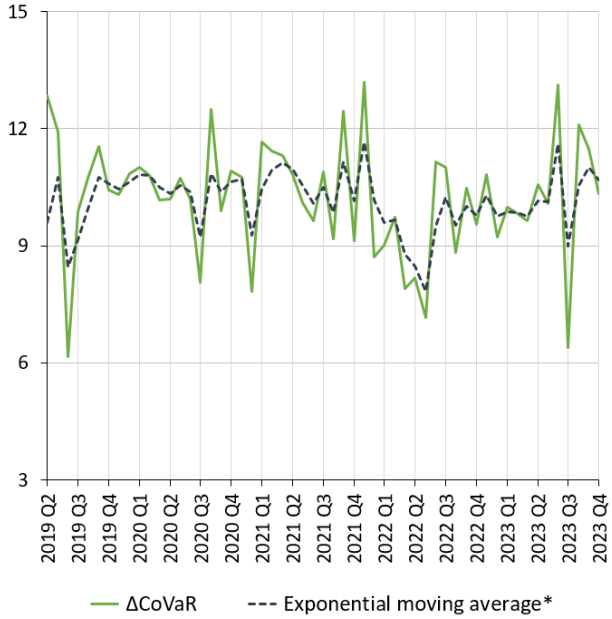


Figure 13. ΔCoVaR for Banking System



Source: CBU staff calculations.

Notes: The ΔCoVaR for the banking sector was calculated using data from 21 banks, due to the long time series available during the observation period and the similarity of individual bank conditions to the banking system. It was computed as the absolute value of the sum of the products of each bank's ΔCoVaR and their respective shares of total banking system capital.

The increase in ΔCoVaR means that systemic risk in the banking system is building up, while the decrease in ΔCoVaR means that systemic risk is decreasing.

*The exponential moving average is a technique used to smooth out the value of an indicator by reducing random and short-term fluctuations. Unlike the simple moving average, this method gives more weight to recent values of the indicator, making it a more accurate representation of current changes in its value.

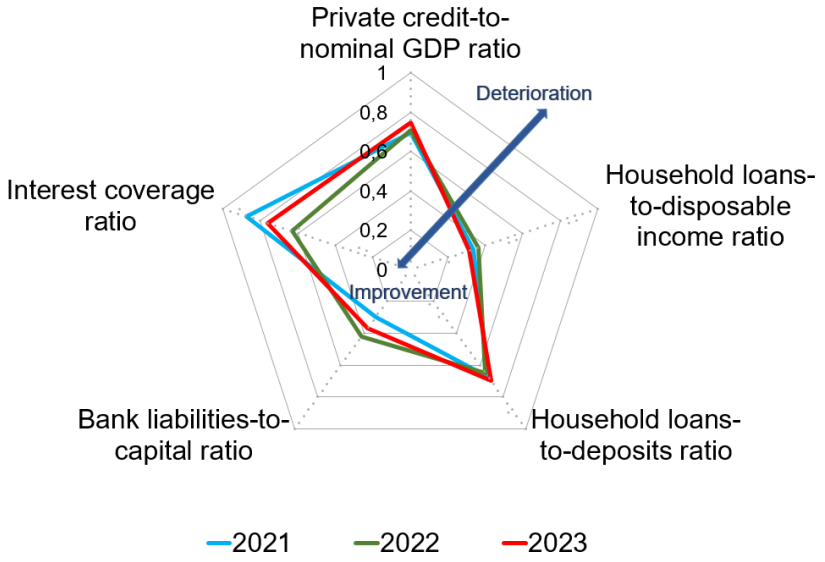
In 2023, the systemic risk indicator for the banking sector maintained its historical average trend despite significant fluctuations. The increased impact of changes in deposit and credit interest rates on the overall risk level of the banking system during this period was reflected in significant changes in the ΔCoVaR[16]. Despite the decrease in liquidity indicators in the banking system, the rise in bank profitability and the reduction in high volatility in the capital market caused the ΔCoVaR to remain in its average trend.

[15] The Central Bank of the Republic of Uzbekistan. (2024). Statistical bulletin 2023.

[16] The methodology of the dynamic ΔCoVaR model is presented in the Financial Stability Report for H1 2023.

The credit market risk map[17] shows an improvement in the ratio of banks' liabilities to capital, which decreased by 28% in 2023. Notably, the banking sector's liabilities increased by 16%, while the growth of capital volume accelerated to 22% in 2023.

Figure 14. Credit Market Conditions



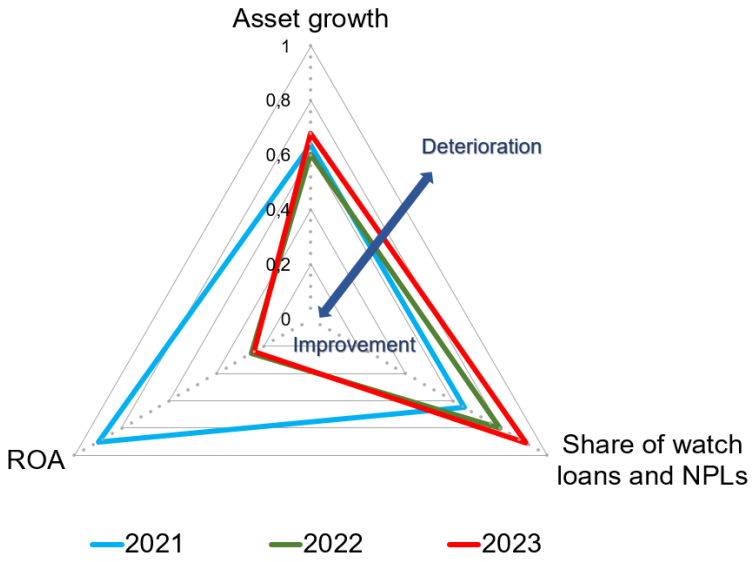
Sources: Statistics Agency and CBU staff calculations.

The interest coverage ratio showed a slight weakening. In 2023, the interest coverage ratio decreased by 7 percentage points.

The private credit-to-nominal GDP ratio continued to climb, rising by nearly 2 percentage points in 2023. Additionally, loans to the private sector grew by 25%, surpassing the nominal GDP growth rate of 20% for the same period.

[17] The risk map methodology is presented in the Financial Stability Report for H1 2022.

Figure 15. Financial Soundness Conditions



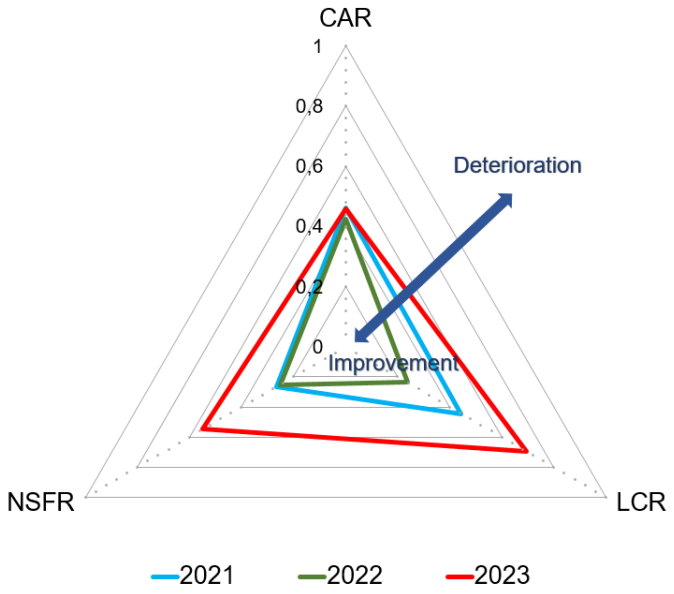
Source: CBU staff calculations.

The map of financial soundness conditions in the banking system indicated that asset growth and profitability remained relatively stable. The return on assets (ROA) persisted at approximately 2.5% throughout 2023. However, the total asset volume growth rate decelerated, showing an 8 percentage point decline compared to 2022.

In the banking system's loan portfolio, the proportion of watch loans and NPLs is on the rise. By the end of 2023, the combined share of watch loans and NPLs reached nearly 20%, representing a 4-percentage-point increase compared to the end of 2022.

Although the banking system's resilience to shocks has weakened, financial soundness indicators remain above the minimum requirements. The NSFR declined by 3.8 percentage points in 2023. A sharp decrease in the LCR to 165% at the end of 2023 resulted from a reduction in the volume of HQLA. The CAR exhibited minimal change in 2023, decreasing by only 0.3 percentage points compared to the end of 2022.

Figure 16. Banking System Resilience



Source: CBU staff calculations.

In 2023, both the CAR[18] and the Tier I capital ratio[19] experienced a slight decline. This downward trend was due to the growth rate of risk-weighted assets (RWA) outpacing the growth rates of total regulatory capital and Tier I capital. Specifically, the CAR decreased by 0.3 percentage points, while the Tier I capital ratio fell by 0.4 percentage points. As of January 1, 2024, banks' total regulatory capital amounted to 106 trillion UZS, with Tier I capital reaching 85 trillion UZS. Notably, approximately 80% of the capital is composed of high-quality Tier I capital.

[18] The ratio of total regulatory capital to RWA.

[19] The ratio of Tier 1 capital to RWA.

Figure 17. CAR in Banking Sector, %

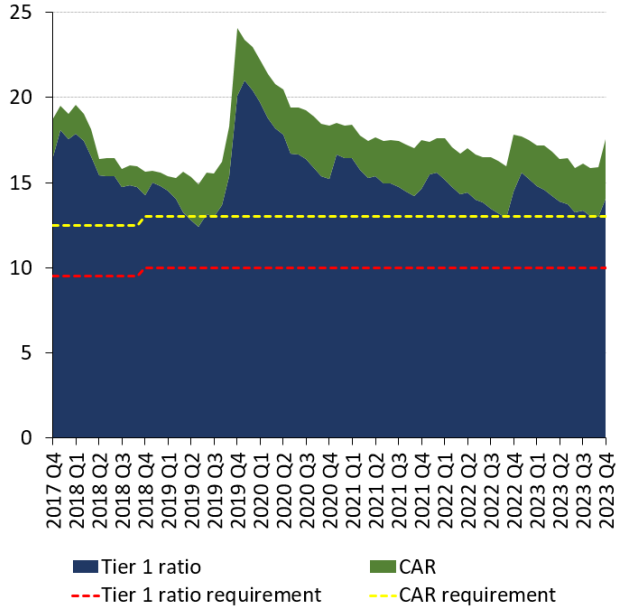
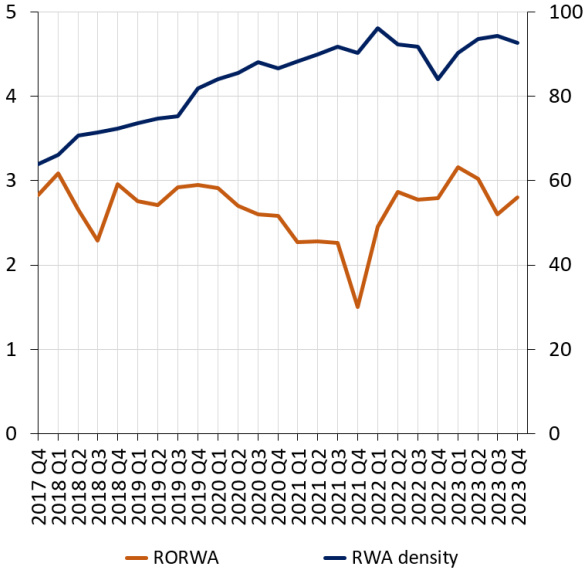


Figure 18. RWA Density[20] and Return on RWA (RORWA), %



Source: CBU.

In 2023, RWA density, a measure of the risk profile of banks' assets, exhibited an upward trend. A substantial 93% of total bank assets were classified as RWA, indicating heightened vulnerability to economic downturns. Despite Uzbekistan's 6% real economic growth rate in 2023, the banking system's RORWA remained stable at approximately 2.5–3%.

A downward trend is evident in the Common Equity Tier 1 (CET1) capital ratio, which declined by 0.3 percentage points in 2023. This decrease resulted from an increase in RWA density, attributed to a deterioration in the banking system's asset quality and a slowdown in total asset growth. Nevertheless, the CET1 capital ratio remained above the minimum capital requirement.

[20] To calculate the RWA density, the amount of RWA is divided by total assets. The RWA density provides a measure of riskiness of assets. An increase in the RWA density indicates a deterioration in overall risk profile of bank assets, while a decrease in the RWA density indicates an improvement in risk quality of assets.

Figure 19. Changes in CET1 Capital Ratio, %

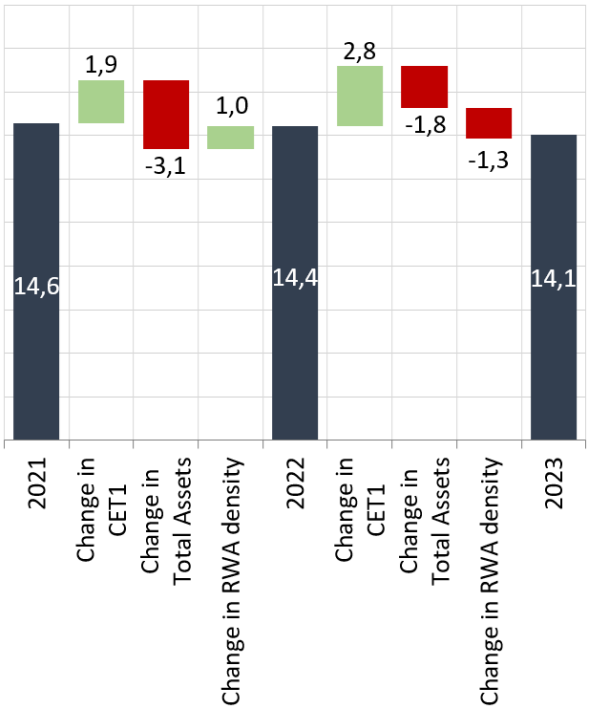
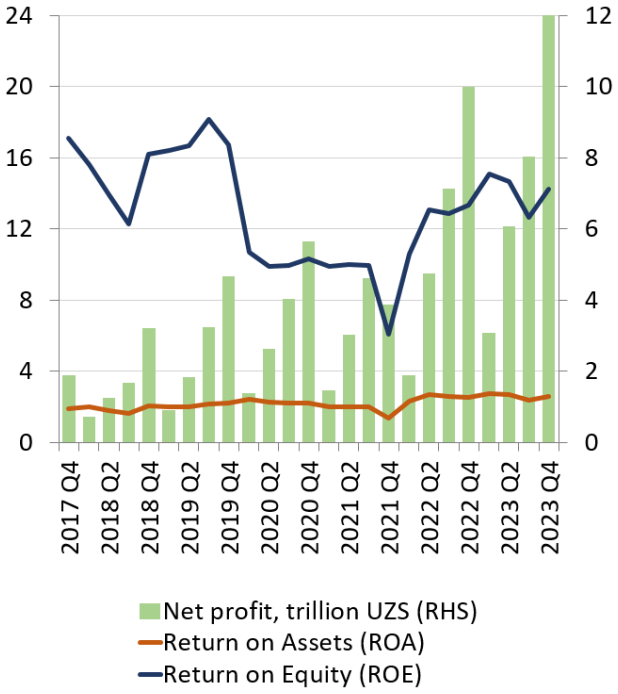


Figure 20. Profitability in Banking Sector



Source: CBU.

The ROA remained relatively constant, standing at 2.6% at the end of 2023. An analysis of ROA decomposition indicates that net interest income and net non-interest income were the primary drivers of ROA. Nevertheless, operating expenses and potential asset losses had a dampening effect on the ROA.

Figure 21. ROA Decomposition for Banking Sector, %

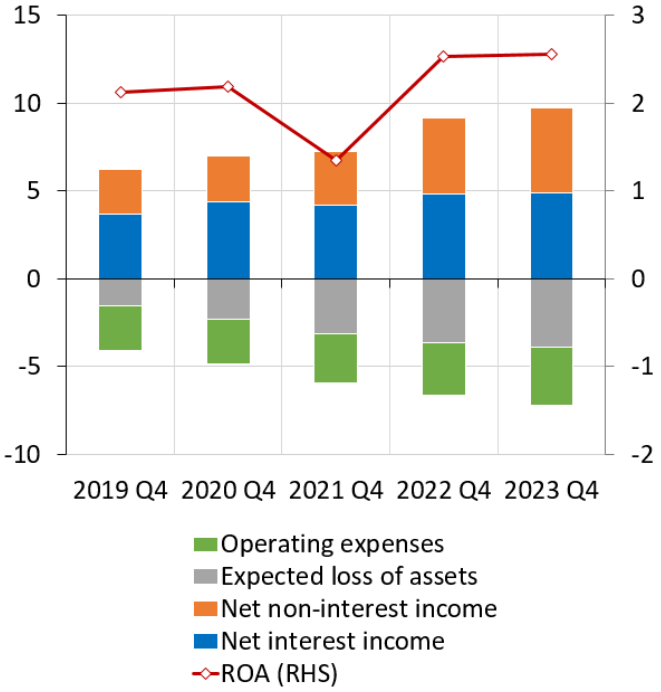
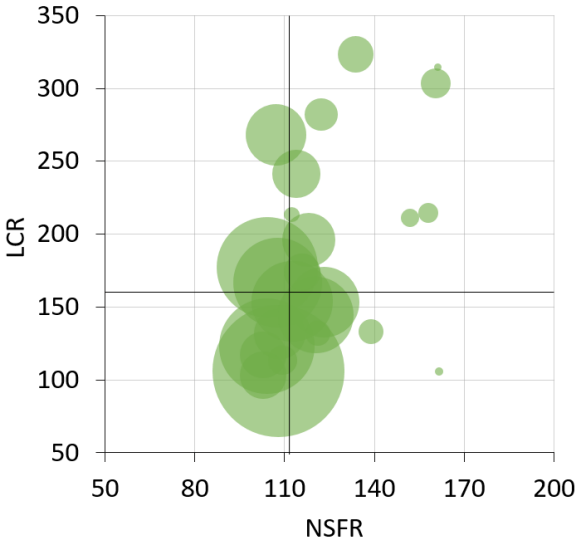


Figure 22. Bank-by-Bank Liquidity Indicators, % (as of January 1, 2024)



Source: CBU.

Note: The bubble size for each bank is proportional to its asset share in the total assets of the banking system. Banks with LCR and NSFR exceeding 400% and 200%, respectively, are excluded in the graph. The continuous straight lines represent the average values of indicators for the banking system as of January 1, 2024.

In 2023, the NSFR experienced a downward trend. The banking system's NSFR decreased by 4 percentage points to 112%, indicating a diminished capacity to finance long-term assets with stable funding sources.

The NSFR for domestic systemically important banks (D-SIBs) has consistently clustered around the 25th percentile. The gap between banks' NSFRs within the interquartile range[21] is expanding. At the end of 2023, the NSFR for D-SIBs stood at 110%. The NSFR for both the banking system and D-SIBs remains below the median.

[21] This type of visual analysis displays the position of the studied indicator within an interval and how far it deviates from the median line. The boundaries are set by disregarding the lowest and highest 25% of all indicators.

Figure 23. NSFR in Banking System, %

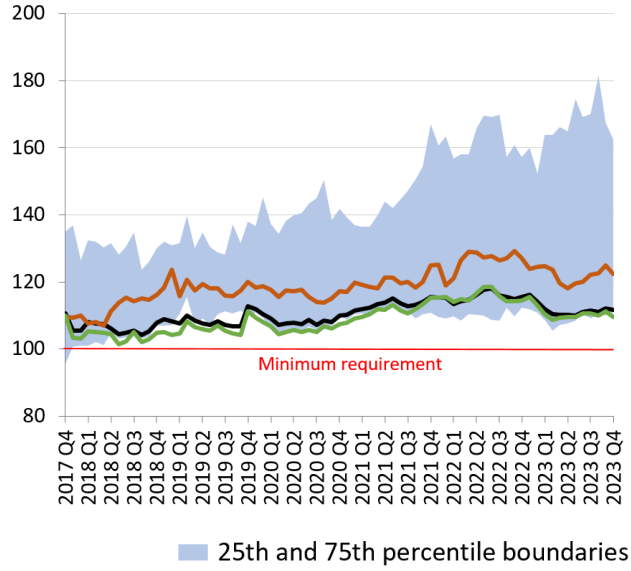
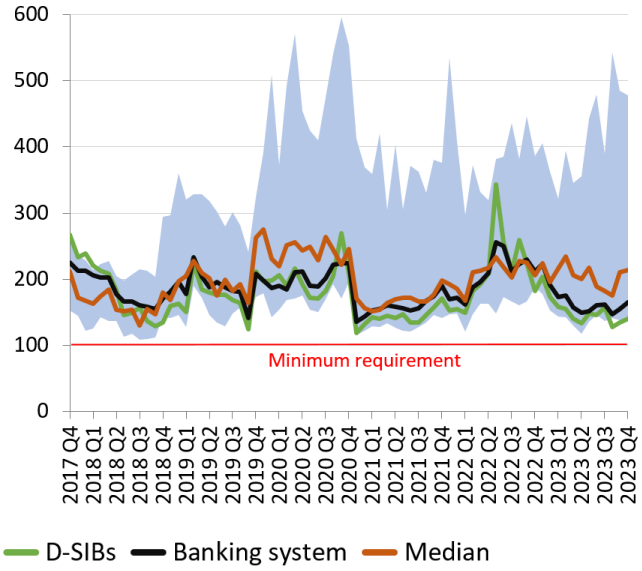


Figure 24. LCR in Banking System, %



Source: CBU.

In 2023, the banking system's LCR showed a downward trend, decreasing by 47 percentage points to 165%. This decline is attributed to a 7% reduction in the amount of HQLA in banks. The LCR for D-SIBs remained at the lower boundary of the interquartile range, reaching 141% by the end of 2023. The median LCR of banks was 213%, indicating that most commercial banks fell below the 25th percentile boundary. A negative trend in the LCR may lead to weaknesses in banks' ability to fulfill obligations promptly without incurring losses during liquidity shocks.

Figure 25. HQLA-to-Total Assets Ratio, %

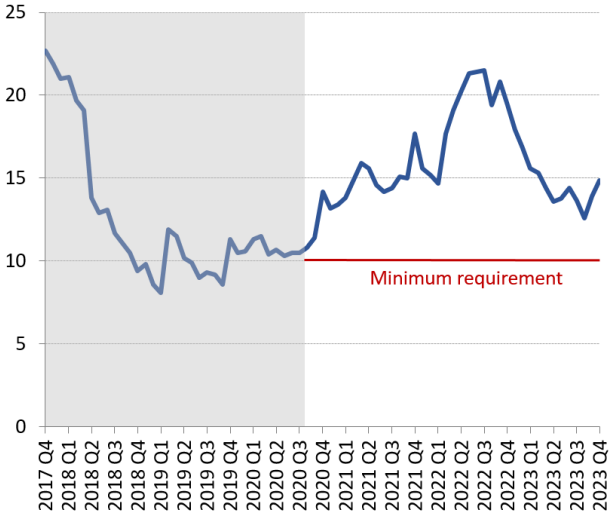
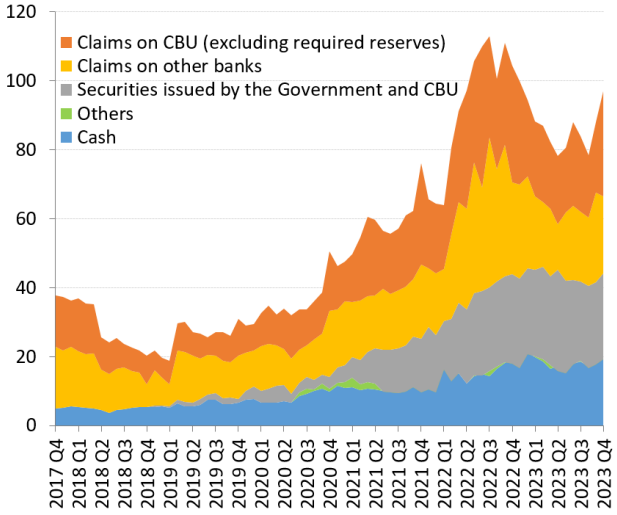


Figure 26. HQLA Composition, trillion UZS



Source: CBU.

Note: As of June 1, 2020, the CBU has set a minimum requirement of 10% for the ratio of HQLA of banks to total assets.

The share of HQLA in the banking system's total assets began to increase following a decline that persisted until Q4 2023. By the end of 2023, HQLA accounted for 14.9% of total assets, a decrease of 4.5 percentage points compared to the same period in 2022. The downward trend of HQLA denominated in UZS throughout 2023 can be attributed to robust demand in the domestic FX market. Specifically, in 2023, funds held in other banks diminished by 4.3 trillion UZS, funds held at the CBU (excluding required reserves) contracted by 3.6 trillion UZS, and government securities decreased by 1.0 trillion UZS. The reduction in foreign currency HQLA was due to customers making import payments and settling foreign debts.

Figure 27. Total Loans-to-GDP Ratio in CCA Countries*, %

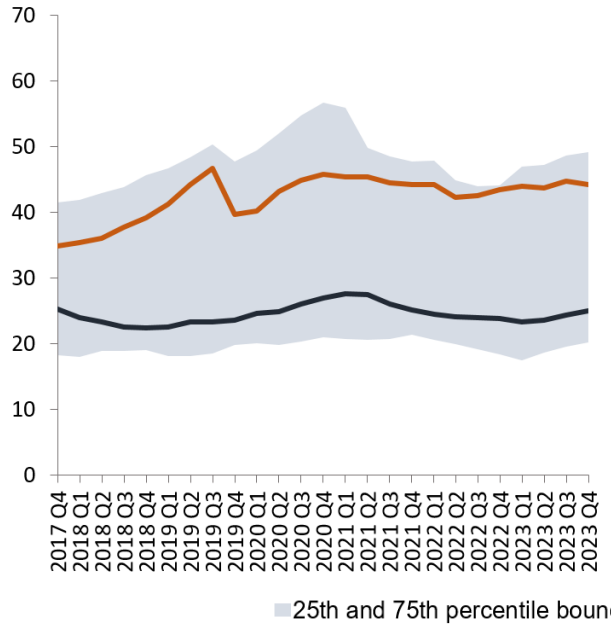
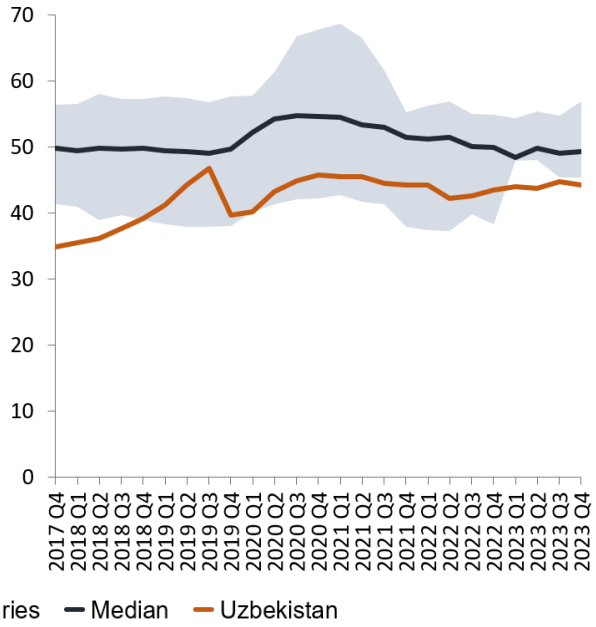


Figure 28. Total Loans-to-GDP Ratio in Low- and Middle-Income European Countries, %**



25th and 75th percentile boundaries — Median — Uzbekistan

Sources: National authorities, Statistics Agency, and CBU staff calculations.

Note: *Armenia, Georgia, Azerbaijan, Tajikistan, Uzbekistan, Kyrgyzstan and Kazakhstan are included.

**Albania, Bulgaria, Bosnia and Herzegovina, Kosovo, Moldova, Russia, Türkiye, Ukraine, Montenegro and North Macedonia are included. Albania and Kosovo in Q4 2023 and Ukraine in 2023 are excluded due to insufficient data.

Intensified competition in the banking system has led to a reduction in loan concentration among banks. The Herfindahl-Hirschman Index (HHI) for 2023 reveals a shift from medium to low loan concentration in the banking system. Specifically, the loan concentration level at the end of 2023 was 986, indicating a medium concentration of loans to legal entities. Conversely, the low concentration observed in loans to individuals signifies a more competitive landscape in the retail loan market.

The development of digital banking is fostering a highly competitive deposit market environment. In 2023, bank deposit concentration remained low. The HHI for

deposits fell to 672, signaling a positive trend. Specifically, deposit concentration decreased by 29 for individuals and by 153 for legal entities.

Figure 29. Loan-to-Deposit Ratio and Difference between Loans and Deposits, %

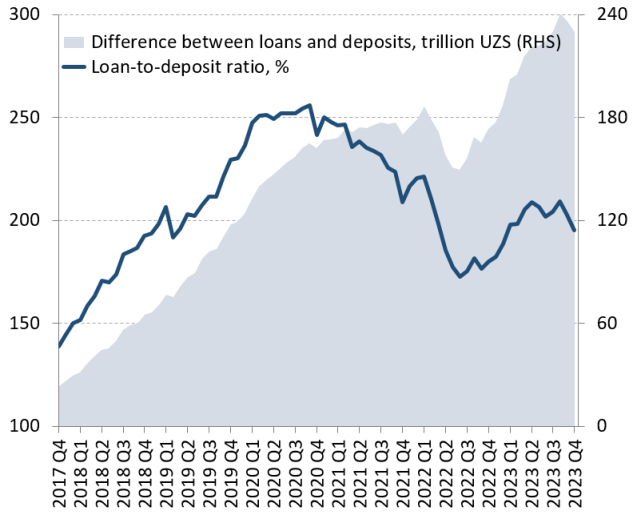
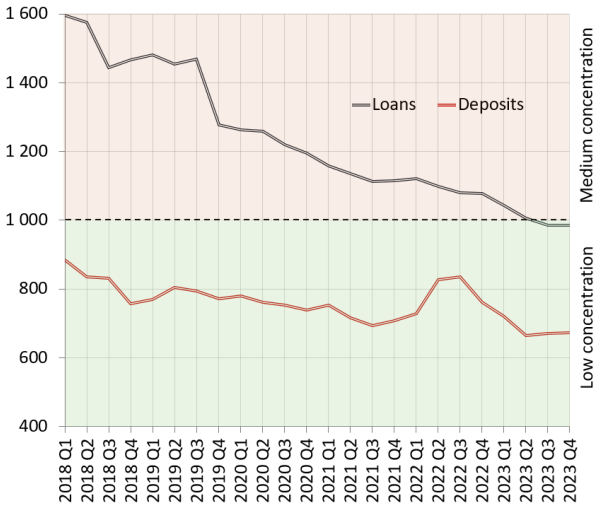


Figure 30. Concentration of Outstanding Loans and Deposits, HHI*



Source: CBU.

Note: *The Herfindahl-Hirschman Index (HHI) categorizes the level of competition in the banking services market into the low concentration (below 1000), medium concentration (from 1000 to 1800), and high concentration (above 1800) groups. The HHI is calculated as the sum of the squares of each bank's shares of deposit and loan balance in the total banking system deposit and loan balance.

In 2023, the gap between the volume of loans and deposits in the banking system continued to expand. Loan growth outpaced deposit growth, with loans increasing by 21% and deposits by 12%. Consequently, banks have become increasingly reliant on funding sources beyond deposits to finance lending activities. The gap between loans and deposits reached 230 trillion UZS at the end of 2023, marking a 33% surge compared to the same period in 2022.

Figure 31. Bank-by-Bank Annual Growth Rates of Loans and Deposits (as of January 1, 2024)

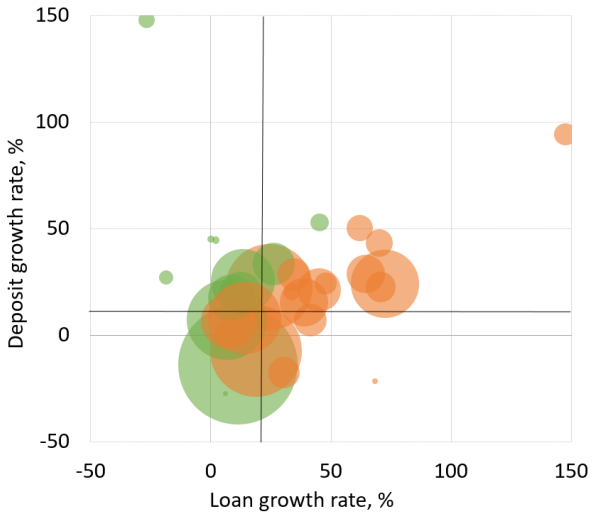
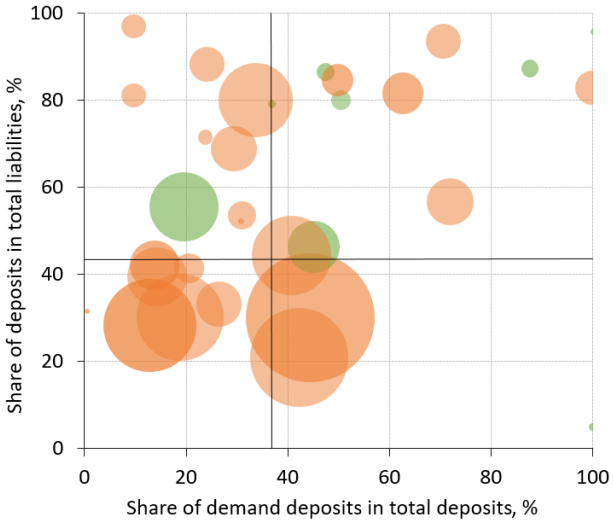


Figure 32. Bank-by-Bank Share of Deposits in Total Liabilities and Share of Demand Deposits in Total Deposits (as of January 1, 2024)

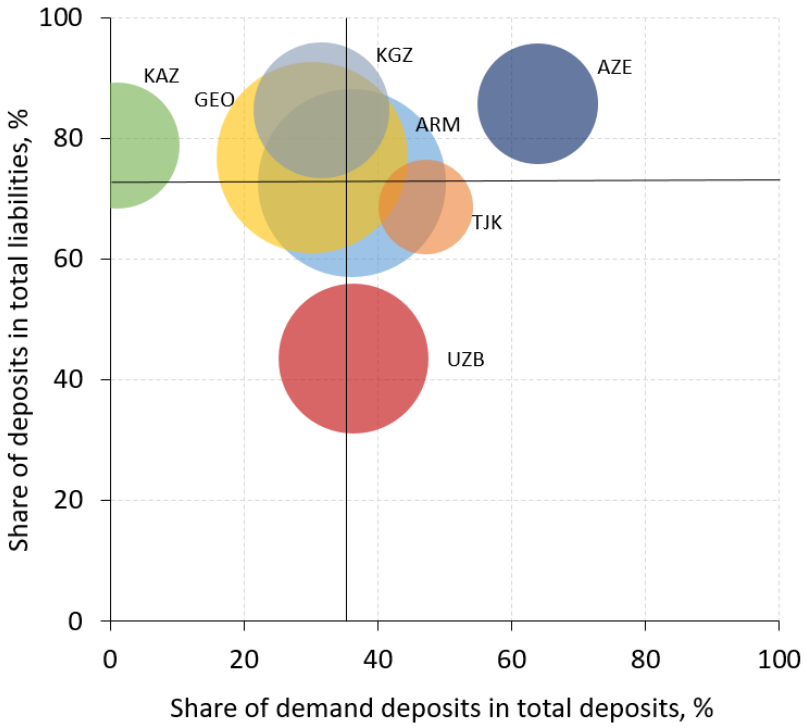


Source: CBU.

Note: In the left graph, the color green on the chart represents banks with a faster growth rate of deposits compared to loans, while light red indicates banks with a lower growth rate of loans. In the right graph, the color green on the chart indicates the banks where the share of demand deposits in total deposits increased compared to the same period in 2022. Light red, on the contrary, represents banks where the share of demand deposits in total deposits decreased compared to the same period in 2022. The bubble size represents the share of a bank's assets in all banks' assets. The continuous straight lines represent the average values of indicators for the banking system as of January 1, 2024.

In 2023, there was a decline in the share of demand deposits within total deposits. On average, demand deposits accounted for 36% of total deposits in the banking system. This downward trend was observable across most banks.

Figure 33. Share of Deposits in Total Liabilities and Share of Demand Deposits in Total Deposits in CCA Countries* (as of January 1, 2024)



Sources: National authorities, Statistics Agency and CBU staff calculations.

Note: Armenia, Georgia, Azerbaijan, Tajikistan, Uzbekistan, Kyrgyzstan, and Kazakhstan are included. The bubble size represents the share of total banking assets in the country's GDP. The continuous straight lines represent the average values of the indicators for CCA countries as of January 1, 2024.

While the share of deposits in liabilities in the banking system of Uzbekistan increased in 2023, it remains lower compared to CCA countries. The share of deposits in total liabilities in Uzbekistan rose by 5 percentage points in 2023, reaching 44% as of January 1, 2024. By the end of 2023, this metric averaged 66% for private banks and 33% for state-owned banks. This disparity arises from private banks' reliance on deposits as a funding source for loans.

The share of NPLs in total loans remained steady at 3.5%. During 2023, the volume of NPLs increased by 19%, reaching 16.6 trillion UZS. At the same time, the annual growth rate of credit stock was approximately 21%, resulting in a stable NPLs-to-loan ratio in the banking system.

Figure 34. Share of NPLs in Total Loans; Annual Growth in NPL Ratio and Outstanding Loans

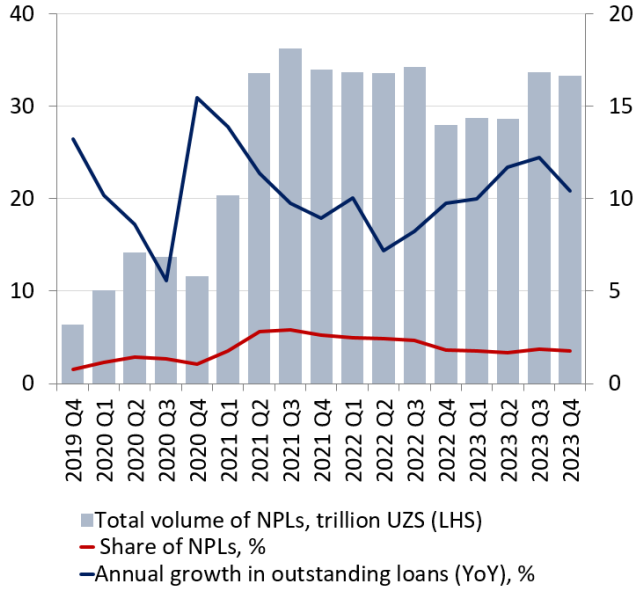
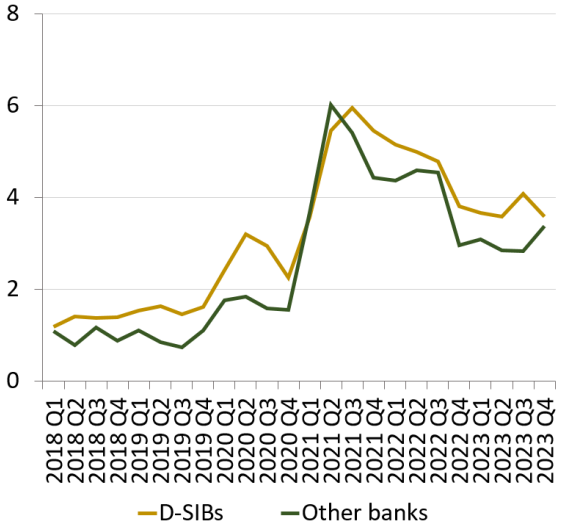


Figure 35. Share of NPLs in Total Loans of D-SIBs and Other Banks, %



Source: CBU.

In D-SIBs, the share of NPLs in total loans remained higher than in other banks. At the end of 2023, D-SIBs had NPLs totaling 12.1 trillion UZS, compared to 4.5 trillion UZS in other banks. The ratio of NPLs to total loans stayed constant at 3.6% for D-SIBs and 3.4% for other banks. The elevated level of NPLs in D-SIBs, relative to other banks, can be primarily attributed to the allocation of directive loans.

Figure 36. NPLs and Provisions, %

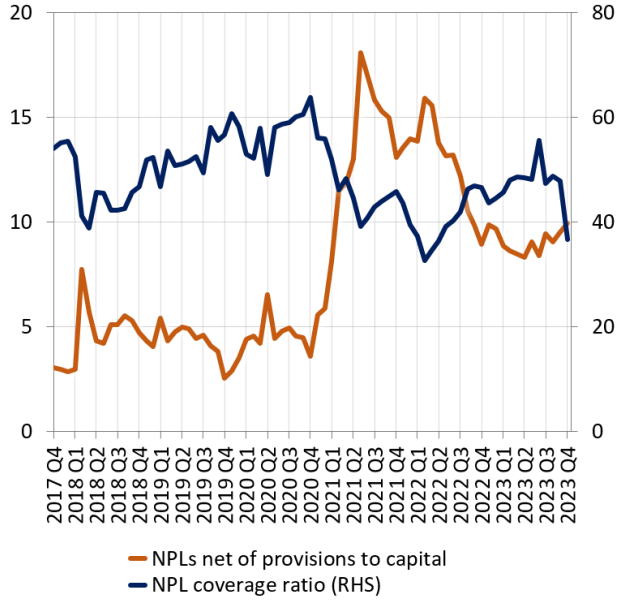
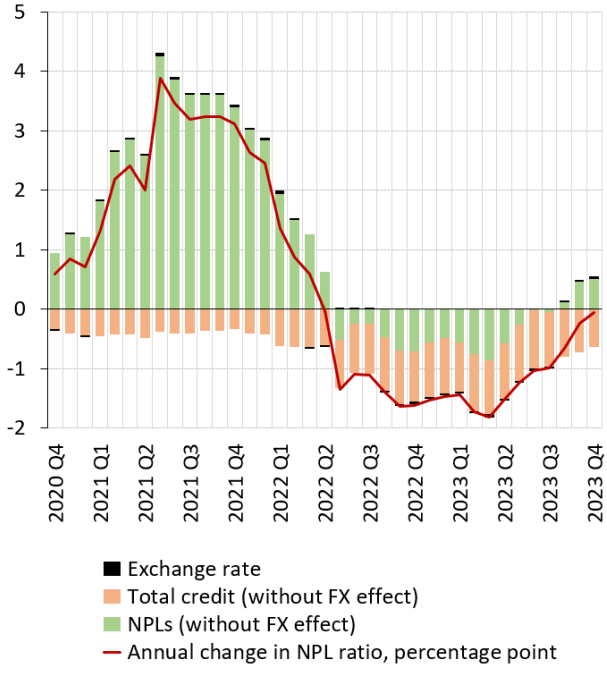


Figure 37. Decomposition of Annual Change in NPL Ratio, %



Source: CBU.

In 2023, NPLs net of provisions to capital for the banking system remained unchanged, while the NPL coverage ratio decreased. The NPLs net of provisions to capital ratio held steady at around 10%. The NPL coverage ratio fell by 10 percentage points, reaching 37%. This decrease in the NPL coverage ratio indicates a weakened capacity of the banking system to absorb loan losses.

Figure 38. NPL Ratio in CCA Countries*, %

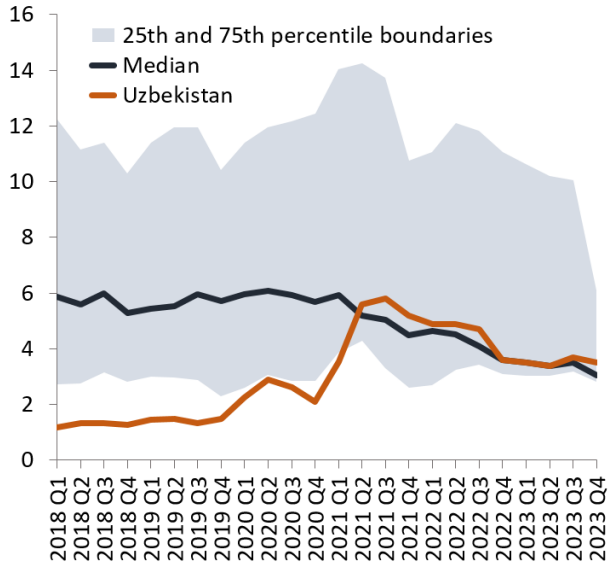
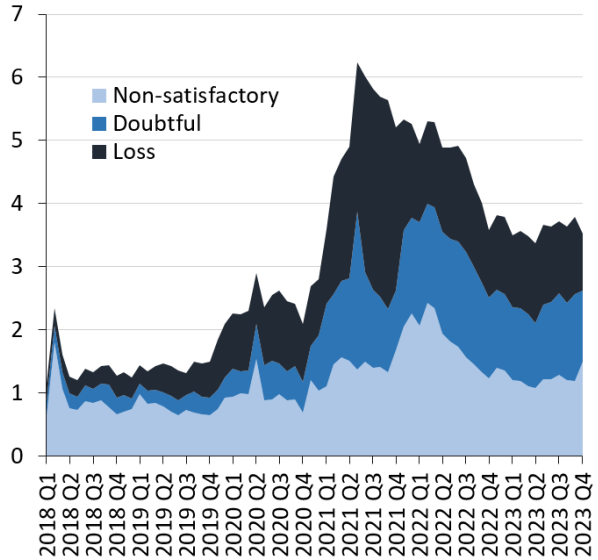


Figure 39. NPL Composition, %



Sources: National authorities and CBU staff calculations.

Note: *Armenia, Georgia, Tajikistan, Uzbekistan, Kyrgyzstan and Kazakhstan, and from Q4 2021 Azerbaijan are taken into account.

The quality structure of NPLs improved in 2023. By year-end, “non-satisfactory”, “doubtful”, and “loss” loans accounted for 43%, 32%, and 25% of NPLs, respectively. The decline in “doubtful” and “loss” loans reduced the overall NPL share by 0.4 percentage points, while an increase in "non-satisfactory" loans raised it by 0.3 percentage points.

Box 2. Systemic Risk Survey

In January 2024, the Central Bank surveyed 35 commercial banks (respondents) to identify potential systemic risks in Uzbekistan's financial system for H1 2024 and assess their impact (see Appendix 6). The survey included sections on anticipated primary systemic risks, risk probability, and recent changes in the financial system.

Respondents identified exchange rate volatility, rising inflation, escalating geopolitical risks, increasing household debt burdens, and cyberattack-related risks as the top five systemic risks to the financial system.

Figure 40. Principal Systemic Risks in Uzbekistan's Financial Sector

Source: CBU Survey.

Note: The font size of systemic risks reflects their level of importance, determined by a weighting system of one to five.

In particular, 77% of respondents identified sharp fluctuations in the exchange rate as one of the five most important systemic risks, followed by accelerating inflation, mentioned by 51%. External geopolitical risks were cited by 49% of respondents, while an increase in household debt burden and risks associated with cyberattacks were noted by 46% and 43%, respectively[22].

[22] In this question, each bank identifies five systemic risks. Importantly, the proportion of respondents citing a particular risk as affecting the financial system does not necessarily correspond to the perceived severity of that risk as a systemic risk. Furthermore, the systemic risks identified by banks are not mutually exclusive, meaning a single bank can designate multiple risks. Consequently, the combined percentage of risks mentioned by respondents does not equal 100%.

Respondents also expressed concerns about potential systemic impacts from climate change risks, economic slowdown, liquidity issues, and sanctions.

Regarding the probability of systemic risk occurrence, 66% of respondents assessed the short-term likelihood (up to 1 year) as low. However, for the medium term (1–3 years), 54% considered the probability to be medium.

Figure 41. Probability of Materialization of Systematic Risks, %

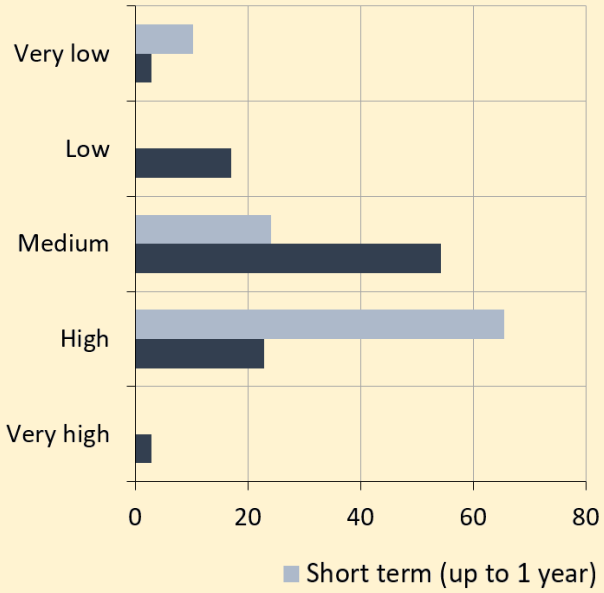
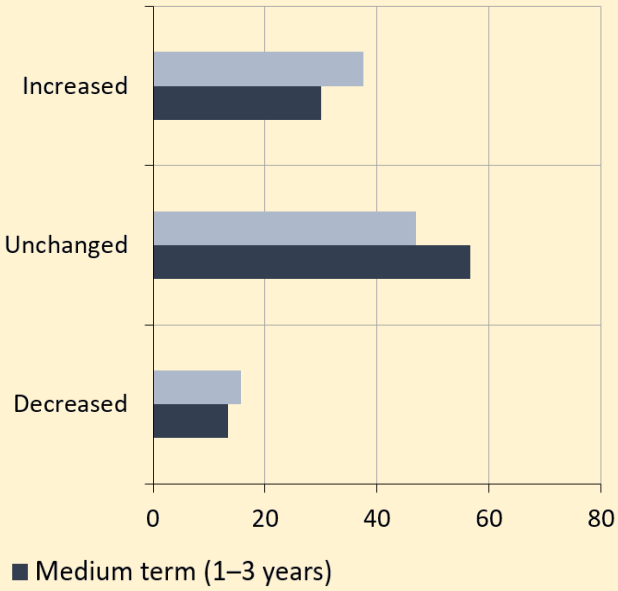


Figure 42. Changes in the Probability of Materialization of Systematic Risks Over the Past Period, %



Source: CBU Survey.

The majority of respondents indicated that the likelihood of systemic risks materializing has remained unchanged in both the short and medium term over the past period. Specifically, 57% of respondents reported no change in the probability of systemic risks in the medium term, while 47% observed no change in the short term. Moreover, 38% of respondents assessed that the probability of systemic risks has increased in the short term, and 30% in the medium term.

Conversely, most respondents expressed high confidence in Uzbekistan's financial system stability over the next three years. Notably, 74% of respondents indicated sufficient confidence in financial system stability. Additionally, 23% of respondents expressed partial belief in the system's stability for the next three years. This implies that respondents remain concerned about factors that could negatively impact the financial system.

Figure 43. Confidence Level in the Stability of Uzbekistan's Financial System Over the Next Three Years,%

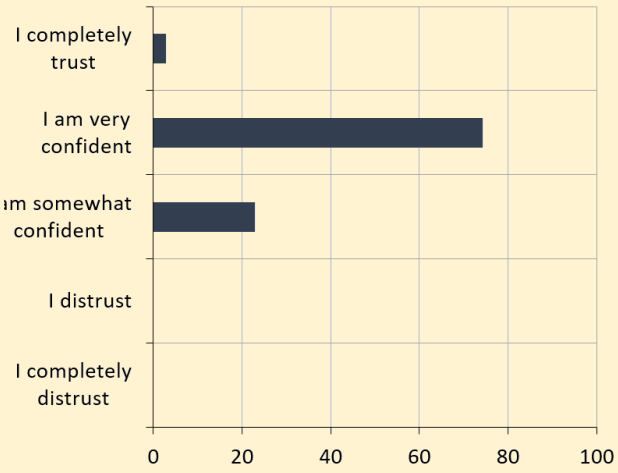
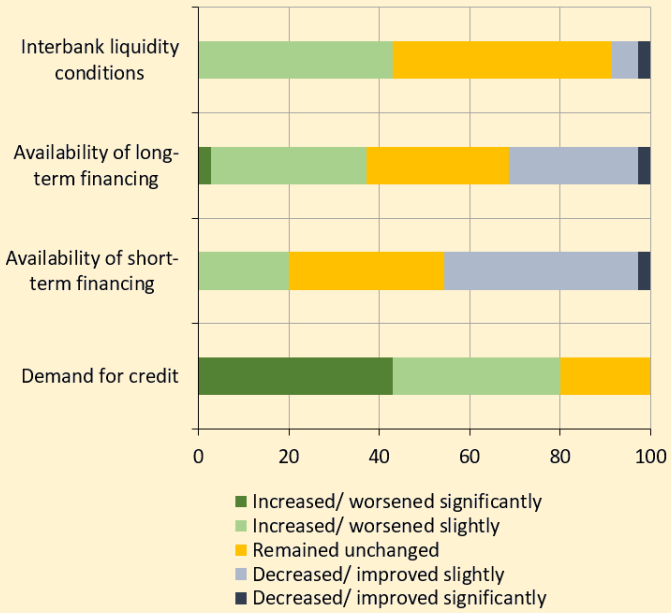


Figure 44. Changes in Factors Affecting Financial Stability Over the Past Six Months, %



Source: CBU Survey.

Survey results indicate that 80% of respondents experienced a surge in credit demand over the past six months, while the remaining 20% observed no change. Additionally, around 40% of participants reported a deterioration in interbank liquidity conditions and long-term financing. In contrast, 43% of respondents noted an improvement in short-term financing conditions.

Box 3. Financial Stability Risks and Challenges in Islamic Banking

The following risks affecting financial stability may arise during the implementation of the Islamic banking system:

1. Certain Islamic deposit products do not guarantee a profit on the invested sum or the return of the principal. The deposit's rate of return is directly tied to the bank's investment performance. Contractual agreements between depositors and Islamic banks do not specify predetermined rates of return. If the bank incurs losses due to unsuccessful investments, depositors may forfeit some or all of their deposits[23].

Mudarabah is a partnership contract between the capital provider and an entrepreneur whereby the capital provider would contribute capital to an enterprise or activity that is to be managed by the entrepreneur. Profits generated by that enterprise or activity are shared in accordance with the percentage specified in the contract, while losses are to be borne solely by the capital provider unless they are due to the entrepreneur's misconduct, negligence or breach of contracted terms.

Musharakah is a partnership contract in which the partners agree to contribute capital to an enterprise, whether existing or new, or towards the ownership of an asset, either on a temporary or permanent basis. Profits generated by that enterprise or asset are shared in accordance with the percentage specified in the Musharakah agreement, while losses are shared in proportion to each partner's share of capital[24].

2. Complexity of effective liquidity management. Islamic banks face challenges in managing liquidity due to their inability to participate in interest-based transactions in the interbank money market. To address this, they must maintain their own liquidity, and the introduction of an Islamic interbank money market can help.

Central banks' ability to act as a "lender of last resort" for Islamic banks is also limited because traditional emergency support involves interest-based loans. Therefore, central banks need to provide liquidity to Islamic banks based on specific Islamic principles[25].

Islamic banks, particularly the full-fledged banks, can also obtain financing from Bank Indonesia through a short-term Sharia financing facility. The facility is based on a Muḍarabah contract and is typically a last resort facility, where an Islamic bank may obtain short-term financing against collateral. The return of this financing is tied to the Muḍarabah deposit rate of the receiving bank, so that the bank has a better expectation of the cost of the facility. The facility can also be guaranteed with high-quality and liquid collaterals. Depending on the level of liquidity distress, the type of collateral eligible for this facility may include Bank Indonesia certificates, sovereign bonds or Sukuk, high-quality corporate bonds or Sukuk, and financing by a high-quality bank.

The receiving bank should be solvent or, in case of a potential systemic crisis, have a positive CAR. The bank must also present a valid action plan for resolving liquidity issues within five

[23] Cihak, M., & Hesse, H. (2008, May). IMF Survey: Study Shows Larger Islamic Banks Need Prudential Eye. International Monetary Fund.

[24] Islamic Financial Services Board. (2015, April). Core Principles for Islamic Finance Regulation (Banking segment).

[25] Halis, M., & Abdssalm Eltawil, A. E. (2017). Risk Management in Islamic Banks: Findings from Libya. The International Journal of Economic and Social Research.

days of the facility disbursement and provide daily reports on the facility's use and liquidity condition[26].

3. An Islamic deposit insurance system is needed for Islamic banks. An Islamic deposit insurance system is necessary for Islamic banks to ensure financial stability, boost public trust, and protect depositors' funds in case of a bank failure. This system must differ from conventional deposit insurance by investing solely in Sharia-compliant instruments and covering only permissible expenses. If used alongside traditional insurance, the Islamic fund must adhere to Sharia requirements and be managed separately.

Malaysia implemented a dual deposit insurance system in September 2005, following the Malaysia Deposit Insurance Corporation Act 2005. The Islamic deposit insurance system operates independently but in parallel with the conventional system, both managed by the Malaysia Deposit Insurance Corporation (MDIC). To ensure Sharia compliance, MDIC uses a contract-based approach endorsed by the Sharia Advisory Council of Central bank of Malaysia.

Islamic deposit insurance operations are funded by premiums from Islamic Banking Institutions (IBIs), including Islamic banks and Islamic banking windows of commercial banks. In 2008, the Malaysian Deposit Insurance Corporation (MDIC) introduced a differential premium system, requiring IBIs to pay annual premiums based on their risk profiles. Higher-risk IBIs pay higher premiums.

The MDIC must invest in Sharia-compliant instruments, avoiding mingling or cross-subsidization between Islamic and conventional deposit insurance funds. If funds are insufficient, MDIC can access government and market funding compliant with Sharia.

To maintain confidence, MDIC must reimburse insured depositors of a failed Islamic bank within three months of a winding-up order. Losses incurred by MDIC in meeting these obligations are charged to the Islamic Deposit Insurance Fund[27].

[26] Alamsyah, H. (2011, November). Lender of Last Resort in Islamic Banking. Islamic Financial Services Board.

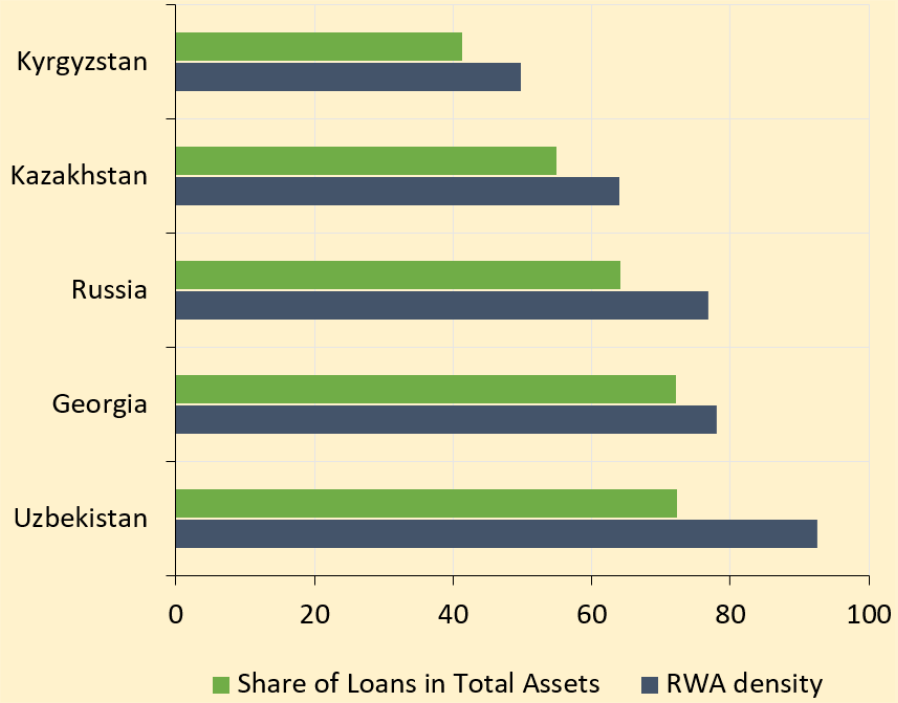
[27] International Association of Deposit Insurers. (2010, February). Deposit Insurance from the Shariah Perspective. Discussion Paper.

Box 4. Risk-Weighted Asset Density by Country

The RWA density is the ratio RWA to total assets, reflecting the average risk level of the bank's assets. A high density signals a worsened risk profile, while a lower density indicates reduced risk.

Given the large share of loans in Uzbekistan's total bank assets and the high risk associated with these loans, the RWA density is notably high. As of January 1, 2024, the RWA density was 93%, with loans comprising 72% of total bank assets.

Figure 45. RWA Density and Share of Loans in Total Assets by Country, % (as of January 1, 2024)



Sources: IMF, national authorities and CBU staff calculations.

In Uzbekistan, the risk weights for exposures to foreign sovereigns, central banks, public sector entities, and companies, including their securities, are determined by Basel III standards based on ratings from Fitch and Standard & Poor's[28]. These assets make up a small share of bank assets.

[28] "Tijorat banklari kapitalining monandligiga qo'yiladigan talablar to'g'risidagi nizomni tasdiqlash haqida" O'zbekiston Respublikasi Markaziy banki Boshqaruvining 2015 yil 13 iyundagi 14/3–son qarori, 2015.

2.2. Non-bank Financial Sector

The non-bank financial sector's[29] role in safeguarding Uzbekistan's financial stability is limited. Its assets constitute a small portion of the overall financial system, reducing the likelihood of vulnerabilities becoming systemic risks. Moreover, the share of loans from non-bank credit organizations[30] in Uzbekistan's credit market remains low.

Figure 46. Annual Growth Rates of Stock of Loans of Non-bank Credit Organizations, %

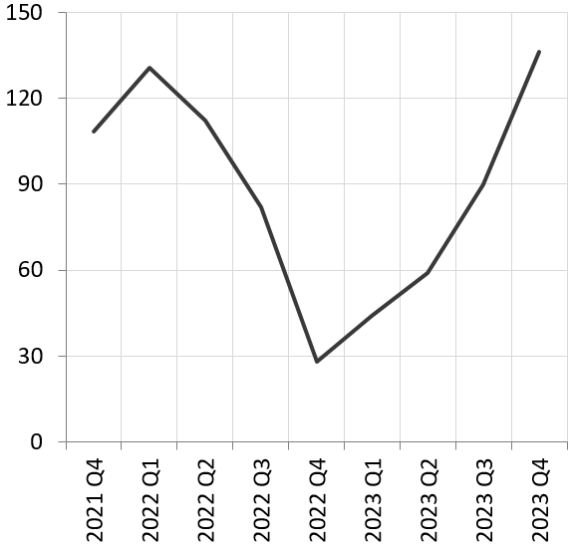
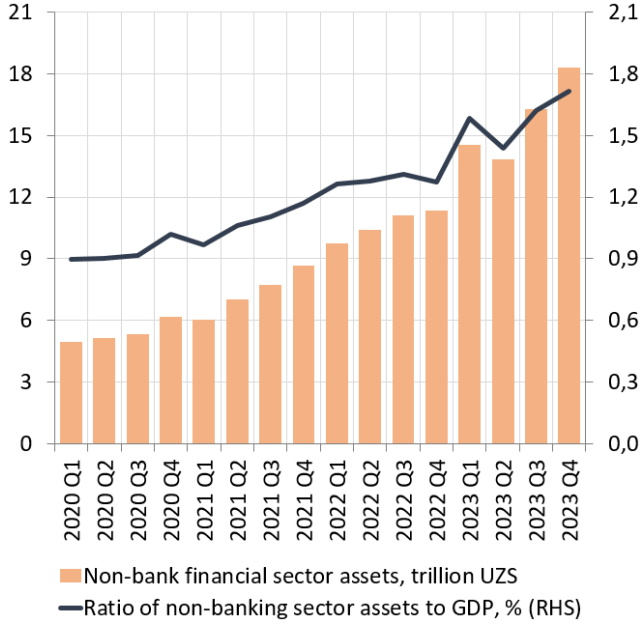


Figure 47. Non-bank Financial Sector Assets, trillion UZS



Sources: Statistics Agency, National Agency of Prospective Projects and Unified Corporate Information Portal and CBU staff calculations.

Despite rapid growth in 2023, non-bank credit organizations remain minor players in Uzbekistan's credit market. Their stock of loans increased by 136% in 2023, surpassing the 108% growth in 2022[31]. The stock of loans issued by the mortgage refinancing organization reached 3.1 trillion UZS, a 173% rise in 2023[32]. The share of non-bank loans in the financial sector[33] increased by 0.4 percentage points, reaching about 1%[34] by year's end.

[29] In analyzing the non-banking sector, non-bank credit organizations and insurance companies were considered.

[30] Non-bank credit organizations include microfinance organizations, pawnshops, and mortgage refinancing organizations.

[31] The Central Bank of the Republic of Uzbekistan. (2024). Indicators of non-banking credit organizations.

[32] Mortgage refinancing company of Uzbekistan. (2024). Financial reports.

[33] Loans from banks and non-bank credit organizations are included in financial sector loans.

[34] The Central Bank of the Republic of Uzbekistan. (2024). Statistics.

The non-banking financial sector's small assets relative to GDP continue to grow. As of January 1, 2024, these assets were 1.7% of annual GDP, a 0.4 percentage point increase from the end of 2022. In 2023, the non-banking financial sector's assets surged by 62% to 18.3 trillion UZS. In particular, non-bank credit organizations' assets rose by 112%.

Figure 48. Investments of Insurance Companies, trillion UZS

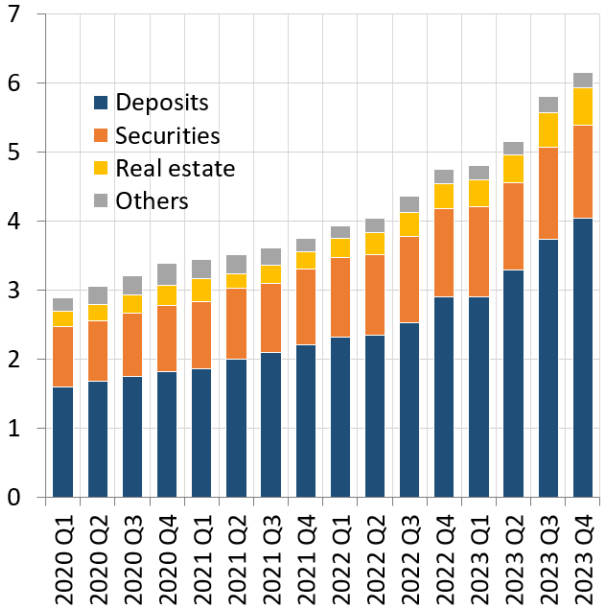
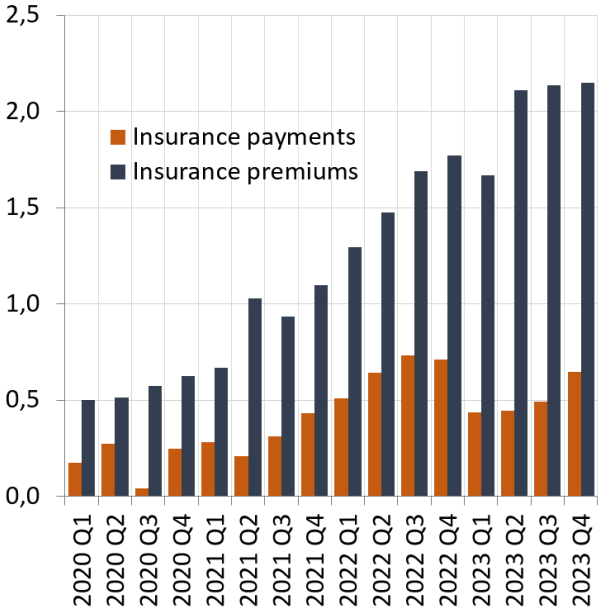


Figure 49. Quarterly Insurance Payments and Premiums, trillion UZS



Source: National Agency for Prospective Projects.

The growth in the investment portfolio of insurance companies is mainly due to low-risk deposits. In 2023, deposits made up 66% of the portfolio, while securities accounted for 22%. The growth rates for these investments were 39% and 5%, respectively. Real estate investments grew by 50%, making up 9% of the total portfolio[35]. The higher growth rate of deposits indicates that insurance companies are favoring safe investments as a stable, long-term income source.

In 2023, total premiums[36] for insurance companies grew by 29%, reaching 8.1 trillion UZS. However, the annual growth rate decreased by 38 percentage points compared to 2022 due to a decline in voluntary life insurance premiums. Voluntary insurance accounted for a substantial portion of the total, totaling 7.1 trillion UZS.

[35] National Agency for Prospective Projects. (2024). Statistics and analysis.

[36] An insurance premium is the amount a policyholder pays an insurer according to the terms specified in the insurance contract and can be paid in national or foreign currency.

Additionally, 1.9 trillion UZS[37] of the total insurance premiums were allocated to reinsurance[38].

Payments[39] from insurance companies have exhibited a downward trend. Consequently, a precipitous decline in voluntary life insurance premiums led to a 22% decrease in total premiums for 2023, amounting to 2 trillion UZS. Insurance payments primarily aligned with the voluntary insurance category in the total insurance sector, constituting 66% of overall insurance payments[40].

Figure 50. Insurance Payments-to-Insurance Premiums Ratio, %

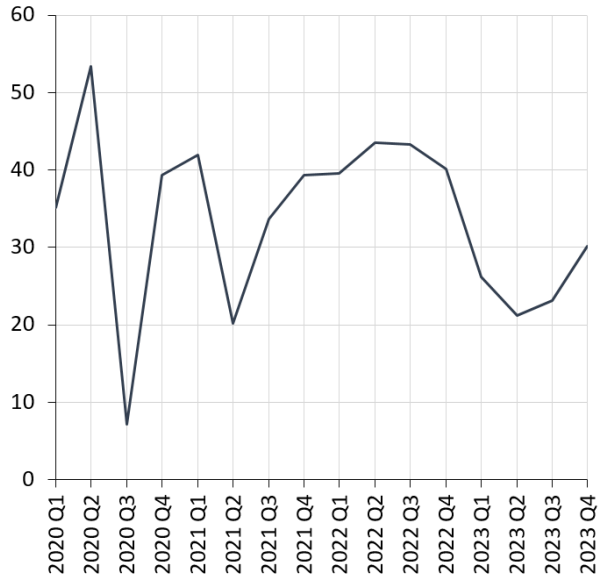
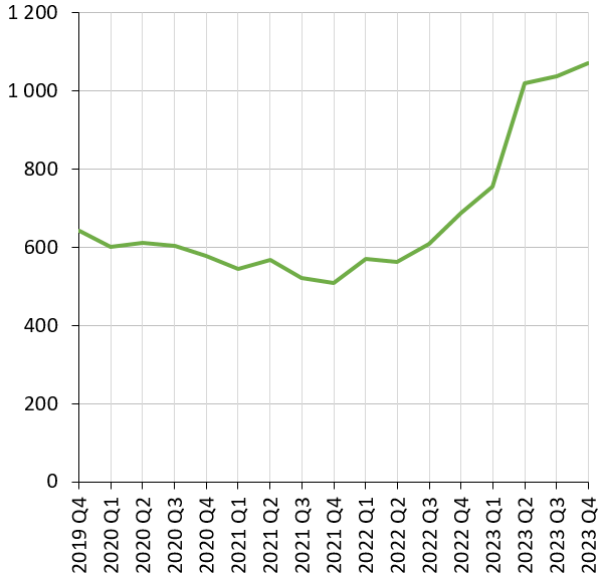


Figure 51. Insurance Premiums Concentration, HHI[41]



Sources: National Agency for Prospective Projects and CBU staff calculations.

Operational efficiency in the insurance sector has improved. In 2023, the ratio of insurance payments to premiums, indicating operational efficiency, showed a positive trend. Specifically, a 1.8 trillion UZS increase in annual premiums and a 575 billion UZS decrease in annual payments positively impacted the efficiency of insurance companies[42].

Concentration in the insurance sector is on the rise. The rapid increase seen in H1 2023 moderated towards year-end, culminating in a medium concentration of 1072. This

[37] National Agency for Prospective Projects. (2024). Statistics and analysis.

[38] Reinsurance is insurance by a reinsurer of all or part of the risk of insurance compensation under the insurance contract of another insurer.

[39] An insurance payment refers to the money paid to the policyholder or beneficiary in the event of an insurance claim. It is typically within the sum insured for each insured person as specified in the insurance contract.

[40] National Agency for Prospective Projects. (2024). Statistics and analysis.

[41] The HHI categorizes industries into low concentration (HHI below 1000), medium concentration (HHI between 1000 and 1800), and high concentration (HHI above 1800).

[42] National Agency for Prospective Projects. (2024). Statistics and analysis.

signifies that a majority of insurance premiums are distributed among a specific group of companies. Considering the insurance sector's modest contribution to the financial system, the probability of systemic risk originating from the insurance market is minimal.

Figure 52. Insurance Penetration and Density in Uzbekistan

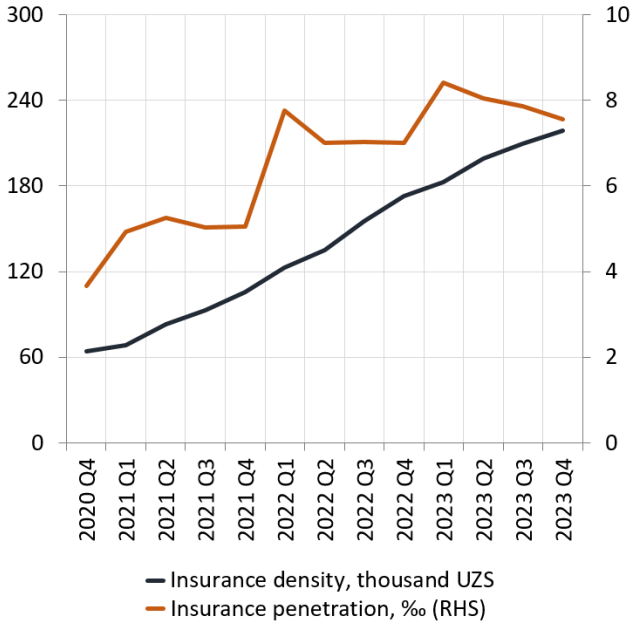
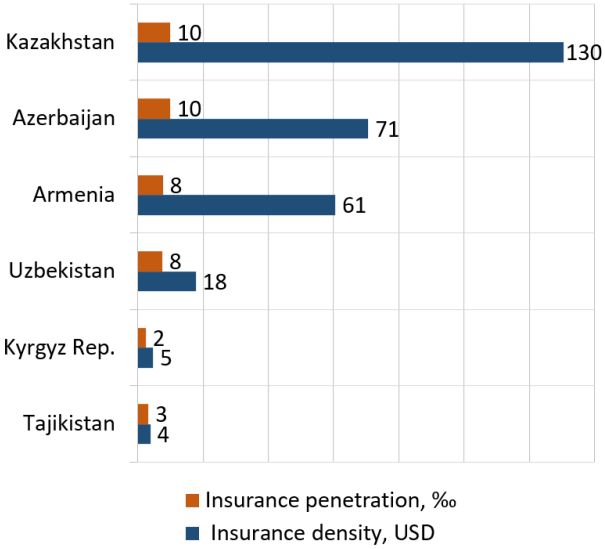


Figure 53. Insurance Penetration and Density in Selected Countries (as of January 1, 2024)



Sources: National authorities, National Agency for Prospective Projects, Statistics Agency and CBU staff calculations.

Note: Per mille (‰) represents one-thousandth of a number or one-tenth of a percent.

Insurance density is calculated by dividing annual total insurance premiums by the population.

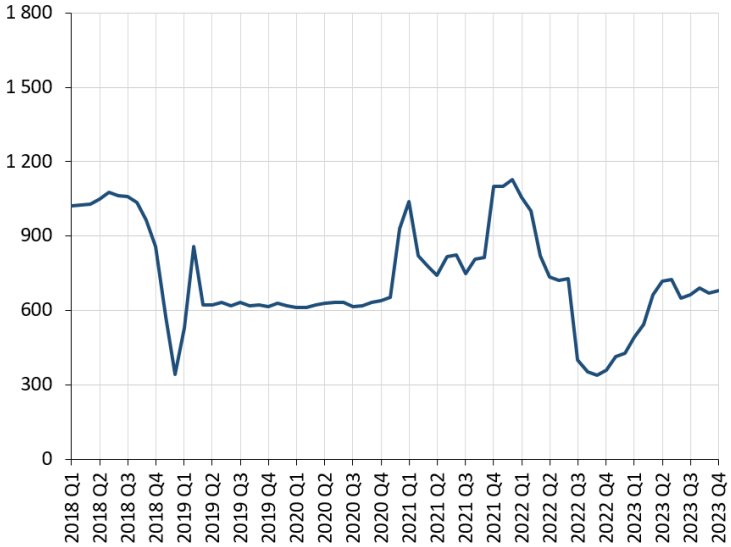
Insurance penetration is calculated by dividing the total insurance premiums by the nominal GDP. The values of insurance premiums and the nominal GDP in the corresponding periods are used for this purpose.

In Uzbekistan, insurance density and penetration are increasing. In 2023, insurance density rose by 27%, with premiums reaching 219,000 UZS per capita. The ratio of total insurance premiums to nominal GDP also grew. By the end of 2023, insurance penetration was 8 per mille in Uzbekistan; however, it remains relatively low compared to peer countries.

2.3. Capital Market

In 2023, the Uzbekistan Composite Index (UCI) grew due to increased stock exchange capitalization[43]. The UCI of the Republican Stock Exchange rose by 82% to 703. In H2 2023, fluctuations in the UCI occurred as equity issuer prices varied, affecting market capitalization. By year-end, capitalization declined due to falling share prices in the mining sector[44]. However, a sharp rise in ordinary and preference share prices of several banks partially offset the decline in the UCI.

Figure 54. Uzbekistan Composite Index*



Source: Republican Stock Exchange.

Note: *UCI[45] is a stock market index that represents the overall performance of listed stock issuers on the Republican Stock Exchange. As of January 1, 2024, there were 117 listed stock issuers on the exchange, out of which 17 were banks.

[43] The total capitalization of the Republican Stock Exchange is determined by multiplying the number of securities and their closing prices on the trading day. If the index value decreases, it means there has been a decrease in the stock prices of the issuers included in the quotation list, resulting in a decrease in the overall market capitalization.

[44] Republican stock exchange. (2024). Quotation price of shares by month.

[45] The UCI is determined by the following formula:

$$UCI = \frac{Market\ Cap_{current\ date}}{Market\ Cap_{base\ date}} * Base\ Index$$

Where,

$Market\ Cap_{current\ date}$ is the total capitalization of issuers included in the exchange quotation list, which was calculated by the system on the last transaction on the current trading date;

$Market\ Cap_{base\ date}$ is the total capitalization of issuers included in the exchange quotation list, which was calculated by the system on the last transaction on the date the index was created (29.08.2016);

$Base\ Index$ is the specified value for the index, which is equal to 1000.

There was a slight decrease in the yield on treasury bonds. In 2023, the unchanged CBU policy rate and a relatively balanced supply and demand led to no sharp changes in the yield[46]. The yield on treasury bonds in 2023 was 17.4%.

Figure 55. Trading Volume of Republican Stock Exchange, billion UZS

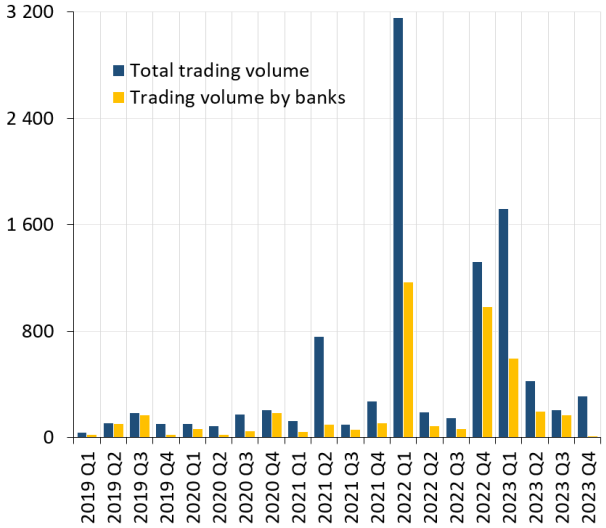
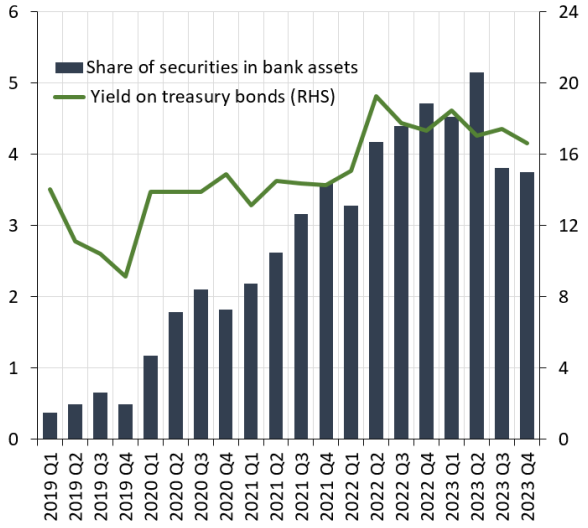


Figure 56. Share of Securities in Bank Assets and Yield on Treasury Bonds, %



Sources: Republican Stock Exchange, Uzbek Republican Currency Exchange and CBU staff calculations.

The impact of stock price fluctuations in the capital markets on banking sector stability remains small. Despite a recent uptick in securities and investments, their share remains low. As of January 1, 2024, the volume of securities in the banking sector reached 24.5 trillion UZS. Furthermore, in 2023, the share of securities in bank assets contracted by one percentage point to 3.8%.

[46] When banks offer more attractive deposits after the policy rate hike, it causes a decrease in demand for bonds. Bonds usually have fixed interest rates and are long-term investments. As a result, changes in supply and demand in the capital market lead to a drop in bond prices.

Figure 57. Yield on Uzbekistan Foreign Currency Sovereign Eurobonds, %

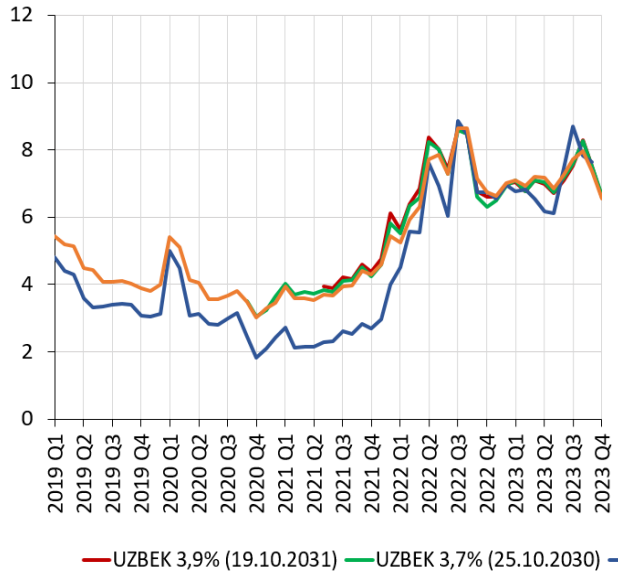
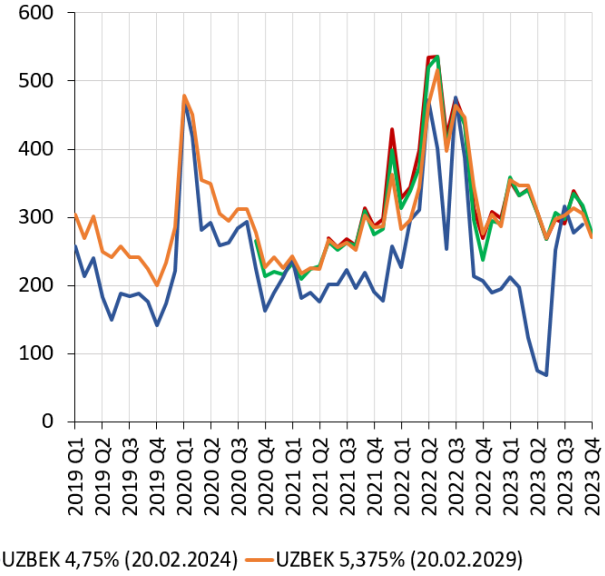


Figure 58. G-spread* of Uzbekistan Foreign Currency Sovereign Eurobonds, basis points



Source: Bloomberg.

Note: *A G-spread is the difference between the bond yield and its benchmark, the US Treasury bond yield. An increase in the G-spread denotes an increase in the risk level of this bond compared to the benchmark bond.

In the global stock market, investors perceive the risk of Uzbekistan's sovereign eurobonds as relatively low. The yield on Uzbekistan's foreign currency sovereign eurobonds remained steady in 2023, with yields for those maturing in 2029, 2030, and 2031 around 6.5%. The spread between Uzbekistan's long-term sovereign eurobond yields and benchmark U.S. Treasury bond yields narrowed compared to 2022. In H2 2023, the risk of Uzbekistan's short-term sovereign eurobonds was also perceived as lower. The spread of Uzbekistan's sovereign eurobonds against U.S. Treasury bonds stabilized at about 300 basis points.

III. Non-financial Sector

3.1. Corporate sector

In 2023, the financial condition in the corporate sector worsened. The leverage[47] of 70 selected enterprises increased, and the cost of servicing foreign currency bank debt rose. Additionally, the interest coverage ratio and profitability indicators for these enterprises declined. These negative trends may heighten the risk of financial losses during shocks in the corporate sector.

Figure 59. Number of Newly Established and Operating Enterprises and Organizations in Uzbekistan, thousand

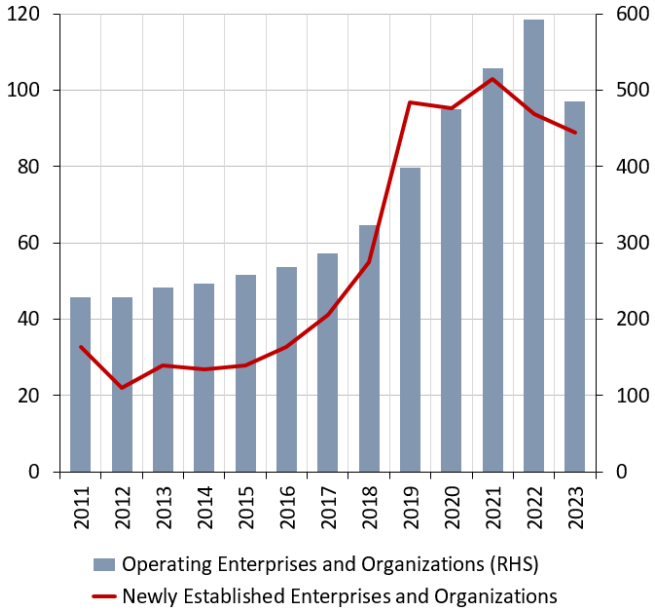
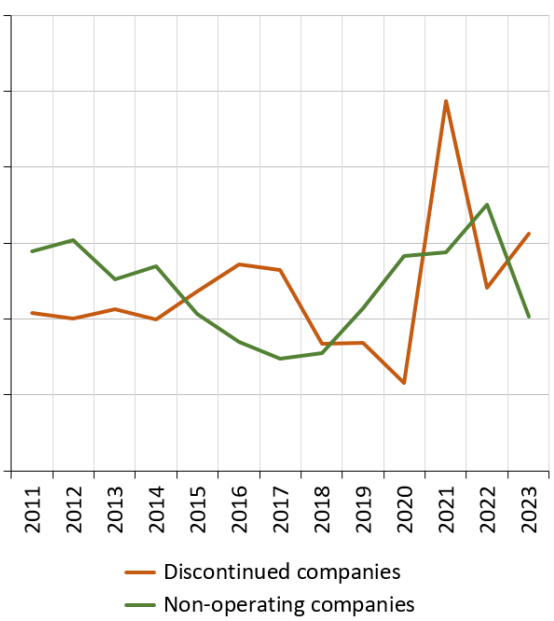


Figure 60. Discontinued and Non-operating Companies in Uzbekistan, thousand



Sources: Statistics Agency and CBU staff calculations.

Notes: Operating enterprises are legal entities that have been state-registered according to the procedure established by registration authorities and have not been notified that they are not conducting financial and economic activities or are in the process of liquidation.

Newly established enterprises are legal entities that have been newly entered into the state register of legal entities within the past year, following the procedure established by registration authorities.

Discontinued companies are businesses whose operations have been terminated either by the founders' voluntary decision or by a commercial court ruling, as well as entities removed from the state register due to inactivity for three years.

Non-operating companies are commercial entities that have not received funds from their financial and economic activities in their bank accounts or have not submitted tax reports for 9 months.

In 2023, Uzbekistan experienced a notable decline in newly established and operating companies and organizations. As of January 1, 2024, there were 88,800 newly established companies, down by 4,800 from 2022. Additionally, the number of

[47] The leverage is determined by the ratio of total liabilities to capital.

operating companies and organizations fell by 107,300 from 2022, totaling 485,000 in 2023.

There has been an increase in the number of discontinued companies and organizations. As of January 1, 2024, there were 31,300 discontinued companies and organizations, representing a 7,100 increase compared to the same period in 2023. Consequently, the number of non-operating companies and organizations decreased by 14,700 in 2023, resulting in a total of 20,300 as of January 1, 2024.

Figure 61. Corporate Loan Stocks by Currency Types and Annual Growth Rate

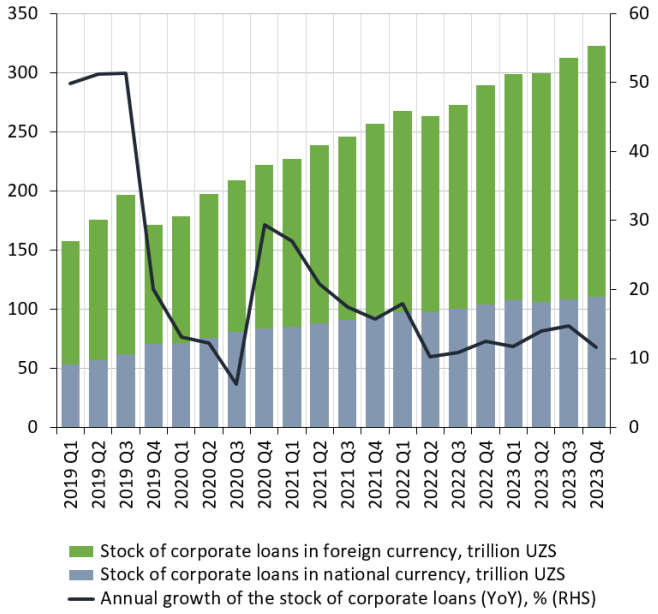
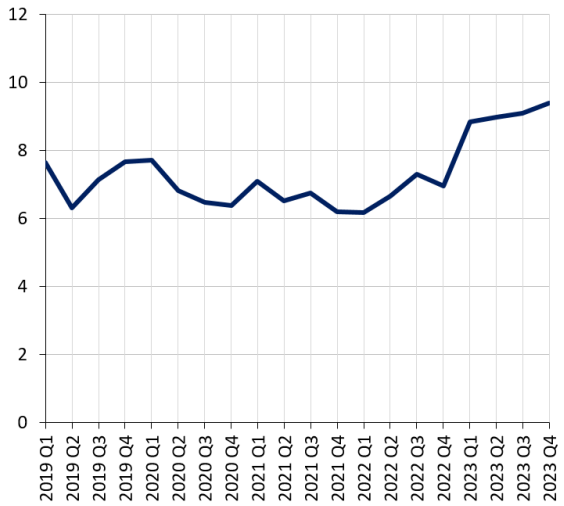


Figure 62. Weighted Average Interest Rate on Foreign Currency Corporate Loans, %



Source: CBU.

The share of foreign currency loans in the corporate loan portfolio remains substantial. In 2023, the stock of corporate loans grew by 12%, reaching approximately 323 trillion UZS. Notably, 66% of these corporate loans were denominated in foreign currency, reflecting a high degree of dollarization within the corporate sector. This significant dollarization can adversely impact enterprise solvency during sharp exchange rate fluctuations.

There has been a rise in the weighted average interest rates on foreign currency loans extended to the corporate sector. In 2023, the weighted average quarterly interest rate climbed to 9.1%, marking an increase of 2.3 percentage points compared to 2022. This surge has led to higher debt servicing costs, negatively impacting the financial condition of businesses and deteriorating the quality of the bank's loan portfolio.

Figure 63. Corporate Loan Stocks-to-Annual GDP by Sector, %

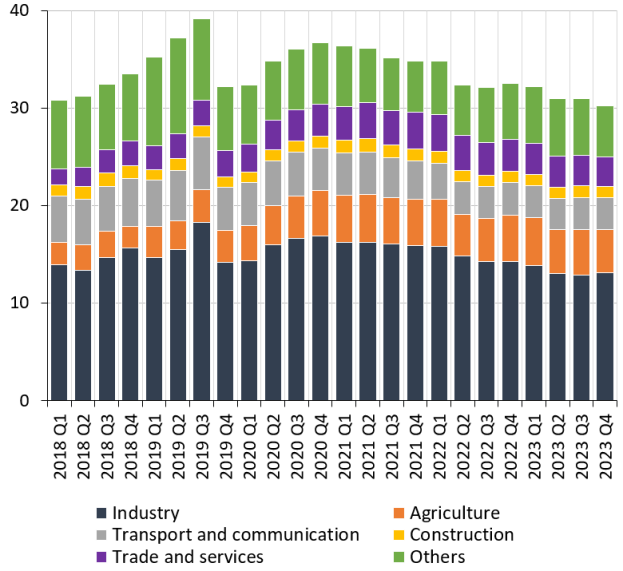
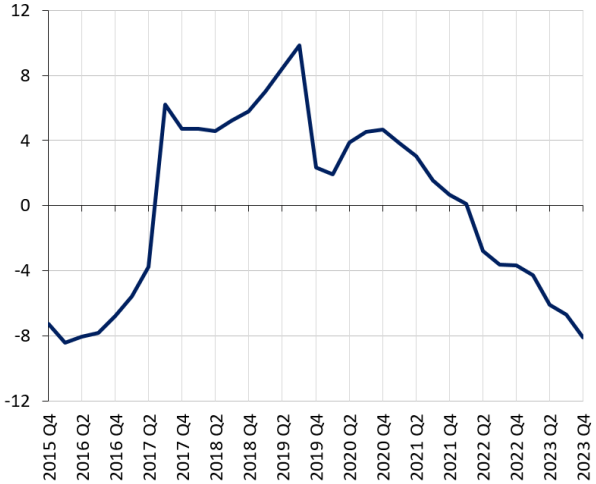


Figure 64. Corporate Loans-to-GDP Gap, percentage point



Sources: Unified Corporate Information Portal, financial reports of companies, and CBU staff calculations.

The corporate loans-to-GDP gap[48], a key early warning indicator for systemic risk, was negative. At the end of 2023, the corporate loans-to-GDP gap was approximately 8%, a decrease of 1.4 percentage points from the end of 2022. The widening of this negative gap relative to its trend suggests a lower level of systemic risk.

Leverage in the corporate sector continues to rise. In Q3 2023, the total liabilities-to-capital ratio for 70 selected large companies was 1.8, an increase compared to Q3 2022. This trend may increase the vulnerability of companies in fulfilling their obligations.

[48] The corporate loans-to-GDP gap is calculated by subtracting the long-term trend from the corporate loans-to-GDP ratio. The long-term trend of the corporate loans-to-GDP ratio is calculated according to the BCBS approach, using a one-sided HP filter with a smoothing parameter of 400,000 for quarterly data.

Figure 65. Total Liabilities-to-Capital Ratio for Selected 70 Large Companies

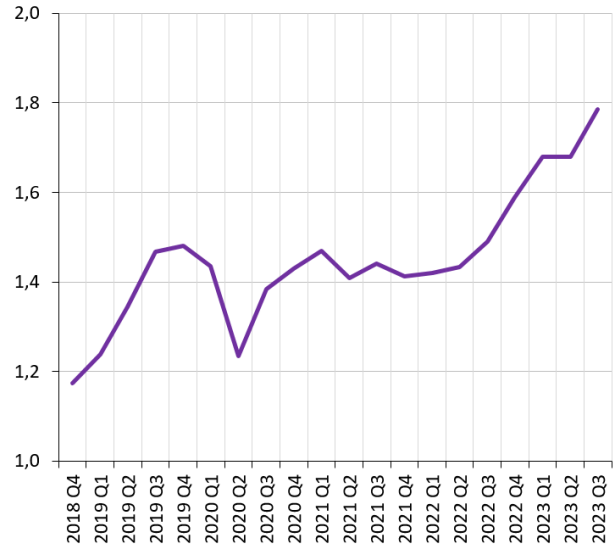
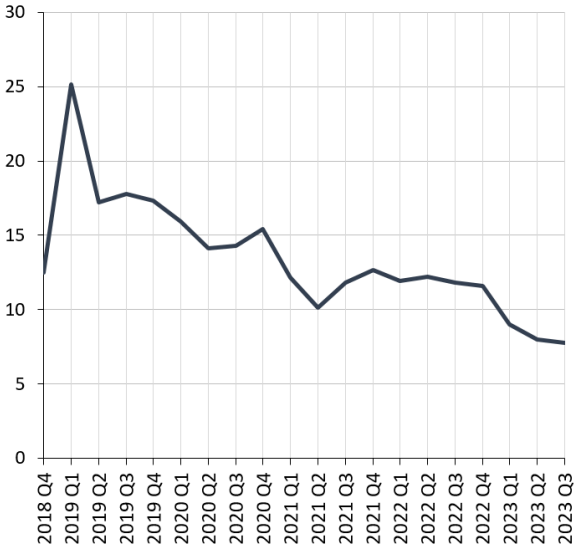


Figure 66. Interest Coverage Ratio for Selected 70 Large Companies



Note: The total liabilities-to-capital ratio was calculated using the data from 70 large joint-stock companies (see Appendix 7).
The interest coverage ratio is calculated using an exponential moving average[49] based on the data from the 70 largest JSCs. This ratio measures the number of times a company's net profit before tax can cover its debt interest costs. If the ratio is less than 1, the company may be unable to meet its debt obligations in terms of interest payments with its current income, putting it at a high risk of default.

The interest coverage ratio of large companies continues to decline. Specifically, in Q3 2023, the interest coverage ratio was 7.8%, marking a decrease of nearly 4 percentage points compared to the same period in 2022. This drop increases the risk of companies struggling to meet their debt obligations.

[49] The exponential moving average is a technique used to smooth out the value of an indicator by reducing random and short-term fluctuations.

Figure 67. Absolute[50] and Current Liquidity[51] Ratios for Selected 70 Large Companies

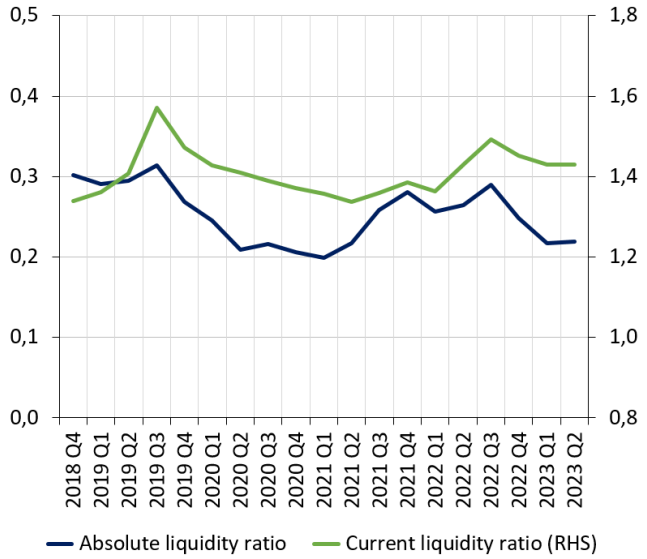
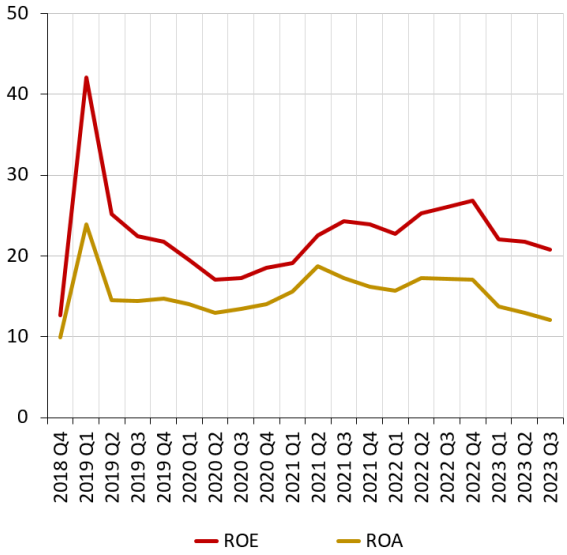


Figure 68. ROE and ROA for Selected 70 Large Companies, %



Source: Unified portal of corporate information, financial reports of enterprises and calculations of the Central Bank.

Note: Indicators are calculated using an exponential moving average based on the data from the 70 largest JSCs. The list of companies has been compiled based on the availability of public information. Due to data limitations, Q4 2024 was excluded.

In Q1-Q3 2023, there was a decline in the liquidity, ROA, and ROE indicators of companies. Specifically, the absolute and current liquidity ratios dropped by 0.1, resulting in values of 0.25 and 1.5, respectively. The absolute liquidity ratio shows that companies can partially cover liabilities, while a current liquidity ratio above 1 means they can meet their obligations. Additionally, in 2023, the ROA and ROE contracted by 5 percentage points.

[50] The absolute liquidity ratio indicates the amount of cash and short-term investments covering current liabilities. This ratio is calculated by dividing the company's most liquid funds by current liabilities.

[51] The current liquidity ratio is determined by dividing current assets by current liabilities. A ratio of more than 1 indicates a stable financial condition of a company.

3.2. Household Sector

The overall debt burden of individuals increased. Despite some improvement, the debt burden rose annually by the end of 2023. In 2023, the aggregate DSR[52] for all individual loans averaged 8%. Borrowers' annual income surged by 41%, while the total volume of loans to individuals climbed by 54%, resulting in a 1 percentage point increase in the overall debt burden compared to 2022.

Figure 69. DSR for All Loans to Individuals (YoY), %

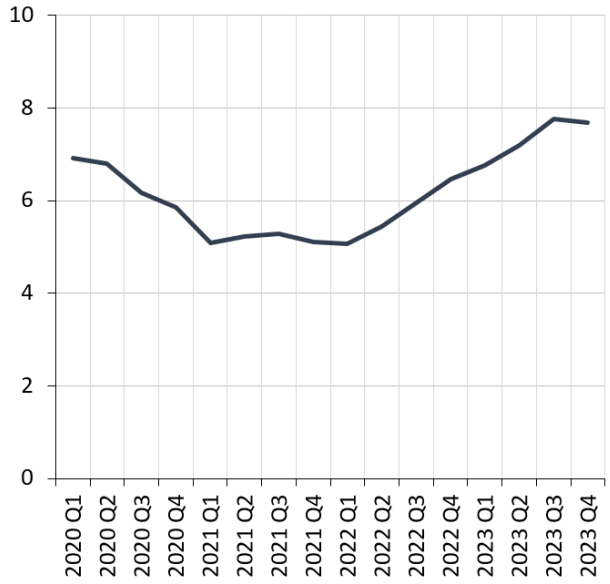
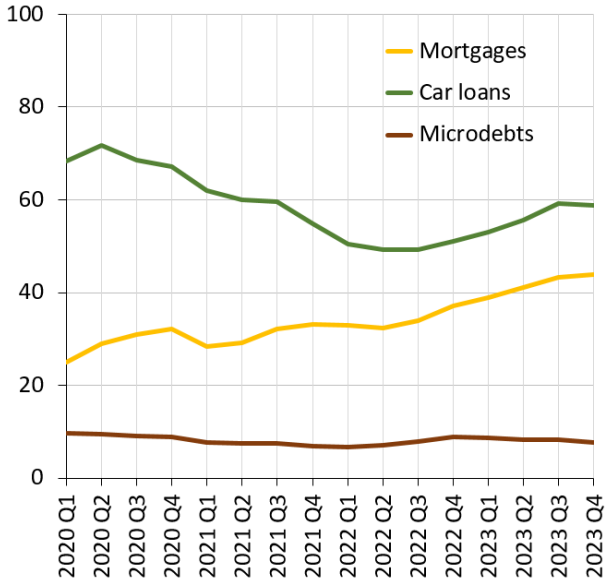


Figure 70. DSR for Mortgages, Car Loans, and Microdebts (YoY), %



Source: CBU staff calculations.

There are concerns about borrowers' ability to meet mortgage debts. The DSR for mortgage loans has increased, with borrowers dedicating an average of 44% of their disposable income to mortgage payments in 2023, up nearly 7% from 2022. Key factors contributing to this heightened debt burden include: a surge in housing prices, a 38% increase in average mortgage amounts per borrower from 2022 to 2023, and a shortened loan maturity to 17.5 years.

The DSR for car loans surpasses that of other loan types. In 2023, the DSR for car loans was 59% on an annual basis, an increase of 8 percentage points compared to 2022. The ability of individuals to meet car loan payments improved on a quarterly basis. Despite a 17.2% increase in the average monthly income of car loan borrowers and a half-year extension in the average loan maturity, the rise in debt burden is attributed to a 45% increase in the average loan volume per borrower compared to 2022.

[52] The DSR methodology is given in the CBU's Debt Service Ratio Analysis for Individuals.

Individuals' capacity to meet their microdebt commitments has enhanced. The DSR for microdebt declined by 1 percentage point compared to 2022 and amounted to 8% in 2023. The DSR has improved because the growth rate of total annual income, at 1.9 times, exceeded the growth rate of microdebt volume, which was 1.8 times. Despite a substantial increase in the average annual interest rate for microdebt to 5.3% in 2023, the average maturity of microdebt has lengthened to 2.5 years, contributing to the reduction in the DSR.

Figure 71. LTV Distribution of Mortgage Loans

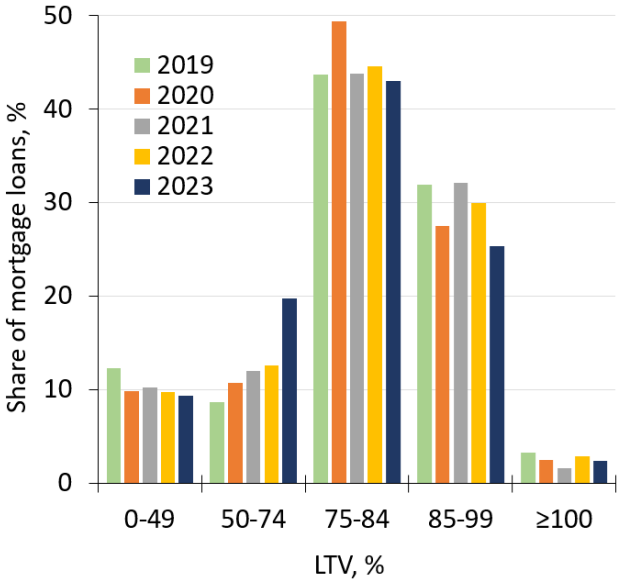
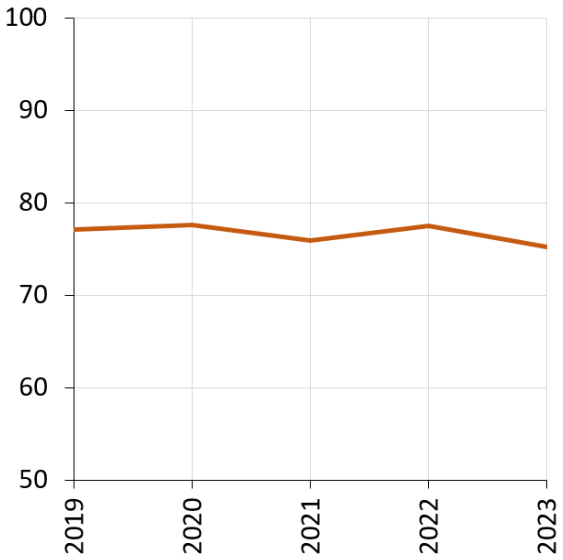


Figure 72. Weighted Average LTV of Mortgage Loans, %



Source: CBU staff calculations.

The weighted average loan-to-value (LTV) ratio for total mortgage loans declined to 75% in 2023. Most mortgage loans issued by banks had LTV ratios in the 75–99% range. Specifically, 43% of total mortgage loans had LTV ratios in the 75–84% range, while 25% had an LTV ratio in the 85–99% range.

Concerns persist regarding the collateral condition of car loans. In 2023, the share of car loans with an LTV in the 76-80% range decreased by 34 percentage points compared to 2022. Meanwhile, the share of loans with an LTV in the 81-85% range sharply increased by 36 percentage points. Consequently, the weighted average LTV for car loans rose to 82%. This rise in high-risk car loans has the potential to exacerbate the debt burden on individuals and increase vulnerabilities in the financial system.

Figure 73. LTV Distribution of Car Loans

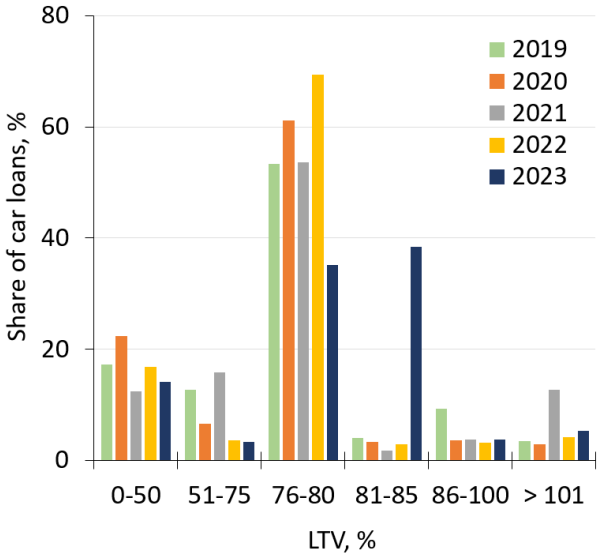
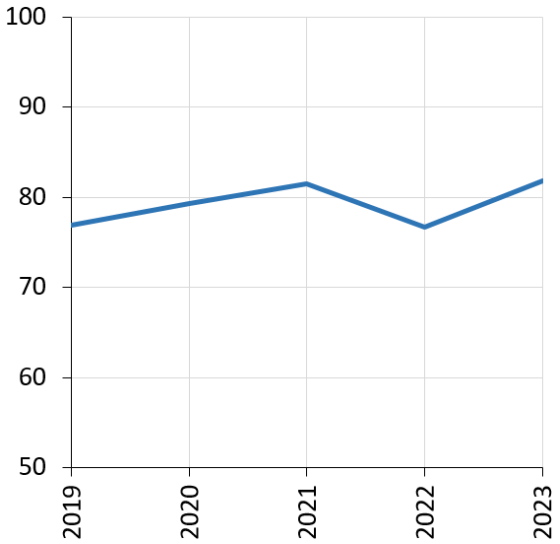


Figure 74. Weighted Average LTV of Car Loans, %



Source: CBU staff calculations.

Tightened macroprudential measures[53] curbed car loan growth in H2 2023. Following a 212% surge in outstanding car loans between July 1, 2022, and July 1, 2023, growth slowed to 92% by January 2024. The annual growth rate of car loan stock declined by 22 percentage points in 2023 compared to 2022. By the end of 2023, car loans to individuals totaled approximately 43 trillion UZS.

Figure 75. Annual Growth (YoY) of Outstanding Loans of Individuals, %

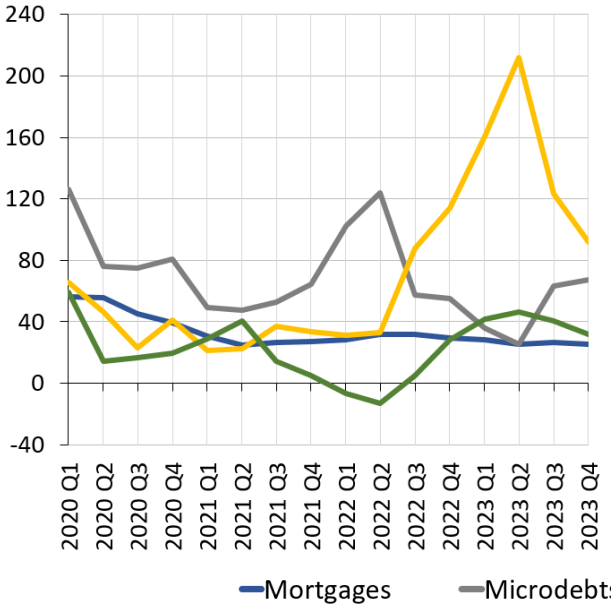
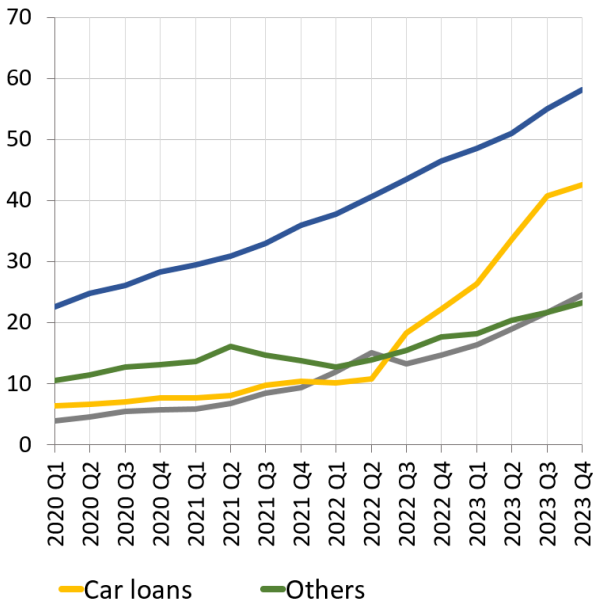


Figure 76. Outstanding Loans of Individuals, trillion UZS



Source: CBU staff calculations.

[53] O‘zbekiston Respublikasi Markaziy banki boshqaruvining 2023 yil 6 iyundagi “Tijorat banklari kapitalining monandligiga qo‘yiladigan talablar to‘g‘risidagi nizomga o‘zgartirishlar va qo‘shimcha kiritish haqida”gi 14/7–sonli qarori.

Loans of individuals-to-GDP gap was positive. In 2023, this gap expanded to 1.2 percentage points, indicating a risk of accumulating vulnerabilities in loans to individuals.

The annual growth rate of outstanding individual loans exceeded the growth rate of nominal GDP. In 2023, outstanding individual loans grew by 47% annually, while nominal GDP increased by 20%. As a result, the annual growth rate of outstanding individual loans in 2023 was 2 percentage points higher than in 2022. Consequently, the ratio of individual loans to GDP increased by 2.6 percentage points in 2023, reaching approximately 14% by the end of the year. The ratios of mortgages and car loans to GDP were significant, totaling 5.5% and 4.0%, respectively, by the end of 2023. Furthermore, the ratio of microdebts and other loans to GDP remained relatively stable.

Figure 77. Loans of Individuals-to-GDP Gap[54], percentage point

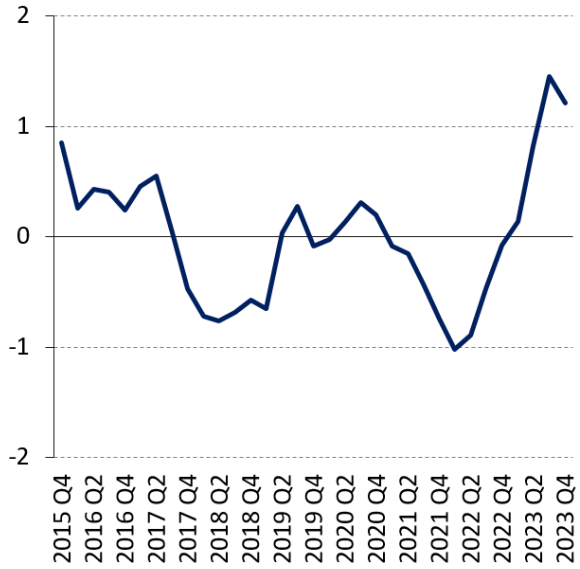
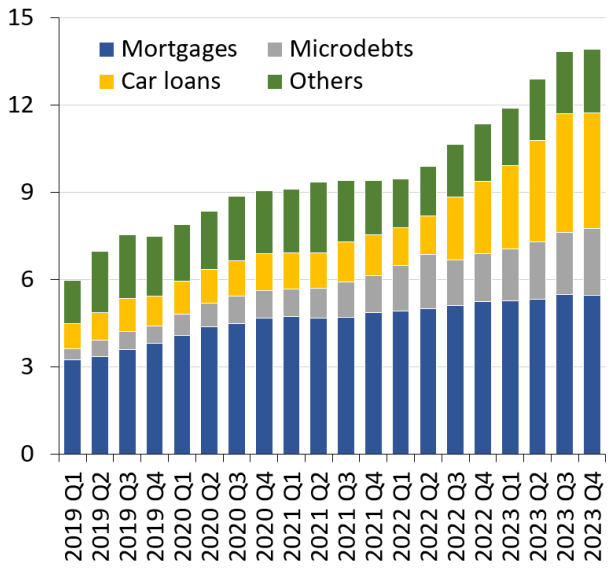


Figure 78. Loans of Individuals by Types, % of GDP



Source: CBU staff calculations.

There was an acceleration in the growth of the number of borrowers per 1,000 working-age residents. The number of borrowers surged by 26% in 2023, reaching a total of 4 million. By the end of 2023, 193 out of every 1,000 working-age permanent residents in Uzbekistan were classified as borrowers, an increase of 38 individuals compared to the end of 2022. The precipitous rise in the number of borrowers suggests enduring robust demand for loans.

[54] The long-term trend of the loans of individuals-to-GDP ratio is calculated according to the BCBS approach, using a one-sided HP filter with a smoothing parameter of 400,000 for quarterly data.

Figure 79. Bank Borrowers and Borrowers per 1,000 Individuals*

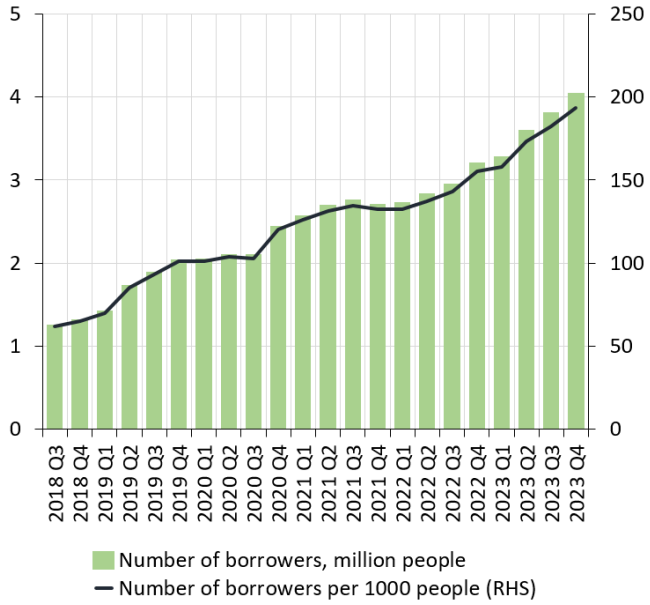


Figure 80. Unemployment Rate and Annual Growth of Nominal Wages (YoY), %

Source: CBU staff calculations.

Note: *The calculation takes into account individuals who are both residents and within the working age group.

Nominal monthly wages grew at a slower pace in 2023. The nominal monthly wage increased by 17.2%, reaching 4.6 million UZS by the end of the year. The unemployment rate in Uzbekistan stood at 6.8%, reflecting a 2.1 percentage point diminution from the corresponding period in 2022.

Box 5. Debt Burden Survey

To gauge the debt burden of individuals in Uzbekistan during Q1 2024, the CBU surveyed 1,284 respondents between April 16 and 23, 2024. The survey encompassed credit and other debts owed to both financial and non-financial sectors.

Households with five members made up the largest group of respondents, comprising 28% of the total. These household members were primarily employed in education, finance and insurance, trade, entrepreneurship, healthcare, and other sectors. 73% of households had an average monthly income of up to 10 million UZS from their primary employment.

Additionally, one-third of respondents reported having an additional source of income. Among these, 58% of respondents had extra income of up to 4 million UZS.

Figure 81. Average Number of Household Members, %

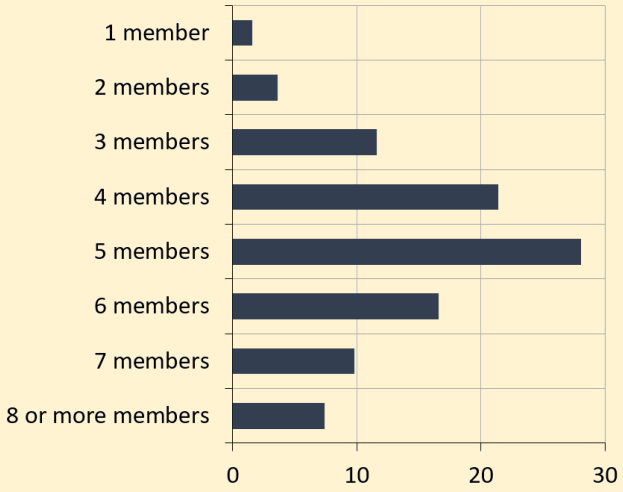


Figure 82. Average Monthly Primary Income by Household Composition, %

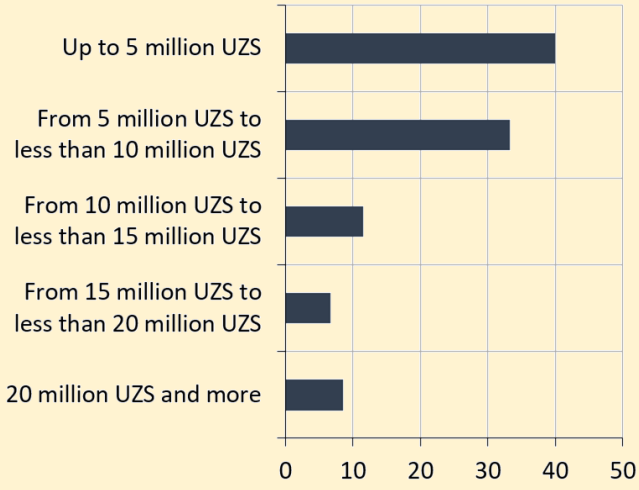


Figure 83. Household Share with Extra Income Sources

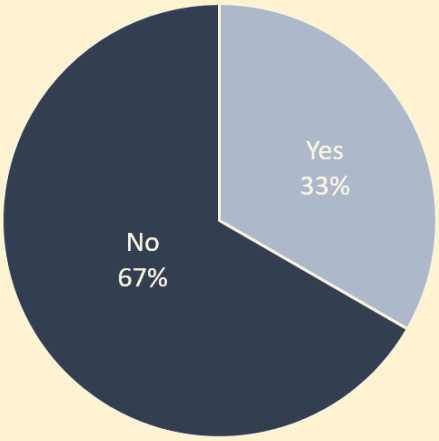
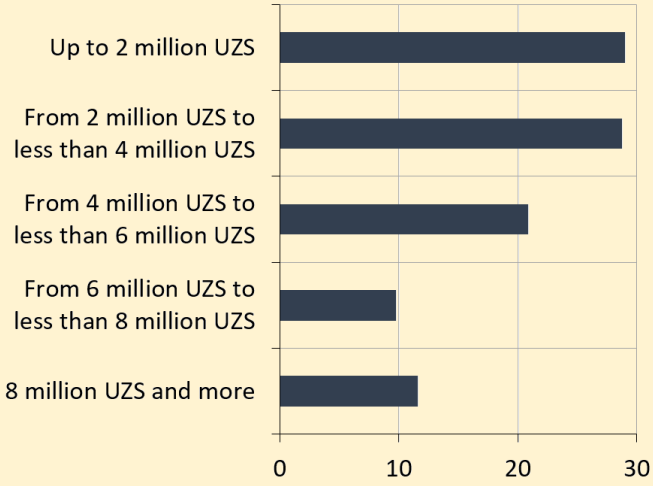


Figure 84. Breakdown of Extra Monthly Income by Household, %



Source: CBU Survey.

Nearly half of the respondents reported monthly household living expenses, excluding loan payments, of less than 5 million UZS, while 35% incurred costs between 5 and 10 million UZS.

In addition, 76% of respondents indicated that a household member held bank loans. Microloans constituted 29% of these debts, followed by mortgages at 25% and car loans at 19%. Real estate and vehicles comprised 39% and 33%, respectively, of the total loan collateral.

Figure 85. Average Monthly Living Expenses Excluding Loan Payments, %

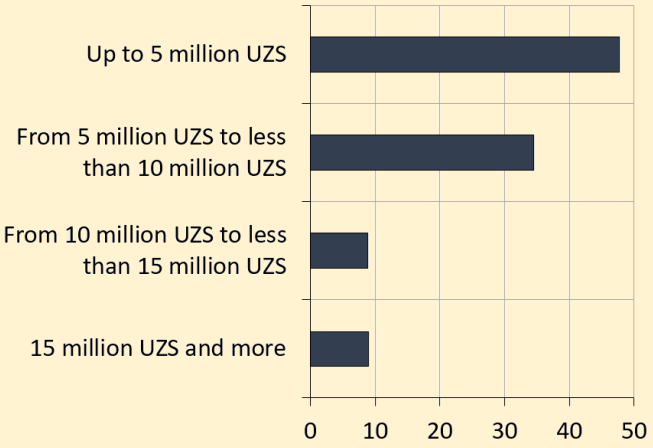


Figure 86. Share of Households Indebted to Banks

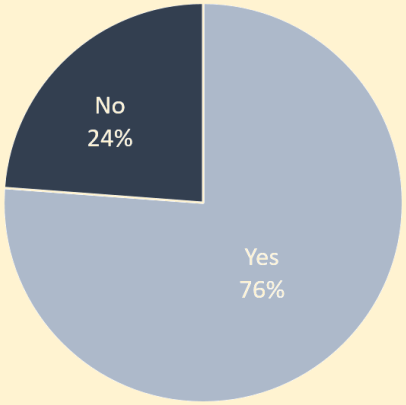


Figure 87. Breakdown of Bank Loan Types, %

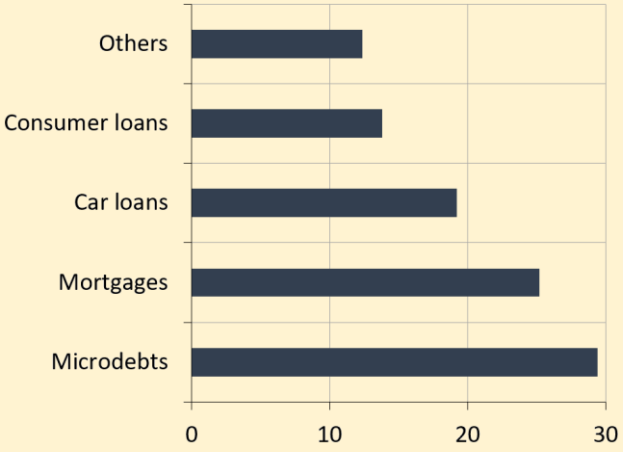
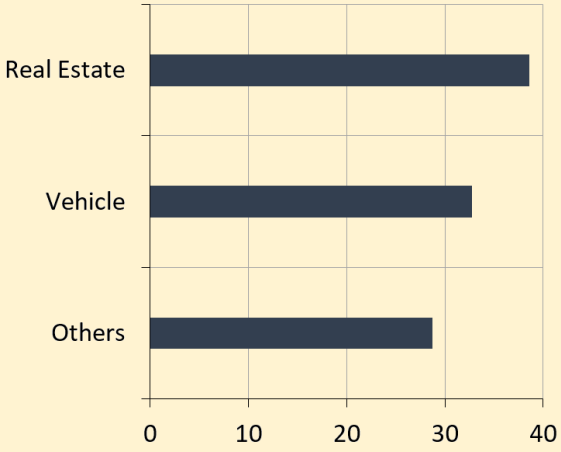


Figure 88. Collateral Types Used for Bank Loans, %



Source: CBU Survey.

A notable 41% of respondents with mortgages reported monthly loan payments of 4 million UZS or more. Additionally, 38% of respondents had monthly car loan payments of 4 million UZS or more. In comparison, 79% indicated that their monthly payments for other consumer loans are up to 4 million UZS, while 80% reported monthly microdebt payments of up to 4 million UZS.

Mortgage borrowers exhibited a longer repayment horizon, with 83% facing a remaining term of five years or more. Conversely, car loan repayment periods were shorter, with 86% of respondents indicating terms between one and five years.

According to the survey results on debt burden outside the banking system, 23% of respondents have debt to both banks and non-bank credit organizations. Additionally, 31% have taken loans from non-financial organizations in addition to bank loans. Furthermore, 16% have obligations to banks, non-bank credit organizations, and non-financial organizations simultaneously.

Figure 89. Monthly Payments for Bank Loans, %

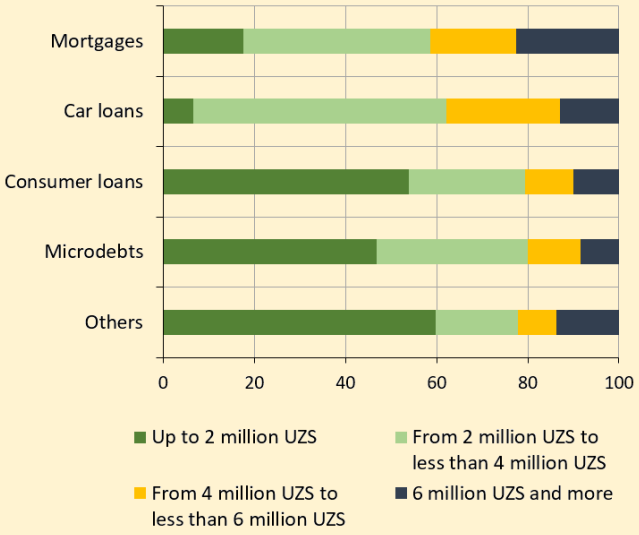


Figure 90. Remaining Maturity on Bank Loans, %

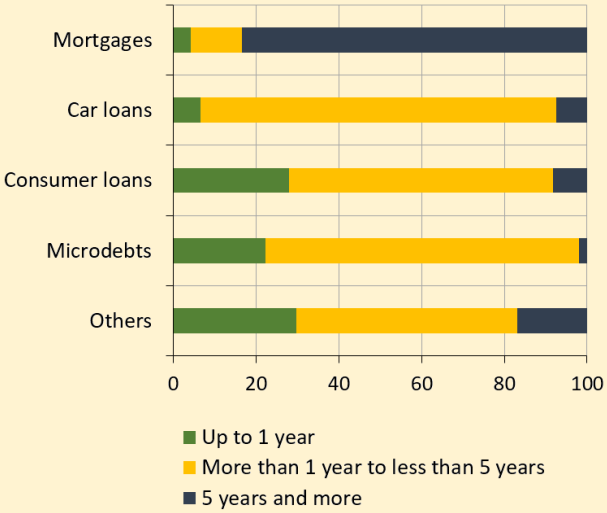


Figure 91. Non-Bank Liabilities of Bank Borrowers

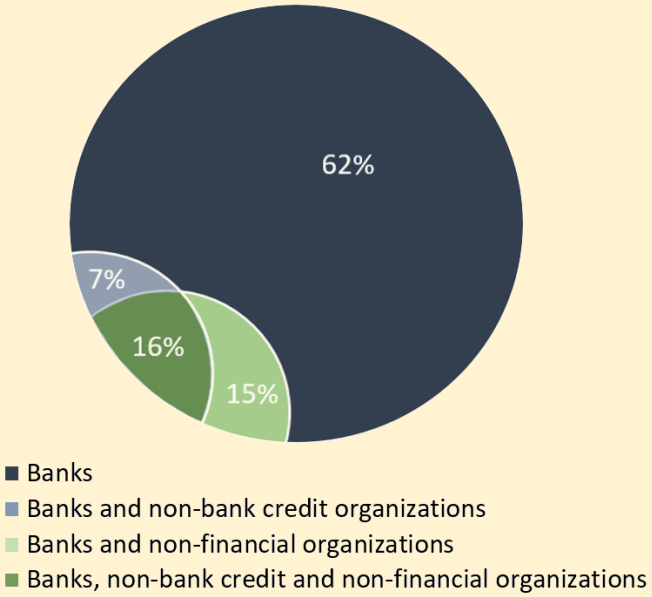
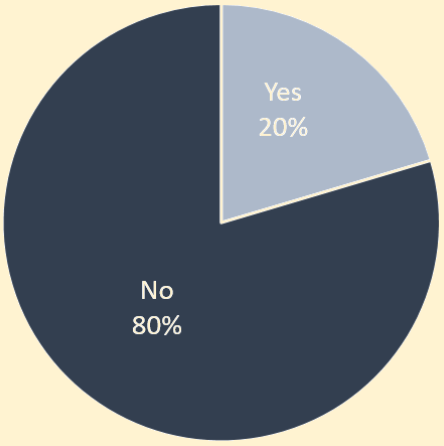


Figure 92. Existence of Debt to Non-Bank Credit Organizations



Source: CBU Survey.

A total of 20% of respondents reported that a household member has debts with non-bank credit organizations. These loans are primarily used for acquiring consumer goods, funding education, buying and renovating property, purchasing vehicles, and covering daily expenses. Motor vehicles and real estate were commonly used as collateral, accounting for 46% of the total.

Additionally, 37% of respondents indicated that their monthly payments to non-bank credits are less than 2 million UZS, while 58% noted that their loan maturities extend up to 2 years.

Figure 93. Non-Bank Credit Borrowing Objectives, %

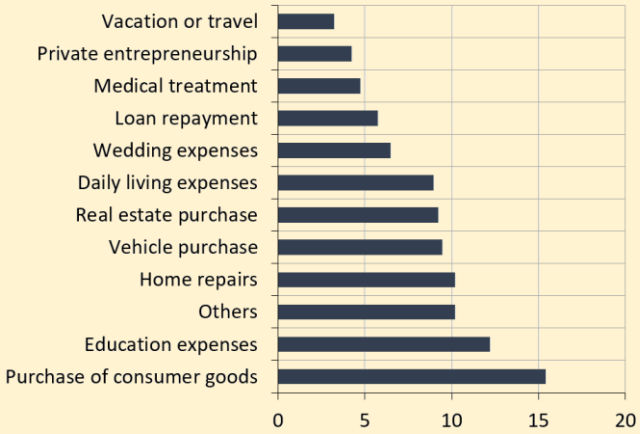


Figure 94. Collateral Types Used for Non-Bank Credits, %

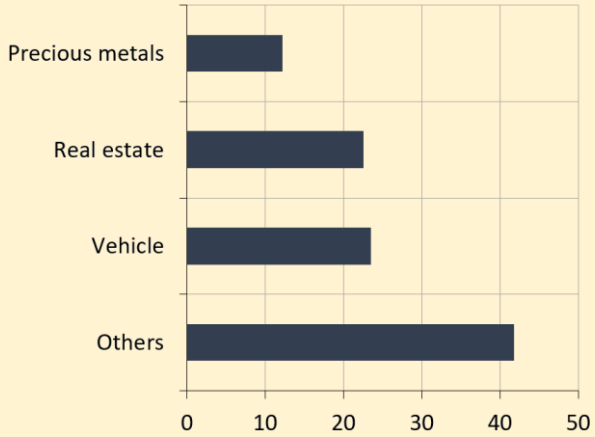


Figure 95. Monthly Payments for Non-Bank Credits, %

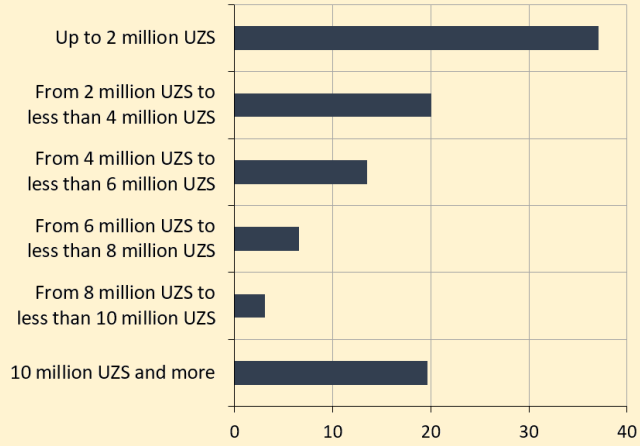
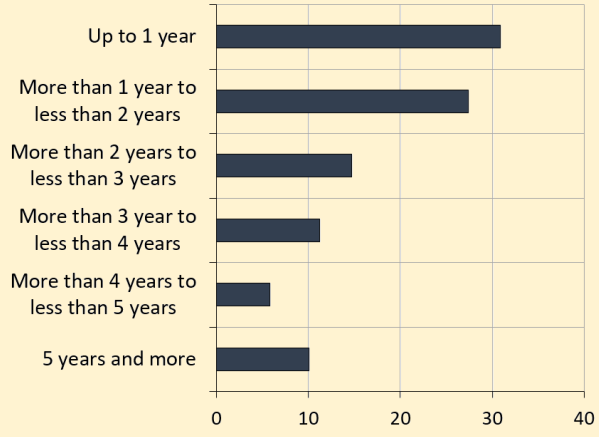


Figure 96. Remaining Maturity on Non-Bank Credits, %



Source: CBU Survey.

Respondents indicated that 27% of household members had debt obligations to non-financial organizations, mainly for installment purchases of consumer goods, vehicles, and real estate. Additionally, 61% of respondents made monthly debt payments of up to 4 million UZS, and 57% had debts with a maturity of less than 2 years.

Figure 97. Existence of Debt to Non-Financial Organizations

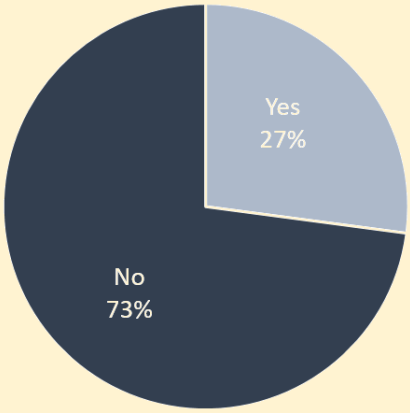
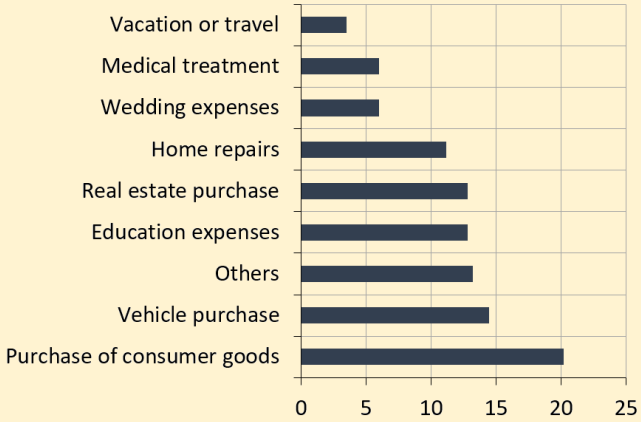


Figure 98. Borrowing Objectives from Non-Financial Organizations, %



Monthly Payment for Debts from Non-Financial Organizations, %

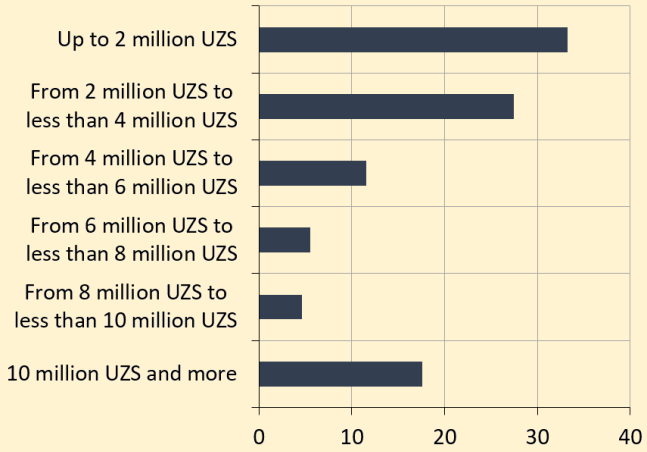
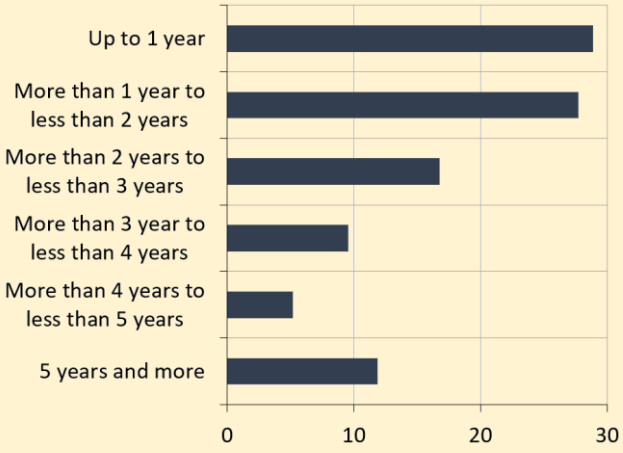


Figure 100. Remaining Maturity on Debts from Non-Financial Organizations, %



Source: CBU Survey.

Survey results on individuals' solvency show that in the past six months, 51% of respondents' solvency remained stable, 33% improved, and 16% deteriorated.

Among borrowers, 61% intend to repay their loans ahead of schedule. Additionally, 46% predict an improvement in their solvency over the next six months, while 29% expect it to remain stable.

Figure 101. Six-Month Change in Respondents' Solvency

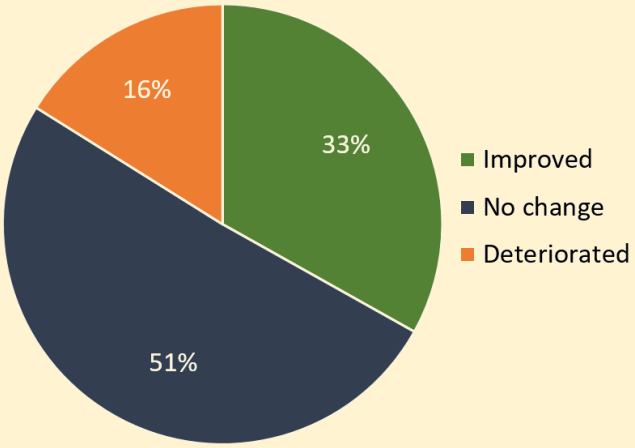


Figure 102. Advance Loan and Debt Repayment Intentions Among Respondents

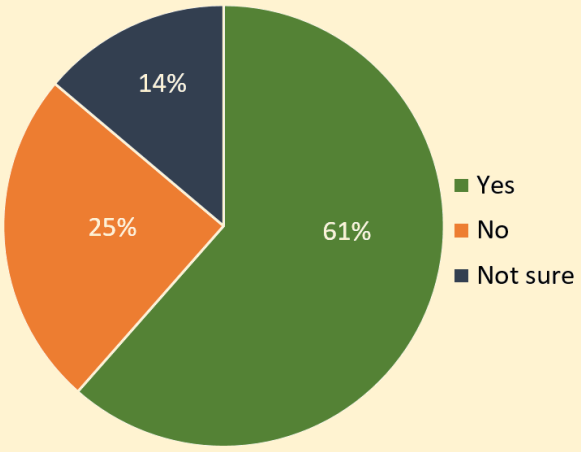


Figure 103. Solvency Outlook for the Next 6 Months

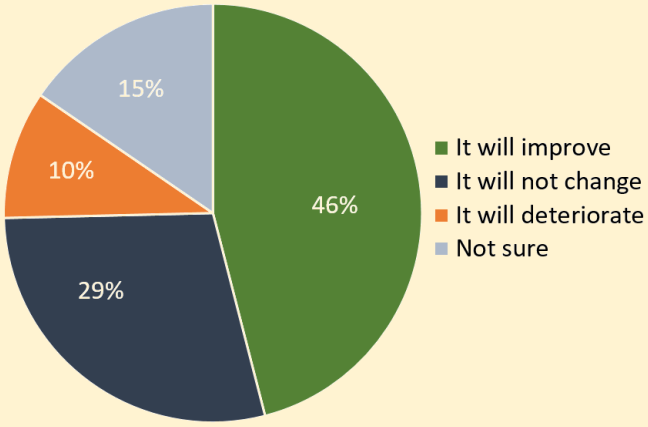
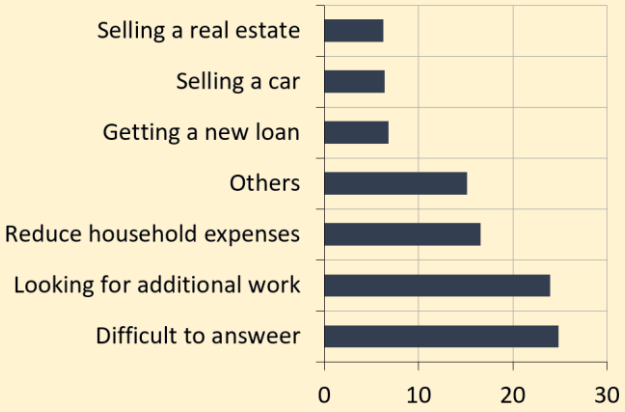


Figure 104. Actions to Alleviate Solvency Concerns, %



Source: CBU Survey.

Respondents reported that 24% of participants plan to seek extra work, and 17% aim to lower daily spending to cope with monthly payment issues, and 25% do not have specific plans for addressing their payment ability.

A total of 62% of respondents do not plan to take on credit or debt from banks or other organizations in the next six months. Meanwhile, those planning to obtain a loan during this period primarily intend to purchase a house or a car.

Figure 105. Intentions for Credit and Debt Over the Next 6 Months

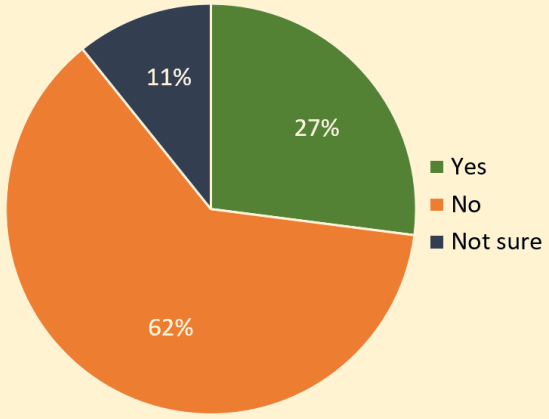
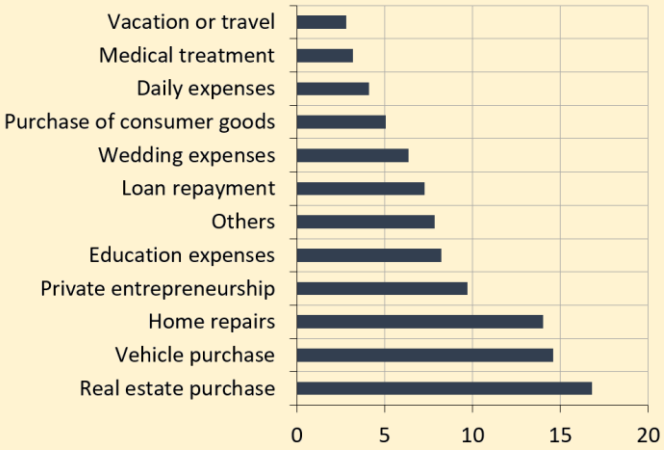


Figure 106. Borrowing Objectives for the next 6 months, %



Source: CBU Survey.

Overall, respondents with debts to banks, non-bank credit institutions, and non-financial organizations had an average debt burden[55] of 87%[56], while the median debt burden was 77%. Additionally, those with bank debts reported that their average monthly living expenses constituted 66% of their total monthly family income from both primary and additional sources.

[55] The total average debt burden of respondents with bank loans was calculated by dividing their total monthly payments on bank and non-bank debt obligations by their total monthly income from primary and additional sources.

[56] To determine households' basic and additional monthly income, expenses, and monthly payments on loans and debts, the average of the upper and lower limits of the intervals given by respondents was used. The conditional upper limit of an unbounded interval was found by adding the previous interval size (the difference between its upper and lower limits) to the lower limit of the current interval.

IV. Asset Markets

4.1. Real Estate Market

The housing market in Uzbekistan is facing overvaluation. The market value of housing has been increasing rapidly, fueling demand for these assets. This high demand, combined with an insufficient supply, has driven up housing prices irrespective of fundamental factors such as the population's income. Moreover, despite a decline in rental profitability, speculation continues to stimulate market activity and demand. As a result, the average market housing price in 2023 exceeded the fundamental price by 24%.

Figure 107. Market and Fundamental Prices of Houses in Uzbekistan, million UZS per square meter

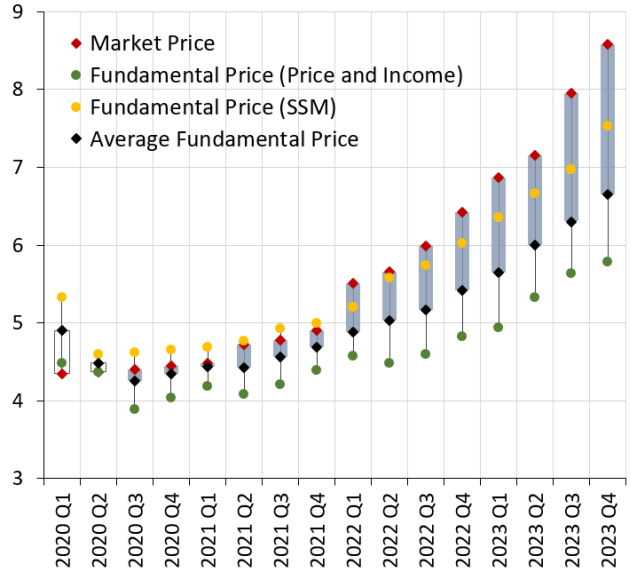
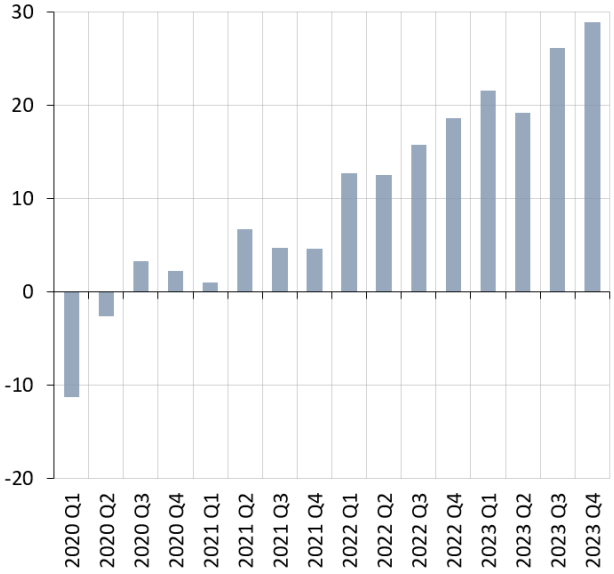


Figure 108. Difference Between Market and Average Fundamental Prices of Houses in Uzbekistan, %



Source: CBU staff calculations.

Note: The rectangular shape in the diagram illustrates the difference between the market price and the average fundamental price of housing in Uzbekistan. The length of the rectangle increases with the size of the difference between the market and average fundamental prices. When the market price exceeds the average fundamental price, the interior of the rectangle is completely filled with dark color; when it is lower, the rectangle is white. The highest point of the vertical black line represents the maximum price index between the market price of houses and the fundamental prices determined by the models for a given year, while the lowest point represents the minimum price.

The market prices per square meter are average prices calculated from online advertisements and may not reflect the actual sales prices.

The State Space Model (SSM)[57] and price and income models[58] indicate that the market price of housing is higher than its fundamental value. Combining these models to determine the discrepancy between market and fundamental values provides a more accurate measure of the price bubble. Therefore, to comprehensively evaluate the real estate market, the SSM model was employed alongside the price and income model, which assesses the fundamental value of housing based on mortgage loan availability (see Appendix 8). In this context, the market value of housing in 2023 was estimated to be 41% higher than the fundamental value derived from the price and income model and 11% higher according to the SSM model.

The nature of real estate purchases in Uzbekistan has shifted from addressing primary needs to focusing on investment. The high growth rates of housing price indexes in both domestic and foreign currencies have increased the demand for real estate. In 2023, the indexes for housing prices climbed by 43 units in national currency and 23 units in foreign currency. Additionally, the weighted average interest rates on term deposits over one year were 20% in national currency and 5% in foreign currency[59], which are relatively lower than the growth in housing prices. Due to the underdeveloped capital market, the limited popularity of financial instruments, and the rapid rise in housing prices, the population views investment in real estate as a highly profitable asset.

Figure 109. Housing Market Price Indexes (2020 Q1=100)

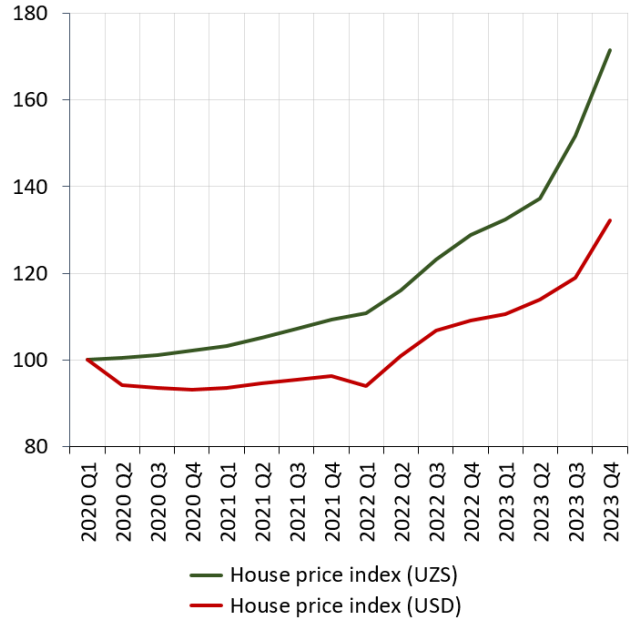
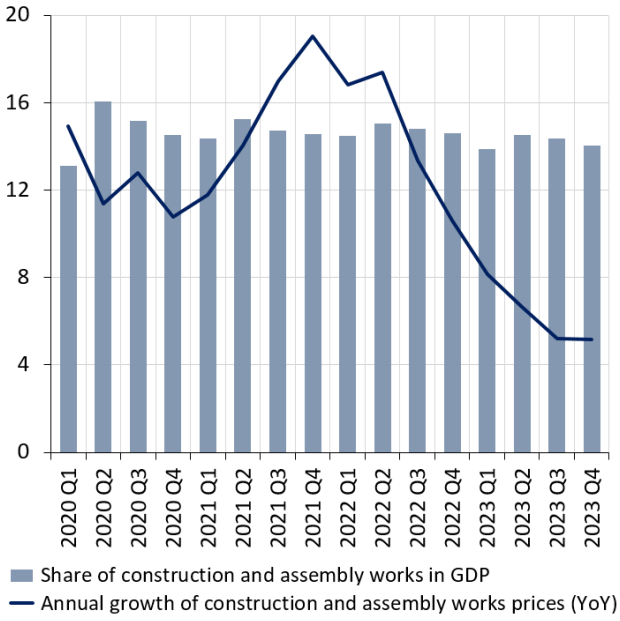


Figure 110. Construction and Assembly Works Prices (YoY change), %



Sources: Statistics Agency and CBU staff calculations.

[57] The SSM model serves to calculate the fundamental value of housing prices by determining the linear relationship function that represents the effect of fundamental factors (income at the disposal of the population, and the ratio of the housing price to the income at the disposal of the population) on an arbitrary variable (the market price of housing).

[58] The price and income model for calculating the fundamental value of housing prices in the real estate market of Uzbekistan is based on the ability to obtain a mortgage loan. In this case, the market and fundamental prices of housing are 1 sq. m. shown in average prices per meter.

[59] The Central Bank of the Republic of Uzbekistan. Monetary and financial statistics.

Supply factors in the surge of housing prices remain subdued. Construction and assembly prices climbed by 5.2% in 2023, down 5.4 percentage points from 2022. This downward shift in construction cost growth throughout the year implies that supply factors are not a major driver of the rapid rise in real estate prices.

The housing market continues to experience a mismatch between demand and supply. In 2023, construction volume rose by 15%, compared to a nominal GDP growth of 19%. This led to a decrease in the construction volume to GDP ratio from 14.5% in 2022 to 14% in 2023. Additionally, the number of residential properties in Uzbekistan increased by 1.4%, reaching 7.7 million by the end of 2023[60]. This indicates that the supply of new housing is not keeping pace with demand.

Figure 111. Ratio of Housing Prices* to Nominal GDP Per Capita, %

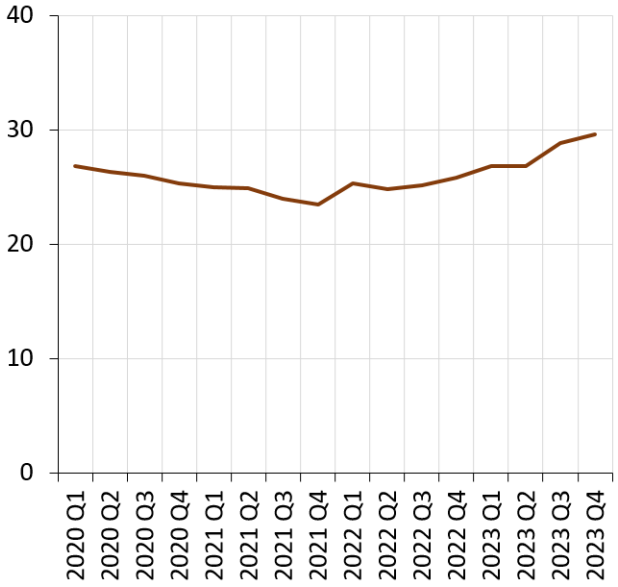
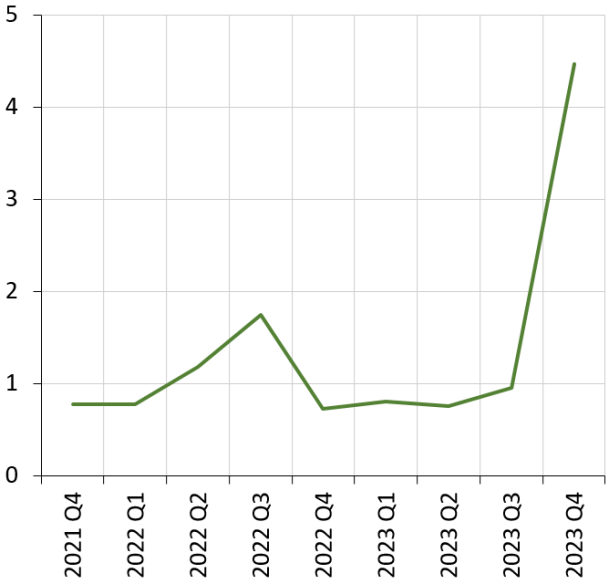


Figure 112. Ratio of Annual Growth Rate of House Prices to Annual Growth Rate of Rents



Sources: Statistics Agency and CBU staff calculations.

Note: The market prices per square meter are average prices calculated from online advertisements and may not reflect the actual sales prices.

Housing affordability in Uzbekistan decreased in 2023. Housing prices increased at a higher rate than the nominal GDP per capita, which represents the average economic condition of the population. By the end of 2023, the price per square meter of housing was 30% of the nominal GDP per capita, an increase of 4 percentage points compared to the same period in 2022. This rise signifies a reduced ability for the population to purchase housing.

[60] Iqtisodiyot va moliya vazirligi huzuridagi Kadastr agentligi. (2024). Infografikalar va press-relizlar. Jismoniy va yuridik shaxslar egaligida bo‘lgan ko‘chmas mulk obyektlari soni to‘g‘risida ma’lumot.

Rental property returns fell markedly in 2023. While rental costs increased by a modest 7%, home prices skyrocketed, rising at a rate 4.5 times higher. Despite this widening gap in returns, the appeal of homeownership remained strong. This suggests that buyers are anticipating substantial future property value growth, highlighting the speculative dynamics driving the real estate market.

Figure 113. Ratio of Annual Growth Rate of Housing Prices to Annual Growth Rate of Average Monthly Salary, %

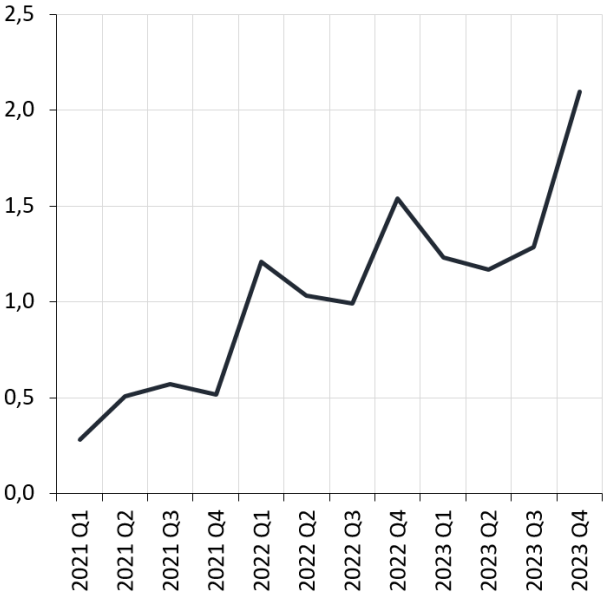
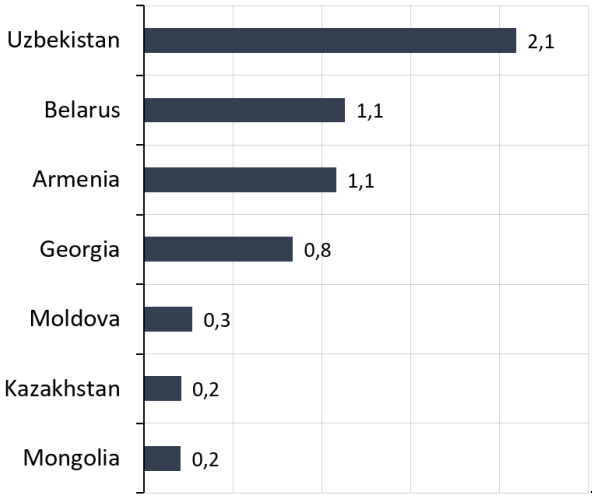


Figure 114. Ratio of Annual Growth Rate of Housing Prices to Annual Growth Rate of Average Monthly Salary in Selected Countries in 2023



Sources: National authorities, Statistics Agency and CBU staff calculations.

Housing prices in the real estate market are driven by factors other than the official income of the population. In Uzbekistan, housing prices have continued to climb at a high rate compared to population income. In 2023, the market value of housing increased by 36%[61], while the average monthly salary of the population increased by 17%[62]. Thus, housing prices grew 2.1 times faster than the average monthly salary. This rate of increase was higher in Uzbekistan in 2023 compared to several CCA and other countries.

[61] O‘zbekiston Respublikasi Prezidenti huzuridagi Statistika agentligi. (2024). O‘zbekiston Respublikasi bo‘yicha uy-joylarning narxlari indeksi.

[62] Statistics Agency under the President of the Republic of Uzbekistan. (2024). Labor market.

Figure 115. Population Density in CCA Countries*, people per square kilometer

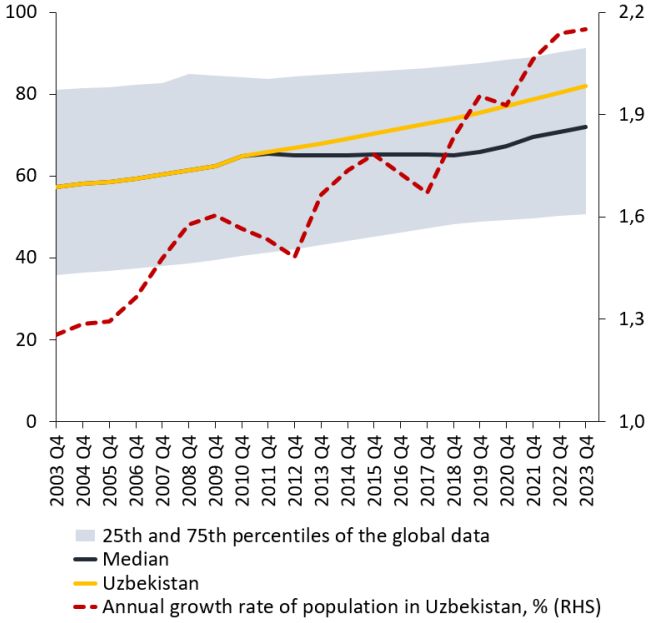
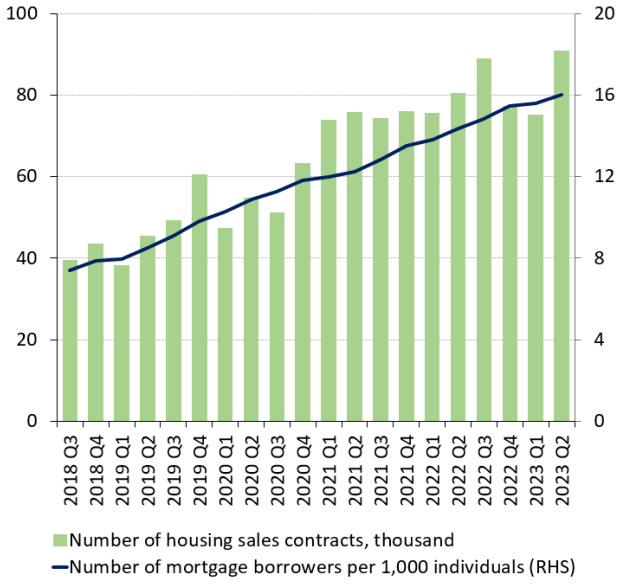


Figure 116. Housing Contracts and Mortgage Borrowers per 1,000 Individuals**



Sources: United Nations, Statistics Agency, Ministry of Justice, and CBU staff calculations.

Note: *Armenia, Azerbaijan, Tajikistan, Uzbekistan, Kyrgyzstan, and Kazakhstan are taken into account. **The calculation is based on the number of people who are residents and of working age.

Demographic statistics suggest strong future demand in Uzbekistan's real estate market. As of January 1, 2024, the population density in Uzbekistan was 82 people per square kilometer[63], higher than the CCA countries median of 72 people. Furthermore, Uzbekistan's population showed a steady annual growth rate, reaching 2.2% by the end of 2023. This continuous population increase, along with a density much higher than the CCA countries median, indicates a long-lasting high demand for housing in the real estate market.

The real estate market exhibited sustained high levels of activity in 2023, with significant promise for future growth fueled by increased mortgage lending. The number of housing sale contracts reached 350,000, marking a 4.4% increase from 2022. Moreover, the number of mortgage borrowers per thousand working-age individuals grew by 11%, reaching 17 by the end of the year. The practice by commercial banks of not requiring official income proof for mortgage loans, instead using scoring systems that consider other legal income sources, may further boost demand in the real estate market[64].

[63] O'zbekiston Respublikasi Prezidenti huzuridagi Stastika agentligi. (2023). O'zbekiston Respublikasining demografik holati 2023 yil yanvar-dekabr.

[64] O'zbekiston Respublikasi Prezidentining 2023 yil 13 apreldagi "2023 yilda bozor tamoyillariga asoslangan ipoteka kreditlari orqali aholini uy-joy bilan ta'minlash dasturini amalga oshirish chora-tadbirlari to'g'risida"gi PF-51–sonli Farmoni.

Figure 117. Weighted Average Term and Interest Rate of Mortgage Loans

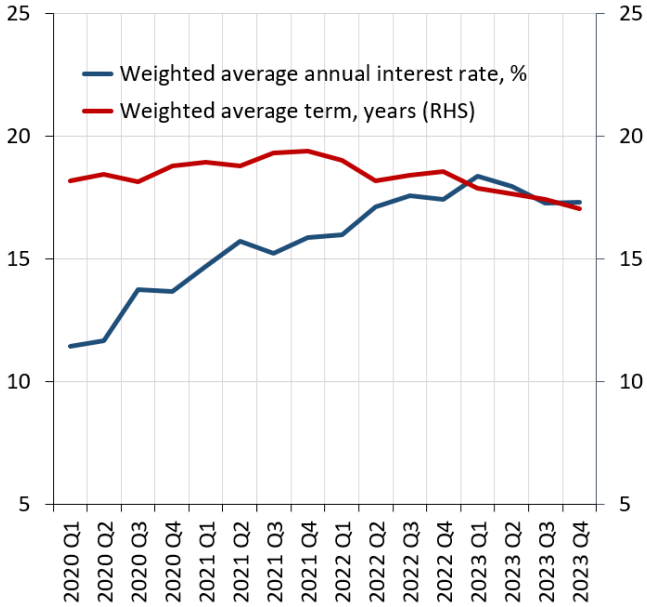
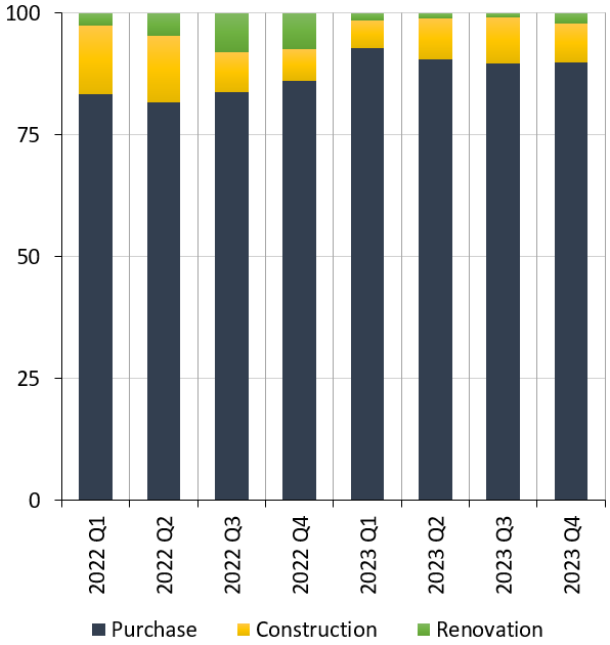


Figure 118. Mortgage Loan Distribution by Purpose, %



Source: CBU.

Mortgage loans primarily funded home purchases. In 2023, 91% of mortgage loans were dedicated to home purchases, with only 8% going toward construction and 1% toward repairs. The focus on home purchases in mortgage lending is likely to increase demand in the real estate market and could lead to the expansion of a price bubble.

There was a tightening of standards for market-based mortgage loans. In 2023, the average weighted interest rate for mortgages was around 18%, and the average loan term was 17.5 years. Consequently, the average weighted term for mortgages issued in 2023 was one year shorter than in 2022, while the average weighted interest rate increased by 0.6 percentage points.

The elevated risk inherent in mortgage loans was limited to a few banks. As of January 1, 2024, the ratio of mortgage loans to total loans in the banking system stood at 12%, while the Tier I capital to total loans ratio was 18%. Banks with higher risk levels had a Tier I capital ratio below the system average and a mortgage loan share above the average. These banks represented 13% of the total assets in the banking system as of January 1, 2024.

Figure 119. Ratios of Tier I Capital to Total Loans and Mortgages to Total Loans (as of January 1, 2024)

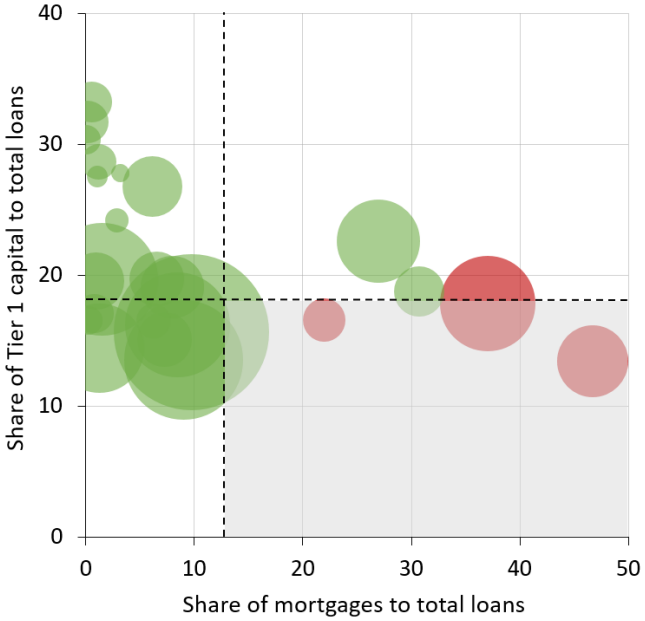
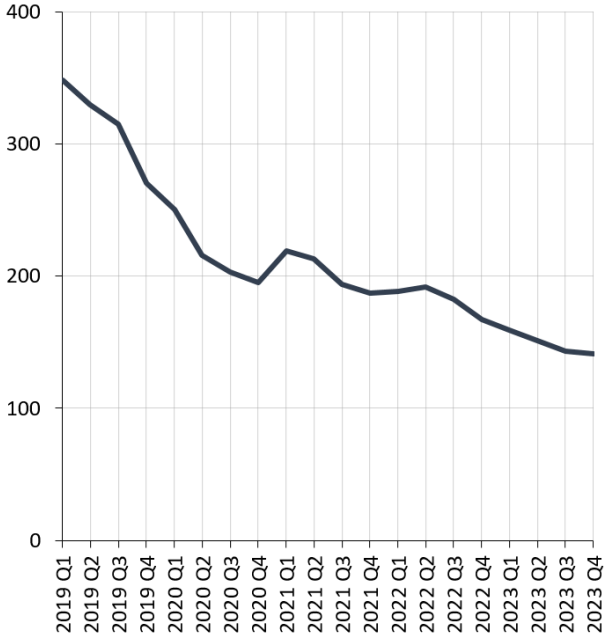


Figure120. Ratio of Average Monthly Salary to Average Monthly Mortgage Payment, %



Sources: Statistics Agency and CBU.

Note: The color green represents banks with lower risk than the banking system average on at least one of the following indicators: Tier I capital to total loans or mortgage loans to total loans. The color red represents banks with higher risk than the banking system average on both of these indicators. The bubble size reflects each bank's share of total bank assets. Banks with a Tier I capital to total loans ratio exceeding 50% were excluded from the analysis. The straight lines on the chart represent the average values of these indicators for the banking system as of January 1, 2024.

The solvency of individuals for repaying mortgage loans is diminishing. In 2023, the ratio of the average monthly salary to the average monthly mortgage payment stood at 141%, down by 26 percentage points from 2022. The surge in real estate prices has significantly driven up the average size of mortgage loans. In particular, the average mortgage loan issued in 2023 was 38% higher than in 2022. The faster growth in average monthly mortgage payments compared to household income could heighten the risk of financial strain for mortgage borrowers.

4.2. Car Market

In Uzbekistan, the gap between car market prices and fundamental values reached 7% by the end of 2023. The expansion of contracts for popular car models and the lowering of customs duties on specific light vehicles significantly boosted supply in a high-demand market. This surge in supply reduced the gap between the fundamental and market prices.

The fundamental price of cars in Uzbekistan was estimated using a price-income model that considers the population's ability to obtain car loans. The model assesses the maximum loan amount by considering interest rates, loan terms, and disposable income of borrowers[65]. The average fundamental value of cars is calculated based on loan availability and LTV ratios[66]. The fundamental price derived from this model reflects a stable car market with low systematic risk and a high likelihood of loan repayment.

[65] Plasil, M., & Andrle, M. (2019). Assessing House Price Sustainability. Czech National Bank.

The maximum attainable amount of a car loan is calculated using the following formula:

$$L_t = \alpha Y_t \left[\frac{z_t(1 - z_t^{N*12})}{1 - z_t}\right]$$

$$z_t = \frac{1}{1 + i_t}$$

Where,
L_t – the maximum attainable amount of a car loan in year *t*;
i_t – the weighted average monthly interest rate on flows of car loans in year *t*;
N – the duration of a car loans in years;
α – the portion of household disposable income to cover the monthly instalment;
Y_t – household disposable income in year *t*.

[66] The fundamental car price is calculated using the following formula:

$$PH_t = \frac{1}{LTV} * L_t$$

Where:
PH_t – the fundamental car prices in year *t*;
L_t – the maximum attainable amount of a car loan in year *t*;
LTV – a loan-to-value ratio.

Figure 121. Market and Fundamental Prices of Cars*, million UZS per unit**

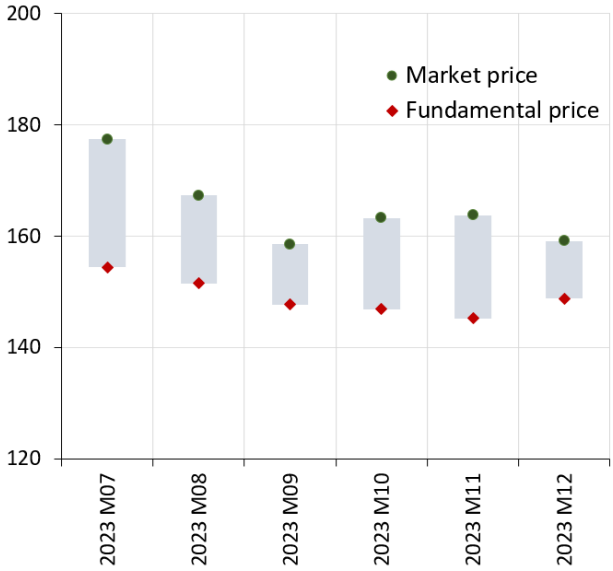
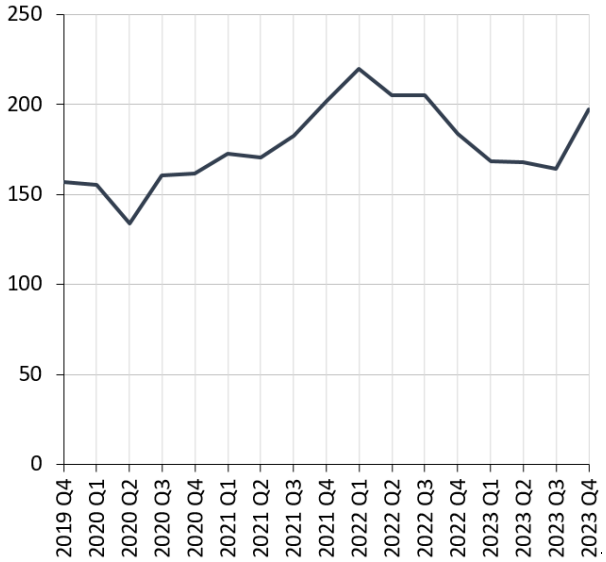


Figure 122. Car Affordability Index***



Source: CBU staff calculations.

Note: *The rectangle in the chart illustrates the difference between market and fundamental prices of cars. The longer the rectangle, the greater the price difference. If the market price exceeds the fundamental price, the rectangle will be fully colored; if it is lower, the rectangle will be white.

**According to commercial banks' requirements for car conditions in car loan allocations, only cars manufactured within the past 5 years are considered for determining market prices. Market prices for popular models such as Chevrolet Cobalt, Damas, Labo, Lacetti/Gentra, Nexia T-250, Spark, and Tracker are used. The average market price is calculated by averaging each car model's price and computing the weighted average based on the number of advertisements on public internet pages. The average market price of used cars in this review is derived from advertisements on open internet web pages and does not reflect actual sales contracts at these prices.

***A decline in the Car Affordability Index signifies a reduced capacity of the population to purchase a vehicle, whereas a rise indicates an enhanced ability to do so.

The introduction of new macroprudential measures has boosted car affordability. In H1 2023, the Car Affordability Index declined due to eased car loan standards by commercial banks. However, from August 2023, a new LTV ratio requirement[67] for evaluating car loan risks was introduced, reducing credit risk and leading to lower average loan amounts and monthly payments. With a 17%[68] increase in average household incomes and a 3% rise in car prices throughout 2023, these changes contributed to an improvement in the index in H2 2023.

[67] O‘zbekiston Respublikasi Markaziy banki boshqaruvining 2023 yil 6 iyundagi “Tijorat banklari kapitalining monandligiga qo‘yiladigan talablar to‘g‘risidagi nizomga o‘zgartirishlar va qo‘shimcha kiritish haqida”gi 14/7–sonli qarori.
[68] O‘zbekiston Respublikasi Prezidenti huzuridagi Statistika agentligi. (2023). Nominal hisoblangan o‘rtacha oylik ish haqi 2023 yil yanvar-dekabr.

Figure 123. Annual Growth Rate of Vehicle Prices (YoY), %

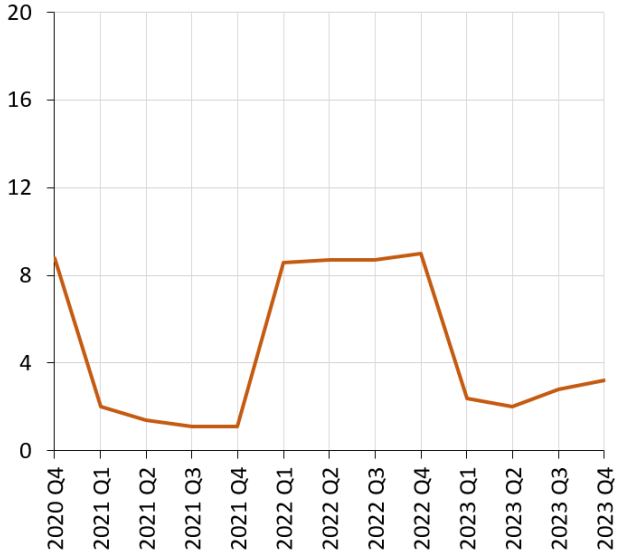
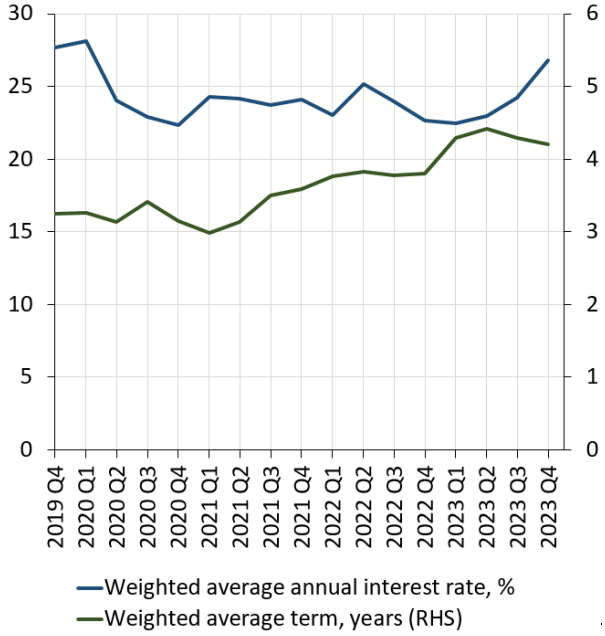


Figure 124. Weighted Average Term and Interest Rate of Car Loans



Sources: Statistics Agency and CBU staff calculations.

The car loan standards of 2023 featured notably longer repayment periods alongside higher interest rates. Car loan interest rates followed an upward trend, averaging 24% in 2023. Additionally, the average weighted repayment term for car loans extended to 4.3 years, half a year longer than in 2022. Despite the rise in average loan rates, the lengthened loan terms had a favorable effect on car affordability for the population.

Figure 125. Passenger Cars Manufactured in Uzbekistan (Excluding Special Vehicles) in Primary Car Market, thousand

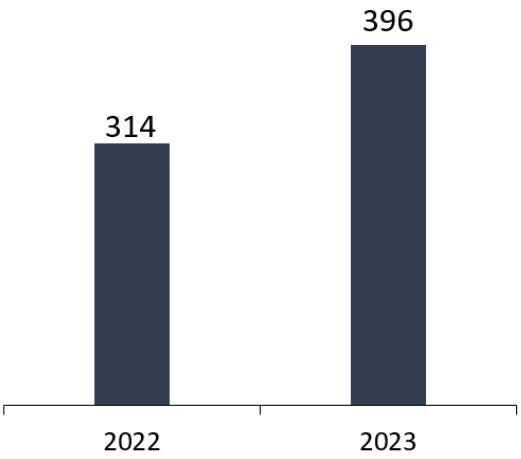
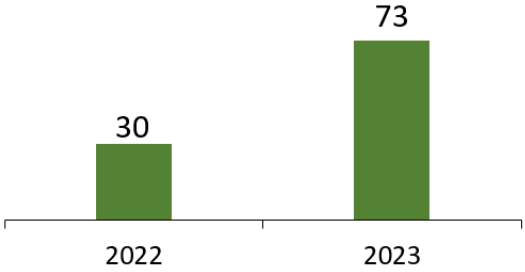


Figure 126. Passenger Car Imports to Uzbekistan, thousand



Source: Statistics Agency.

A substantial influx of vehicles made in Uzbekistan has impacted the car market. In 2023, approximately 396,000 vehicles (excluding special vehicles) were produced in the country, marking a 26% rise compared to 2022[69]. This surge in production, aided by the rise in passenger car manufacturing companies, has substantially enhanced the market supply.

There was a significant uptick in passenger car imports to Uzbekistan, which partially alleviated domestic demand. This spike was driven by a reduction in customs duties on new cars under a year old[70], leading to a sharp increase in import volumes. In 2023, 73,000 passenger cars were imported into the country, a 2.4-fold increase compared to 2022.

Figure 127. Passenger Cars per 1,000 Individuals (as of January 1, 2024)

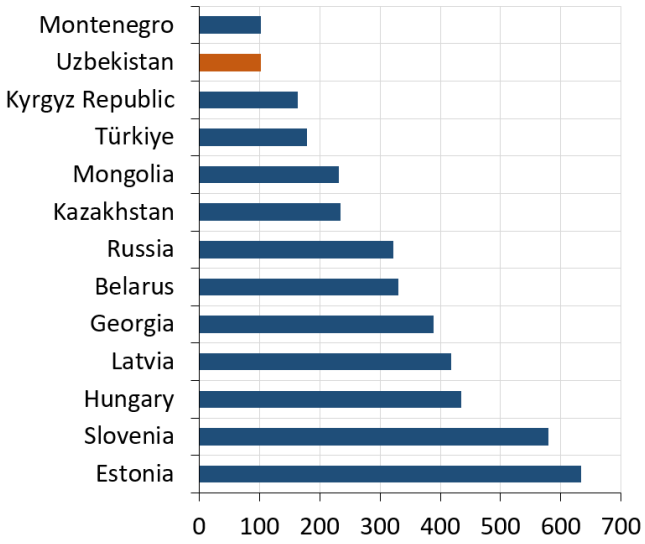
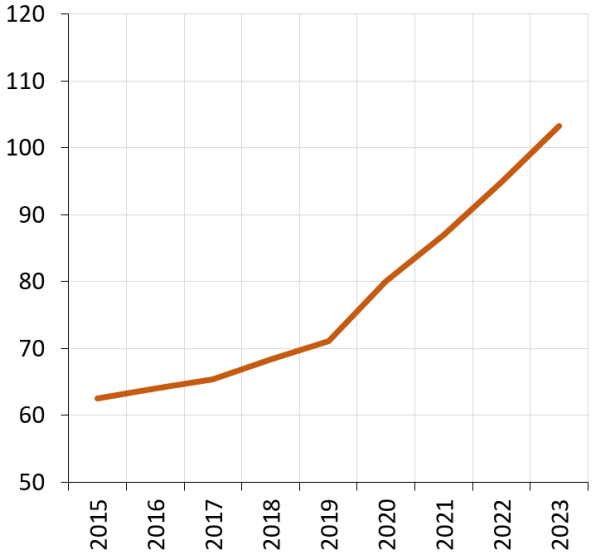


Figure 128. Passenger Cars per 1,000 Individuals in Uzbekistan



Sources: National authorities, Statistics Agency and CBU staff calculations.

Uzbekistan's burgeoning fleet of passenger cars contrasts with its still-low car ownership rates relative to Central Asian countries and beyond. In 2023, the number of passenger cars in Uzbekistan increased by approximately 11%. As of January 1, 2024, there were 103 cars per 1,000 permanent residents, reflecting an increase of 8 cars compared to the same period in 2023[71].

The adoption of macroprudential measures has significantly dispersed concentration in the car loan market. In 2023, a new regulation was introduced to mitigate the risk of credit concentration, mandating that car loans make up no more than 25% of a commercial bank's loan portfolio. This regulation had a beneficial impact on

[69] O'zbekiston Respublikasi Prezidenti huzuridagi Stastika agentligi. (2023). O'zbekiston Respublikasining sanoat ishlab chiqarishi 2023 yil yanvar-dekabr.

[70] O'zbekiston Respublikasi Prezidentining 2023 yil 16 iyundagi "Aholining yengil avtotransport vositalariga bo'lgan ehtiyojini qondirish bo'yicha qo'shimcha chora-tadbirlar to'g'risida"gi PQ-193–sonli qarori.

[71] O'zbekiston Respublikasi Prezidenti huzuridagi Stastika agentligi. (2024). Stastika agentligi rasmiy telegram kanali.

diversifying the loan portfolios of banks with a significant share of car loans. By the end of 2023, the HHI had dropped by 16% compared to the same period in 2022, settling at approximately 1900. As of January 1, 2024, the number of banks with car loans making up more than 50% of their total loans to individuals has declined. Despite the reduction in concentration, the HHI for car loans remains in the highly concentrated range (HHI>1800).

Figure 129. Concentration in Bank Car Loan Portfolio, HHI

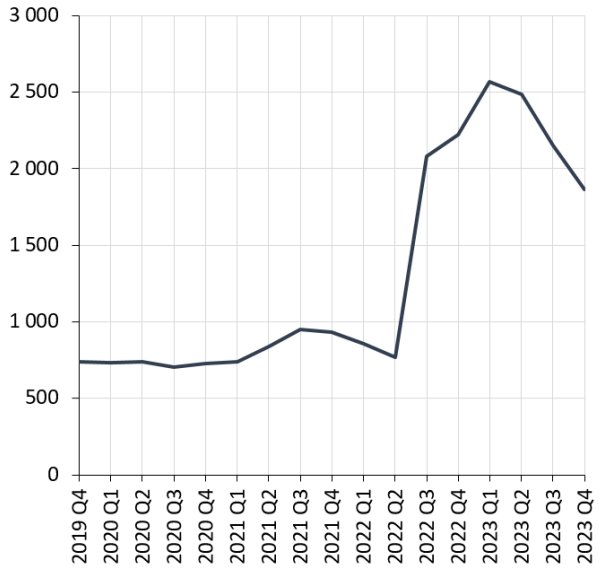
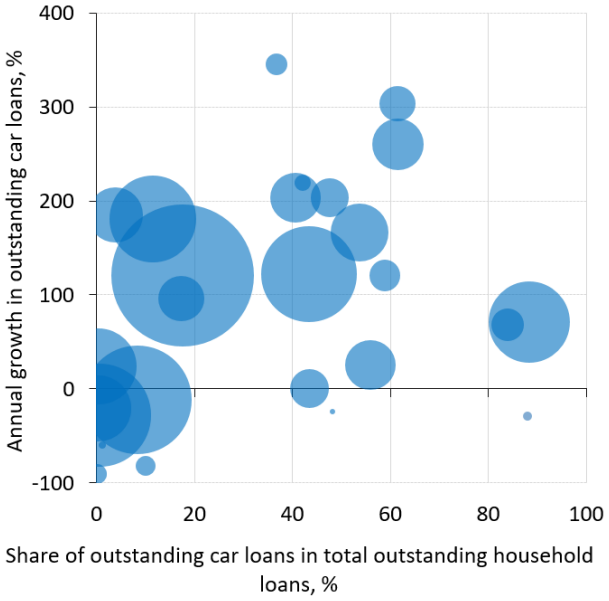


Figure 130. Bank-by-Bank Car Loans Issued to Individuals*, (As of January 1, 2024)



Source: CBU staff calculations.

Note: *The bubble size corresponds to the share of bank assets in the total assets for each respective bank. Banks with an annual growth rate in outstanding car loans exceeding 1,000% are excluded.

The financial stability of the banking system continues to be at risk due to potential challenges in the car market. In 2023, the rapid growth of car loan portfolios increased concerns about potential losses if car prices were to drop sharply. Additionally, the growing share of car loans in portfolios, which constitute a large portion of the banking system's assets, raises systemic risks due to potential uncertainties in the car market. To address these concerns, macroprudential measures[72] have been introduced, enabling banks to set aside provisions for potential car loan losses in the event of a market downturn[73].

[72] A requirement was introduced to determine the risk level of loans allocated to individuals for the purchase of a car based on the ratio of the loan amount to the collateral amount.

[73] O‘zbekiston Respublikasi Markaziy banki boshqaruvining 2023 yil 6 iyundagi “Tijorat banklari kapitalining monandligiga qo‘yiladigan talablar to‘g‘risidagi nizomga o‘zgartirishlar va qo‘shimcha kiritish haqida”gi 14/7–sonli qarori.

V. Macro Stress Test for Banking System

5.1. Macroeconomic Scenarios

The resilience of the banking system was evaluated using a "top-down" macro stress test on solvency[74], based on both baseline and adverse macroeconomic scenarios for the period 2024–2026. The baseline scenario paints a picture of future economic stability, assuming continuity in current trends. Conversely, the adverse scenario incorporates low-probability internal and external shocks—tail risks—with significant potential negative impacts on the banking system. This scenario considers shocks affecting indicators such as real GDP growth, inflation, interest rates, exchange rate, and annual growth in credit stock.

A statistical approach was employed to estimate the real GDP growth rate under the adverse scenario. In the baseline scenario, the projected growth rate significantly surpassed the historical average. To fully reflect the risks in the adverse scenario, a shock of four standard deviations from the baseline GDP growth rate was introduced[75].

The credit portfolio quality and profitability of the banking system for upcoming periods were assessed using satellite models based on macroeconomic scenarios. These models estimated the share of NPLs in total loans, the ratio of net interest income to total interest-bearing assets, and the ratio of net non-interest income to total assets. The estimates were provided for both baseline and adverse scenarios.

In the 2024–2026 credit risk model[76], the share of NPLs is projected to rise to 10% under an adverse scenario. This scenario accounts for slowing economic growth, which negatively impacts the loan portfolio. Lower growth rates lead to reduced borrower incomes, weakening their solvency. Consequently, the increasing debt burden contributes to a higher share of NPLs in total loans.

The forecast for 2024–2026 suggests a decrease in returns on interest-bearing assets across both baseline and adverse scenarios. The model[77], which evaluates the ratio of net interest income to total interest-bearing assets, predicts that lower loan interest rates will likely lead to reduced net interest income for banks. The adverse scenario introduces an additional risk of UZS depreciation, which could exacerbate the impact by increasing NPLs in foreign currencies, thus further constraining net interest income for banks.

In the adverse scenario, a decrease in the net non-interest income-to-total assets ratio is assumed. A reduction in financial transactions, stemming from slowed

[74] The top-down macro stress-test tool is an instrument designed to assess the stability of the banking system based on macroeconomic scenarios. It employs the same scenarios, assumptions, and models for all banks.

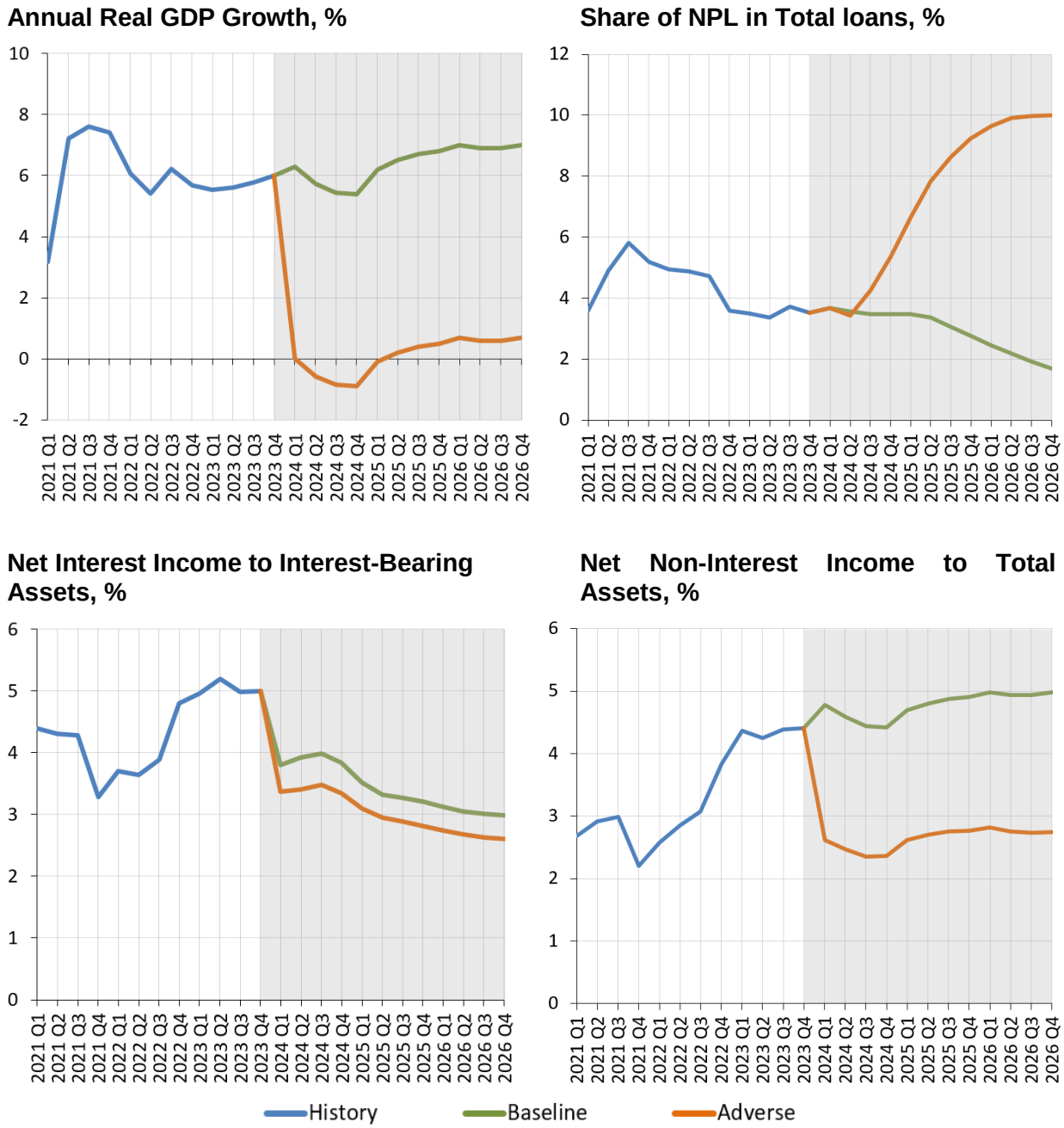
[75] Ding, X., Gross, M., Krznar, I., Laliotis, D., Lipinsky, F., Lukyanstsau, P., & Tressel, T. (2022, April). The Global Bank Stress Test. International Monetary Fund.

[76] The credit risk model projects the share of NPLs by using the NPL value lagged once, GDP growth, and the loan interest rate values based on scenarios.

[77] The model estimating the ratio of net interest income to total bank interest-bearing assets uses the scenario-specific values of loan interest rates and the exchange rate.

economic activity, could negatively impact banks' net non-interest income. The model[78] indicates that a contraction in banking services and commercial activities would likely reduce net non-interest income in the banking sector. However, due to the high proportion of net income earned from foreign currencies, depreciation of the national currency exchange rate would likely boost net non-interest income in this scenario, offering a compensatory effect amid overall negative trends.

Figure 131. Macroeconomic Scenarios[79]



Source: CBU staff calculations.

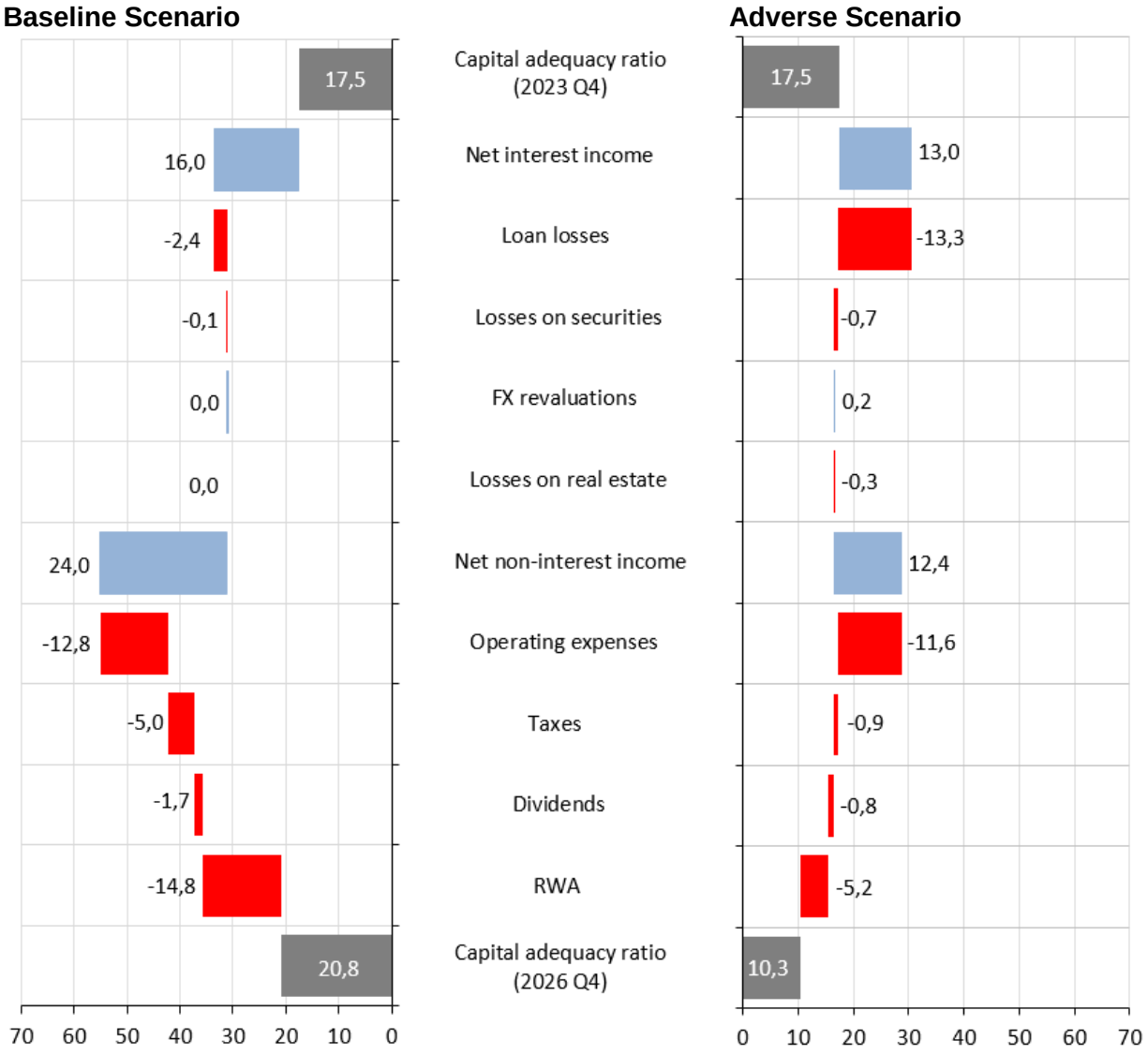
[78] The ratio of net non-interest income to total assets was estimated using the scenario-specific values of GDP growth and the exchange rate.

[79] Macroeconomic scenarios do not constitute forecasts of indicators. The scenarios address high-level risks, known as tail risks, which have a very low probability of occurrence. The tail risks were developed to create adverse scenarios and assess the resilience of banks in Uzbekistan to the shocks.

5.2. Macro Stress Test Results

The macro stress test results for 2024–2026 indicate that Uzbekistan's banking system can withstand macroeconomic shocks under the baseline scenario but would incur significant losses under the adverse scenario. In the baseline scenario, both the CAR and leverage ratio are projected to remain above the required minimums. However, in the adverse scenario, the CAR is expected to decline below the minimum requirement, reaching 10.3%, while the leverage ratio[80] is forecasted to drop to 7.5% by the end of 2026. A downturn in economic activity and a sharp UZS depreciation under the adverse scenario are likely to cause debt-servicing difficulties for foreign currency borrowers, leading to an increase in NPLs and loan losses. This rise in foreign currency NPLs would adversely affect banks' net interest income.

Figure 132. Macro Stress Test Results



Source: CBU staff calculations.

[80] The leverage ratio is a measure that indicates the level of capital adequacy in relation to a bank's total assets. It is calculated as the ratio of Tier 1 capital to the sum of total assets and off-balance-sheet exposures.

The results of the macro stress test under the baseline scenario suggest enhanced resilience for the banking system, with the CAR potentially rising to 20.8% by the end of 2026. Nonetheless, some small banks may struggle to meet minimum capital requirements. These banks are expected to constitute 8% of the banking system's assets, indicating a low probability of systemic risks due to their financial instability.

Figure 133. CAR of Banking Sector in Baseline and Adverse Scenarios, %

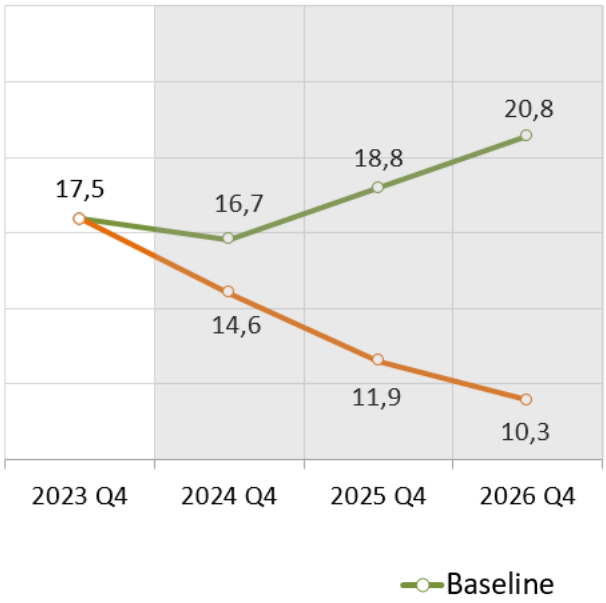
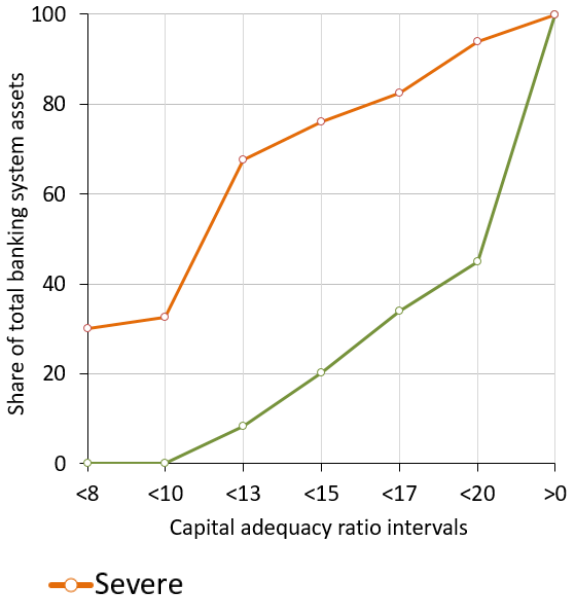


Figure 134. Distribution of Banking Sector's CAR Intervals and Shares in Total Assets, %

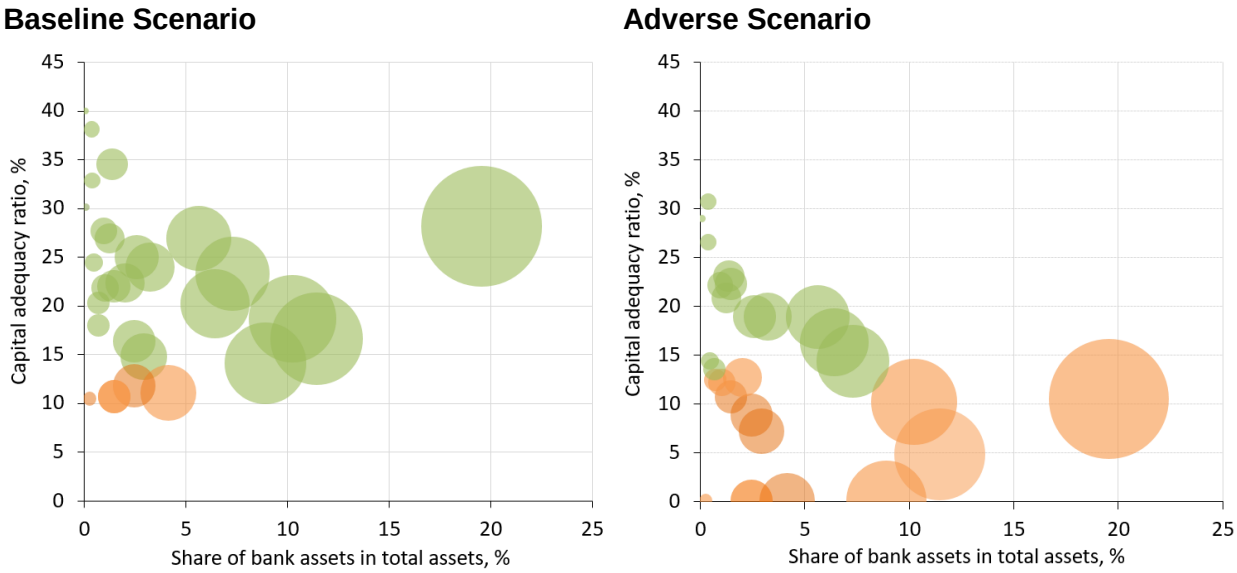


Source: CBU staff calculations.

Note: The cumulative order is used to set the shares of total assets of banks located within specific CAR intervals.

In the adverse scenario, certain large banks may fail to meet CAR requirements. By the end of 2026, these banks could represent 68% of the system's total assets. Losses in a few major banks, due to macroeconomic shocks in this scenario, could lead to structural systemic risks in the banking system.

Figure 135. Bank-by-Bank Macro Stress Test Results



Source: CBU staff calculation.

Note: The graph presents data on banks, each depicted by a bubble, showing their capital adequacy ratio within the 0–45% range. The bubble size for each bank is proportional to its asset share in the total assets of the banking system. Banks are color-coded: a green bubble denotes a bank that satisfies the minimum capital adequacy requirement of 13%, whereas a light red bubble represents a bank that falls short of this threshold.

In the adverse scenario, the leverage ratio of the banking system is anticipated to decrease, though it is expected to remain above the established minimum requirement of 6%. By the end of 2026, the baseline scenario predicts that the banking system's net income will grow significantly, which will increase Tier 1 capital. Consequently, despite an increase in total assets, the capitalization of bank assets will remain well above the minimum required level. In the adverse scenario, slower economic growth and lower loan interest rates will reduce interest income and raise operating expenses, which will hurt the banking system's net profit. This will likely cause the leverage ratio to drop, as retained earnings will grow more slowly than total assets.

Figure 136. Leverage Ratio of Banking Sector in Baseline and Adverse Scenarios, %

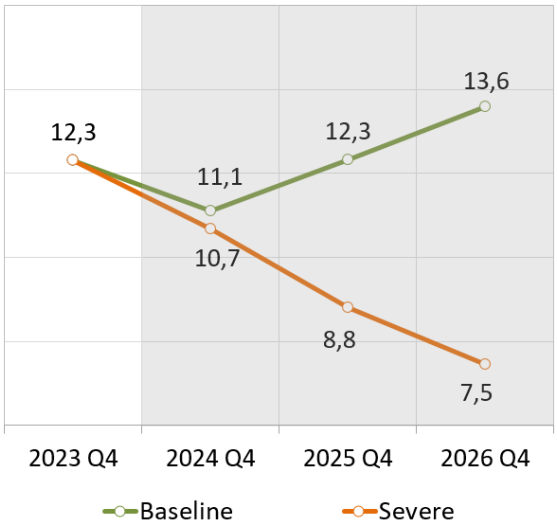
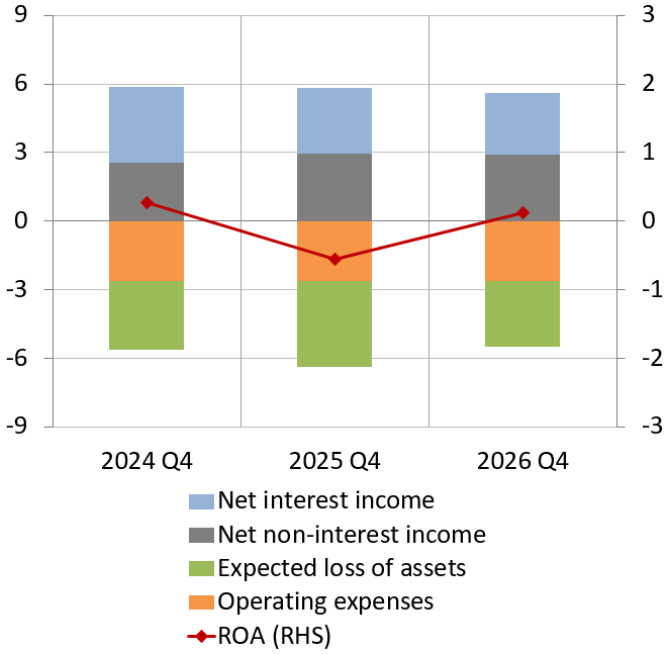


Figure 137. Banking Sector ROA in Adverse Scenario, %



Source: CBU staff calculation.

Under the adverse scenario, slower economic growth and reduced loan interest rates are expected to negatively impact banks' ROA. Projections for 2024 and 2025 indicate ROA levels of 0.3% and -0.6%, respectively, with an improvement to 0.1% in 2026. Additionally, banks are likely to experience increased expected asset losses and reduced net interest income. However, despite declining net interest income, the alignment of operating expenses with total assets and a modest improvement in loan portfolio quality by the end of the period could help reduce expected asset losses. This may result in a slight recovery in ROA by the end of 2026.

5.3. Contagion Risk

In the adverse scenario, contagion risk is evaluated using the losses-tied-to-capital[81] and unrecoverable-losses[82] approaches. This risk arises when the failure of one or more banks, precipitated by various shocks, adversely impacts other banks through the interconnected financial relationships in the banking system. Banks with CAR below the minimum requirement are more prone to default and may be unable to meet their obligations to other institutions. Consequently, financial difficulties in some

[81] In the approach, where losses from bank defaults are tied to capital, the extent of banks' losses from contagion risk is influenced by the defaulting bank's capital adequacy ratio. The lower the failing bank's capital adequacy ratio, the greater the proportional losses incurred by banks that have financial connections with it, such as those that have provided loans to or placed deposits with the defaulting bank.

[82] In the approach, where losses from bank defaults are not recoverable, banks face the loss of all their loans to or deposits placed with a bank with a high probability of default, i.e., a bank with the capital adequacy ratio below the required minimum.

banks can result in losses for others that have extended loans or deposits to them, potentially leading to systemic risks in the banking system.

The losses-tied-to-capital approach suggests a contagion risk of bank defaults affecting other banks. Under the adverse scenario, an increase in the number of banks with a CAR below 13% would result in higher liabilities owed by these banks to others. Consequently, this scenario leads to losses in other banks, proportional to the CAR of the potentially defaulting banks. As a result, two banks would struggle to meet their minimum capital requirements. Notably, by the end of 2023, interbank liabilities accounted for 3.6% of total bank assets, indicating a relatively low level of financial interdependence among banks.

Figure 138. Contagion Risk: Bank Default Losses Tied to Capital (Approach 1)

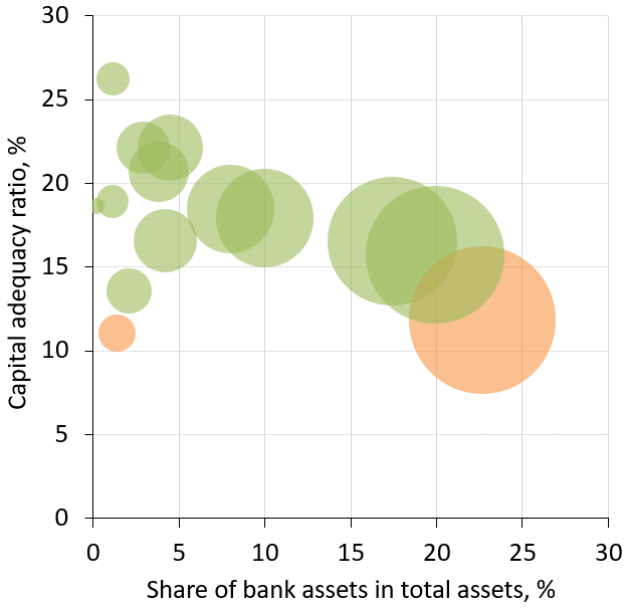
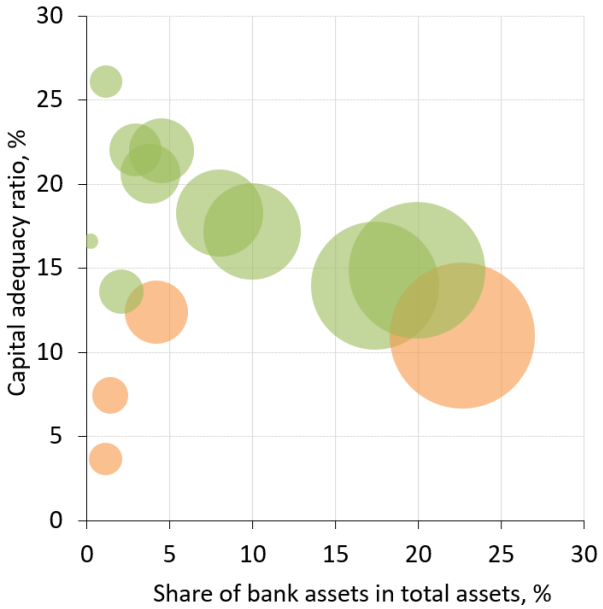


Figure 139. Contagion Risk: Unrecoverable Bank Default Losses (Approach 2)



Source: CBU staff calculations.

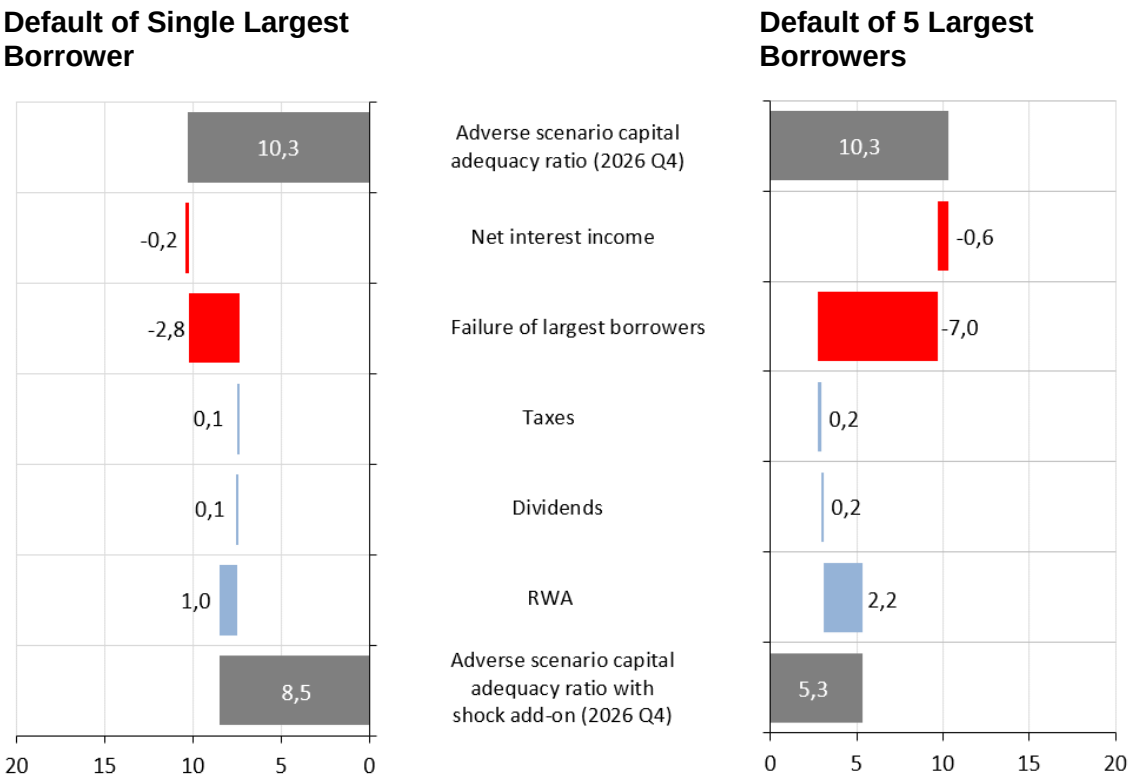
Note: The graph presents an analysis of various banks, categorized based on three criteria: those with a CAR below 30%, those with liabilities to other banks, and those that meet the minimum capital adequacy requirement of 13% under the adverse scenario. Each bank is represented by a bubble, the size of which indicates its proportion of interbank liabilities relative to the total interbank liabilities. Banks that comply with the minimum capital adequacy requirement are denoted by green bubbles, whereas light red bubbles indicate banks that fail to meet this threshold.

In the unrecoverable-losses approach, contagion risk may drive the CAR of some banks below the required minimum. Under the adverse scenario, the default of banks with CAR below the required minimum could lead to non-repayment of their debt obligations to other banks, triggering losses across the banking system. However, since the obligations of some banks that fail to meet the minimum capital requirements after this contagion risk are negligibly small, other banks are unlikely to face challenges in meeting their capital adequacy requirements.

5.4. Additional Shocks under Adverse Scenario

In the adverse scenario, the banking system's CAR could drop below the minimum requirement even without additional shocks. To assess systemic risk, extra shocks were added, such as high concentration risk and a steep fall in asset prices. By the end of 2026, high concentration risks and a potential 40% drop in asset prices under the adverse scenario could result in banks failing to meet the minimum capital adequacy requirement.

Figure 140. Macro Stress Test Results with Concentration Risk, %



Source: CBU staff calculation.

The default of borrowers holding a significant share of a bank's loan portfolio can lead to substantial loan losses, potentially causing the banking system's capital adequacy ratio to drop below the minimum requirement. By the end of 2026, the default of either the single largest borrower or the top five borrowers at each bank could reduce the capital adequacy ratio to 8.5% and 5.3%, respectively. It is assumed that the loss-given default (LGD) would be 50%, implying that half of the outstanding loans would be unrecoverable due to these borrowers' default.

To assess the potential impact of a drastic fall in housing prices on the banking system's stability, an additional shock was introduced in the adverse scenario. The potential impact on loan portfolio quality was evaluated based on 2023 data across three scenarios: 20%, 30%, and 40% declines in asset prices. The analysis included the rise in LTV ratios caused by the lower market value of properties serving as collateral

for mortgage and car loans. In this sub-scenario, it was assumed that if the LTV ratio exceeds 120% due to a steep decline in house prices, borrowers would forfeit their collateral and default on their mortgage loans.

Figure 141. LTV Distribution of Mortgages after House Price Shocks, 2023

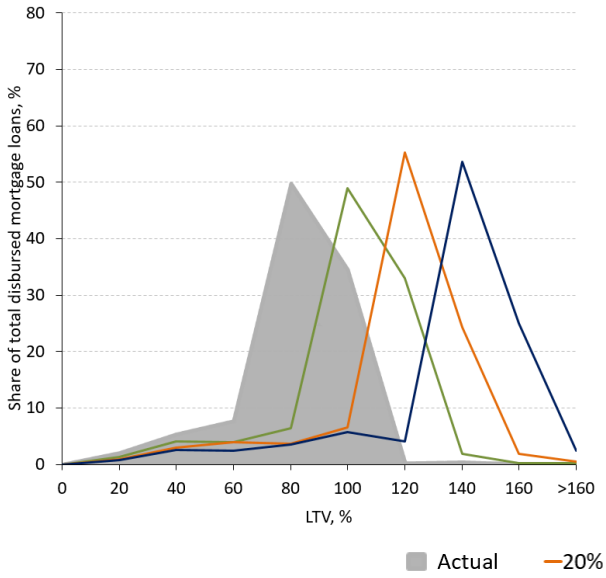
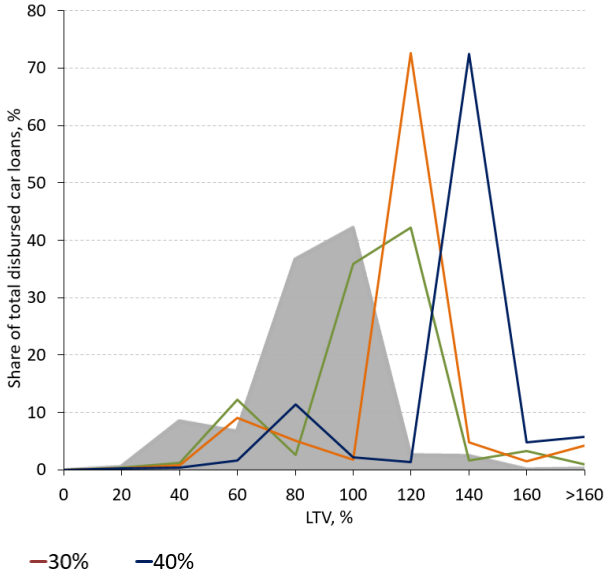


Figure 142. LTV Distribution of Car Loans after Car Price Shocks, 2023



Source: CBU staff calculation.

Note: The numbers displayed on the horizontal axis, along with the preceding number, indicate the upper and lower boundaries of the LTV distribution range.

A 20% drop in house prices is unlikely to significantly affect banks' asset quality. Loans with an LTV ratio above 120% represent just 2% of total mortgage loans, indicating that most are well-collateralized.

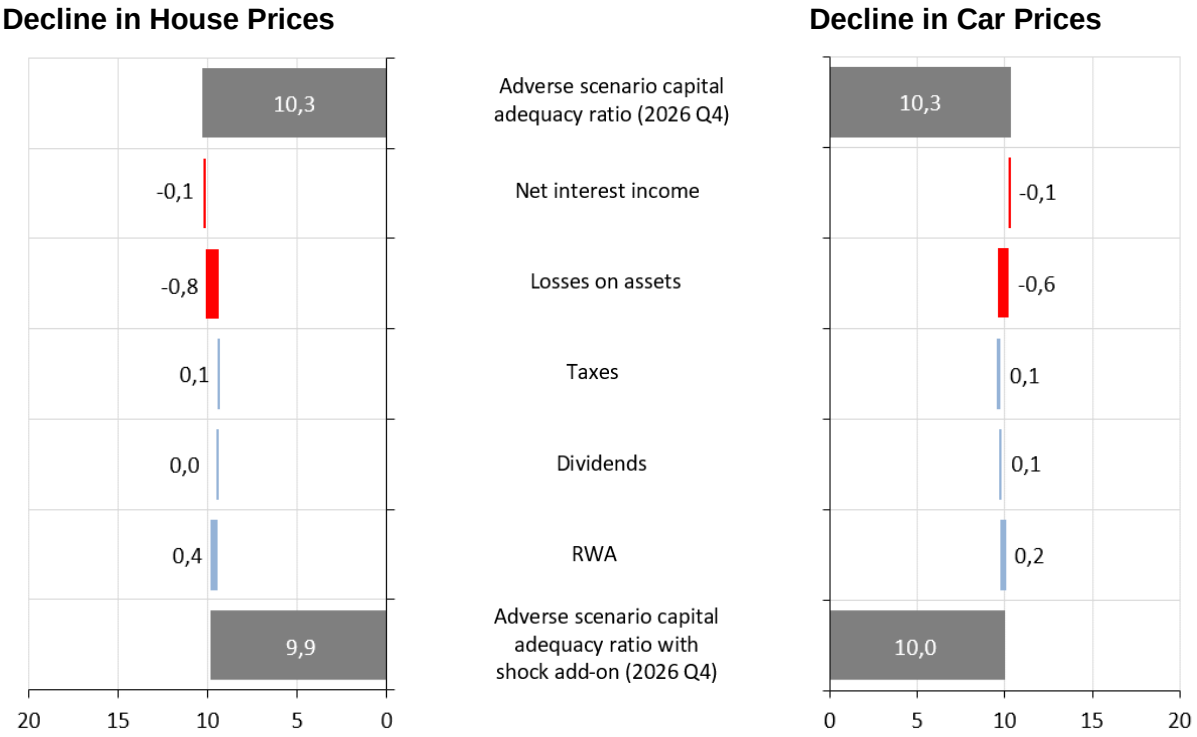
Uzbekistan's banking sector would withstand a 30% drop in housing prices to fundamental levels. However, 82% of the mortgage loans issued in 2023 would lack adequate collateral. Consequently, the share of NPLs in total loans could reach 4.5% by the end of 2024.

A 40% decrease in housing prices would pose a considerable threat to the banking system's stability. This decline would result in 81% of mortgage loans having an LTV ratio above 120%, suggesting that a significant portion of borrowers might prioritize foreclosure over repayment. As a result, credit risk would escalate notably. By the end of 2024, this housing price reduction could increase the share of NPLs in total loans to 6.4%.

A 20% decrease in car prices would likely exert a negligible influence on the credit portfolio quality of banks. In this context, the share of car loans with an LTV ratio greater than 100% and 120% in car loans issued in 2023 stood at 48% and 6%, respectively. Additionally, a 20% decline in car prices could result in nearly half of the car loans being inadequately collateralized.

A reduction of 30 to 40% in car prices would substantially negatively affect the banks' asset quality. In the event of price decreases by 30 and 40%, 83 and 84% of the car loans issued in 2023, respectively, would be left with insufficient collateral. Furthermore, the proportion of car loans with an LTV ratio exceeding 120% stands at 11% when car prices fall by 30%, and 83% when the drop is 40%. This suggests that borrowers are more likely to surrender the collateral to the bank rather than repay the loans, given that the loan amount significantly exceeds the value of the car. Consequently, by the end of 2023, the car market's 30 and 40% price reductions may result in an increase in the share of NPLs in total loans to 5 and 10%, respectively.

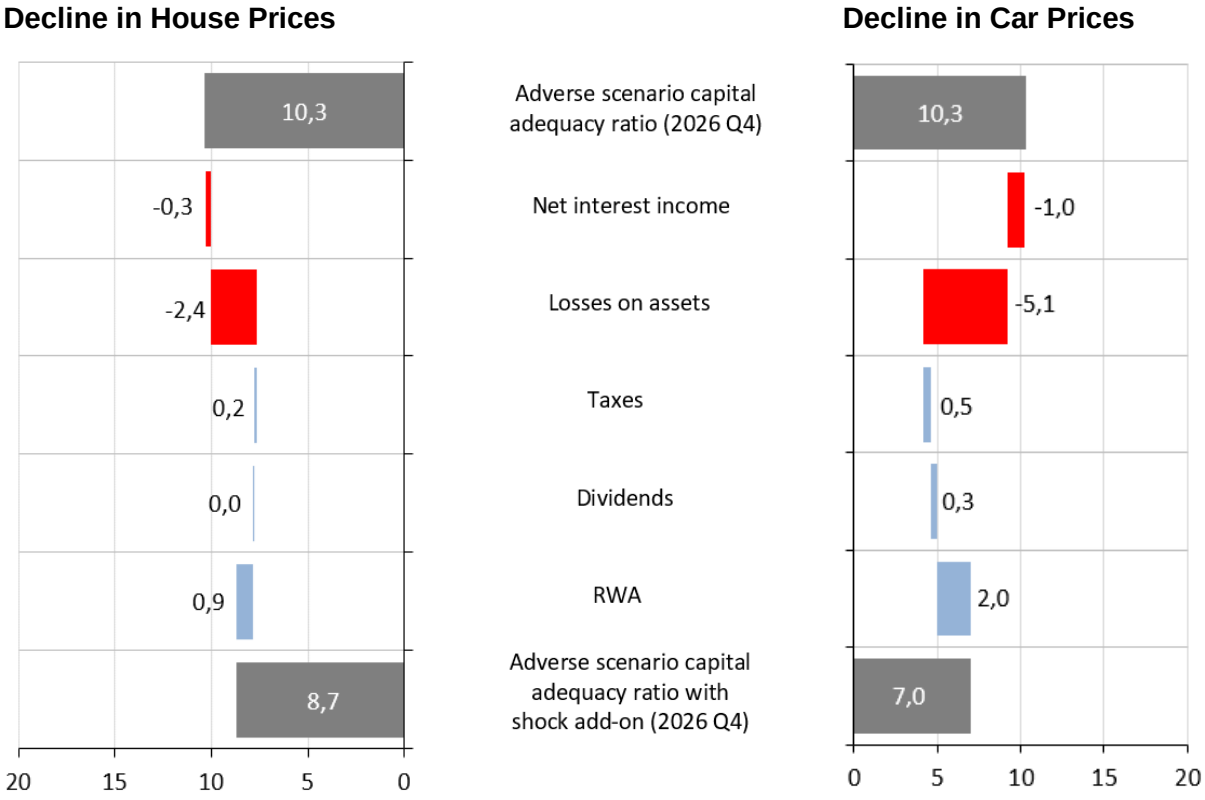
Figure 143. Macro Stress Test Results with 30% Decline in Asset Market Prices, %



Source: Central Bank calculation.

A 30% decline in asset market prices would reduce the banking system's CAR below the minimum requirement. By the end of 2026, a similar 30% decline in house prices could raise the share of NPLs in the total individual loan portfolio to 11%, while the CAR of the banking system could drop to 9.9%. Likewise, a 30% drop in car prices would also significantly impact car loans, reducing the CAR to 10%.

Figure 144. Macro Stress Test Results with 40% Decline in Asset Market Prices, %



Source: Central Bank calculation.

A 40% reduction in asset prices would significantly lower the banking system's CAR below the minimum requirement. By the end of 2026, a 40% drop in housing and car prices could push individual NPLs to 17% and 29%, respectively. Consequently, increased loan losses in both shocks could reduce the CAR to 8.7% and 7%, respectively.

VI. Climate Change Risks

Climate change risks are intensifying worldwide. High levels of greenhouse gas emissions are significantly reducing countries' chances of achieving the Paris Agreement's[83] core objectives[84]. As a result, transition risks are increasing as governments advance initiatives to transition to a low-carbon economy.

The climate change dashboard has been designed to assess the implications of climate change risks for financial stability in Uzbekistan. The dashboard incorporates three key components: economic activities, mobilization, and climate-related risks (Appendix 9).

The dashboard highlights that Uzbekistan will likely experience moderate risks from climate change. Transition risks[85] stemming from the swift move to a low-carbon economy could impact key sectors like agriculture, energy, and industry. Moreover, physical risks[86] like increasing air temperatures, water shortages, salinization, and the desertification of cultivated land could emerge. In 2022, Uzbekistan emitted nearly 224 million metric tons of CO_2 equivalent, accounting for 27% of the total greenhouse gas emissions in CCA countries.

Figure 145. Total Greenhouse Gas Emissions in CCA Countries, 2022 (in million tons of CO_2 equivalent)

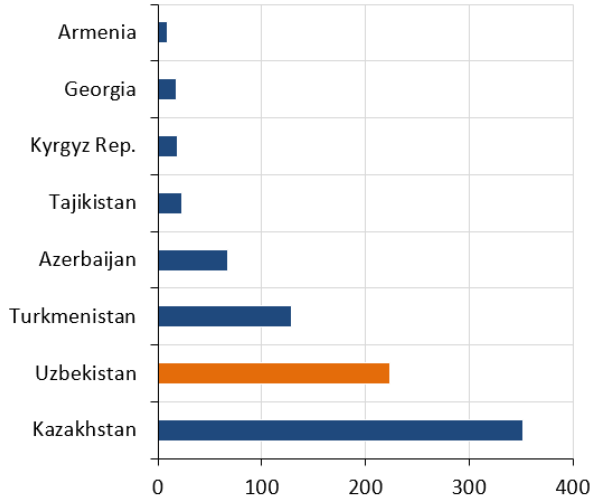
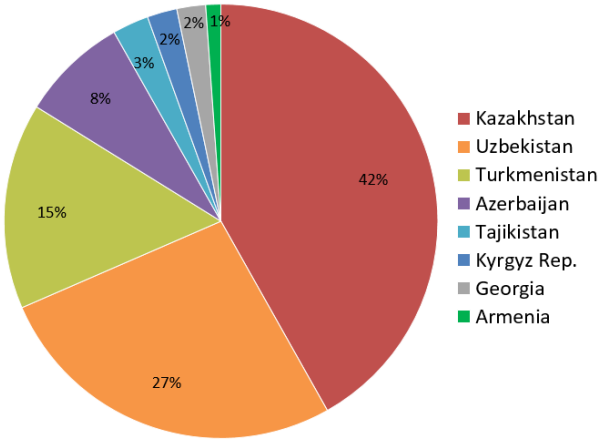


Figure 146. Distribution of Total Greenhouse Gas Emissions by CCA Countries, 2022



Sources: IMF and CBU staff calculations.

[83] The main goal of the Paris Agreement is to reduce the risks of climate change by 2100 by keeping global temperature rise well below 2ºC above the pre-industrial (1850–1900) average temperature and to limit the increase in temperature to 1.5ºC.

[84] United Nations Environment Programme. (2023, November). Emissions Gap Report 2023: Broken Record.

[85] Transition risks are related to the process of adaptation to a low-carbon economy. During such an adjustment, changes in climate change mitigation and adaptation policies can affect the value of financial assets and liabilities.

[86] Physical risks are the economic costs due to the intensification of climate-related extreme weather events, which can reduce the value of financial assets or increase liabilities.

The ND-GAIN Index[87] indicates that Uzbekistan maintains a notable level of tolerance to climate change risks. The rise in this index reflects an improvement in the country's resilience to potential challenges, which surpasses the growth in its climate vulnerability. Uzbekistan's index is above the global median, indicating greater resistance to climate risks compared to most countries.

Figure 147. ND-GAIN Index

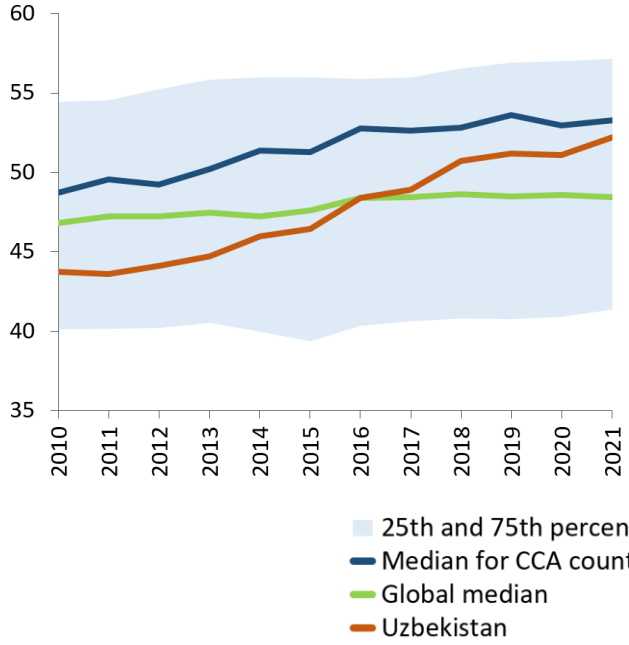
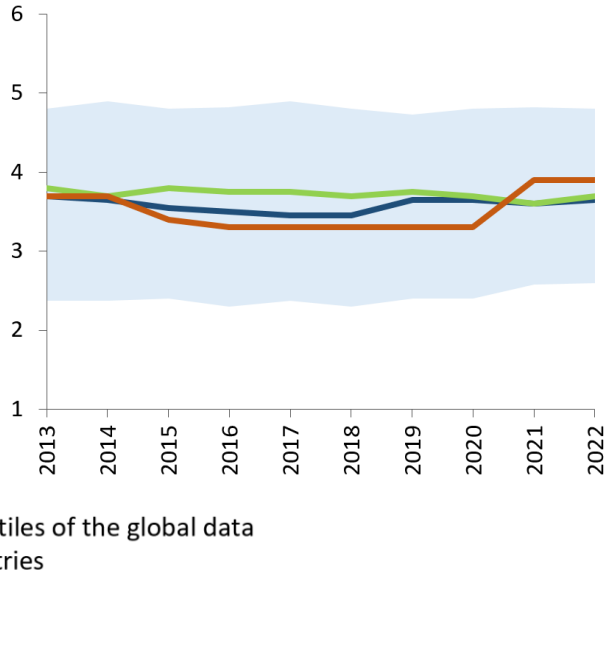
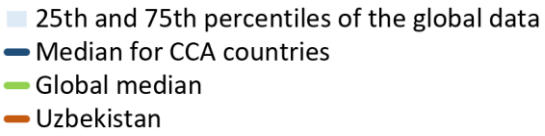


Figure 148. Climate-driven INFORM Risk Indicator





Sources: IMF, University of Notre Dame and CBU staff calculations.

Note: The ND-GAIN Index assesses the susceptibility of 192 countries to climate change and various global challenges, alongside their readiness to enhance resilience against these challenges. A lower index score indicates a country's vulnerability to climate change and related issues, whereas a higher score denotes relative resilience. Essentially, the index inversely reflects a country's vulnerability to climate change and similar threats, and directly correlates with its preparedness to bolster its defenses against these challenges.

The climate-driven INFORM risk indicator, covering 188 countries, measures three key aspects: exposure to climate risks, vulnerability to these risks, and lack of resilience. Adapted from the INFORM Risk Index by IMF staff to focus exclusively on climate-related factors, the indicator reflects the interplay between risk levels and tolerance. Higher exposure and reduced tolerance result in higher index values, while lower risks and improved tolerance produce lower scores. This index uses a 0–10 scale, with medium risk categorized between 3.2 and 4.9.

[87] The Notre Dame Global Adaptation Initiative (ND-GAIN) index measures a country's susceptibility to climate change and other global challenges, as well as its capacity to mitigate these challenges' effects. This calculation assesses the vulnerability of a nation across six crucial sectors: food, water, health, ecosystem services, human habitats, and infrastructure. It evaluates the extent to which the country is exposed to climate change, the sector's sensitivity to climate change, and the society's adaptive capacity to address climate change-induced issues. A country's preparedness for climate change is gauged by its effectiveness in directing investments towards climate change adaptation. The ND-GAIN index evaluates a country's readiness for climate change through three key components: economic, governance, and social.

The climate-driven INFORM risk indicator reveals that the level of risks associated with climate change in Uzbekistan is classified as medium. By the end of 2022, this risk indicator for Uzbekistan exceeded both the median values for CCA countries and the global median. Specifically, the slightly elevated value of the risk indicator in 2022 suggested that climate change-related risks could potentially have a negative impact on the country's economy.

Figure 149. Greenhouse Gas Emissions Across Economic Sectors in Uzbekistan (in million tons of CO_2 equivalent)

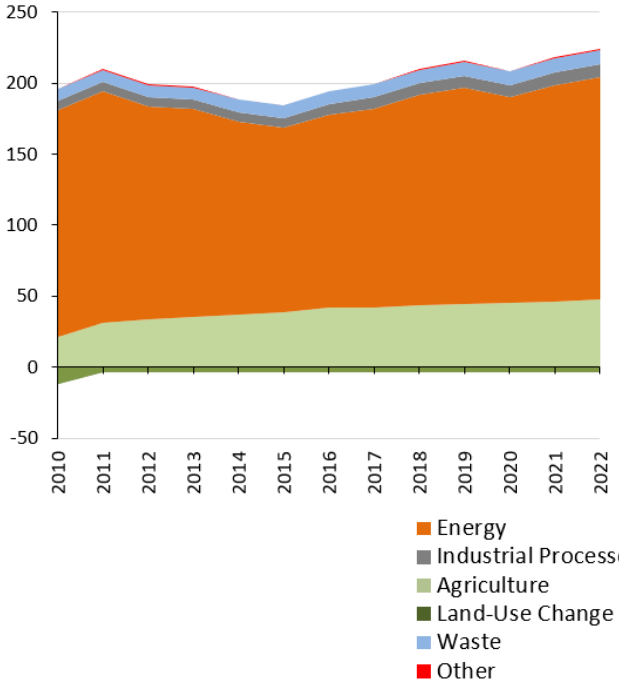
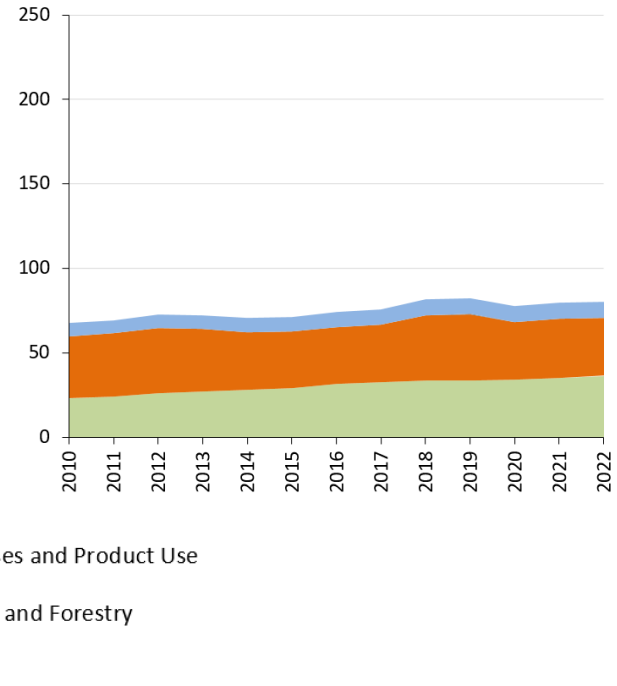
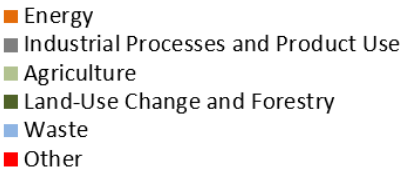


Figure 150. Methane Emissions Across Economic Sectors in Uzbekistan (in million tons of CO_2 equivalent)





Source: IMF.

Note: The most recent data available is from 2022, as data publication occurs on a 1–2-year cycle.

An assessment of climate change transition risks indicates a moderate level of impact on significant sectors of the Uzbek economy. Policy and technological changes toward a low-carbon economy may increase costs for enterprises and affect their financial health. The energy and agricultural sectors, which have relatively high greenhouse gas and methane emissions, are particularly vulnerable. By late 2021, these sectors accounted for approximately 70% and 23% of total emissions, respectively.

Figure 151. Distribution of Total Electricity Consumption by Sectors, %

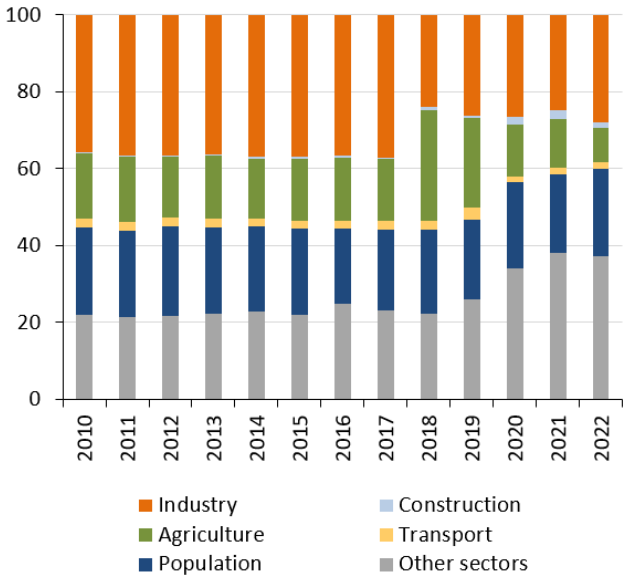
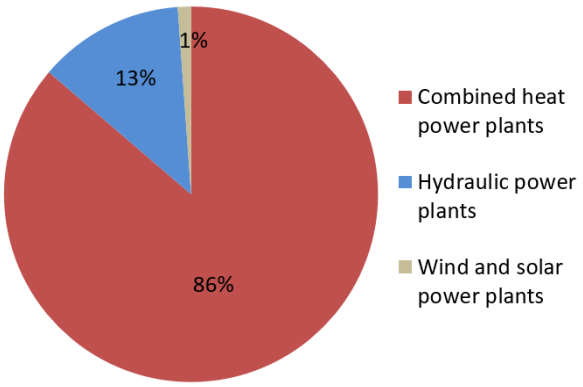


Figure 152. Composition of Electricity Production Capacity by Sources, 2022



Sources: Statistics Agency and CBU staff calculations.

Climate change poses physical risks that can lead to economic losses. In Uzbekistan, these risks include rising temperatures, water shortages, and land degradation[88]. The World Bank estimates that natural disasters cause 92 million USD in annual economic losses (0.2% of GDP)[89]. A rise in physical risks can increase banks' credit risk by reducing asset values used as loan collateral and weakening borrowers' solvency.

Rising air temperatures in Uzbekistan may heighten physical risks. In 2022, the average temperature was 2.4°C above the 1951–1980 average. Forecasts suggest that under a high greenhouse gas concentration scenario (SSP5-8.5)[90], the median air temperature will reach 15.8°C by 2050, with over one-third of the year experiencing temperatures[91] above 30°C[92]. This sharp increase could trigger more landslides,

[88] Land degradation refers to the reduction or loss of the biological and economic productivity of land due to natural factors (such as drought, relief features, excess precipitation, floods, strong winds, natural fires, and swamping) and anthropogenic factors (such as mining, construction of engineering communications, artificial fires, improper animal husbandry and agriculture, inefficient irrigation, deforestation, urban expansion, etc.).

[89] World Bank. (2023, November). Country Climate and Development Report: Uzbekistan.

[90] Shared Socioeconomic Pathways (SSPs) are comprised of five distinct scenarios, each reflecting varying changes in socio-economic factors such as population, economic growth, education, urbanization, and technological development through the end of the 21st century. These scenarios include: SSP1 (Sustainability), which envisions a world embracing sustainability and green initiatives; SSP2 (Middle of the Road), where social, economic, and technological trends continue along a trajectory similar to current patterns; SSP3 (Regional Rivalry), where nationalism drives policy and focus is placed on regional and local issues rather than global issues; SSP4 (Inequality) is characterized by reduced investment in human capital and increasing economic disparities between nations, leading to heightened economic inequality; and SSP5 (Fossil-fueled Development), which leans towards development fueled by non-renewable energy sources. These scenarios serve as a foundation for developing climate change projections using Integrated Assessment Models (IAMs).

[91] This pertains to days when the daily air temperature exceeds 30℃.

[92] World Bank Climate Change Knowledge Portal | Uzbekistan.

accelerate glacier melt, and reduce drinking water availability. Furthermore, economic productivity may decline by 2–3.5% by 2050 due to rising temperatures[93].

Figure 153. Average Annual Air Temperature Change with Respect to a Baseline Climatology* in Uzbekistan, ºC

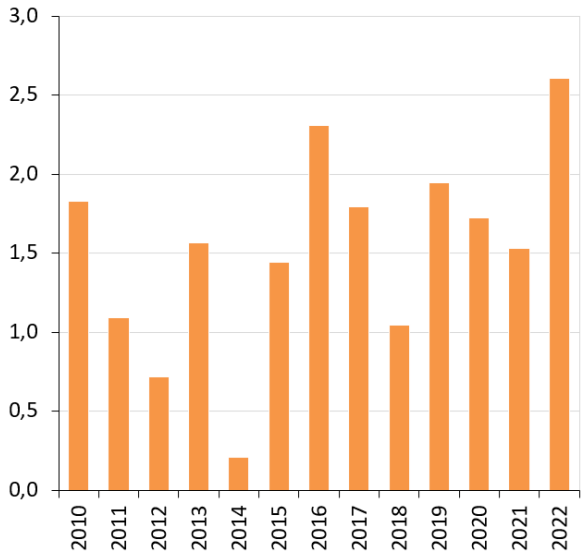
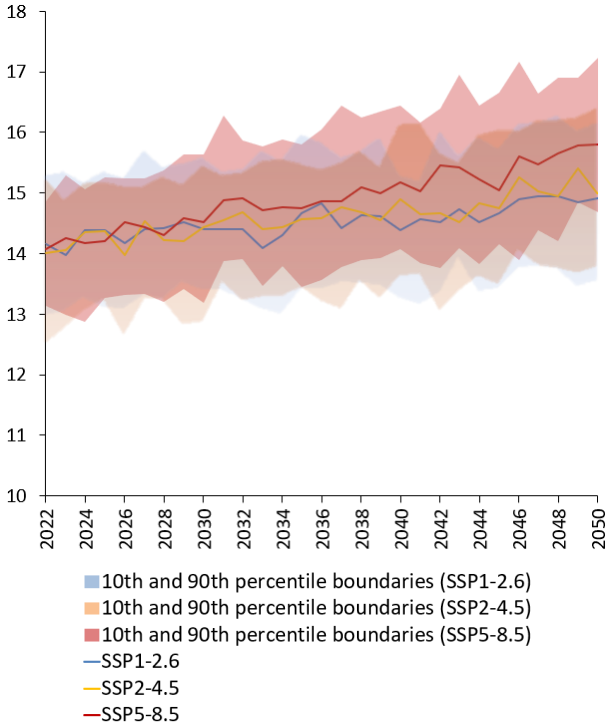


Figure 154. Air Temperature Scenarios (Average Annual Air Temperature), °C



Sources: IMF and World Bank.

Note: *The average air temperature from the period 1951–1980 is used as the baseline value. Elevated average air temperatures negatively impact the economy.

Water shortages driven by climate change may lead to losses in Uzbekistan's agricultural sector. The World Bank estimates that by 2050, water availability in some catchments will decline by 30–40%, while irrigation demand will rise by 25%. As a result, the annual water deficit is expected to reach 7 billion cubic meters by 2030 and 15 billion cubic meters by 2050[94]. Higher temperatures, land degradation, and worsening water scarcity could reduce agricultural productivity. Given agriculture's 23%[95] share of GDP in 2023 and its 10%[96] share in the total credit portfolio by the end of 2023, the sector's risks are likely to have a moderate effect on Uzbekistan's financial stability.

[93] World Bank. (2023, November). Country Climate and Development Report: Uzbekistan.

[94] World Bank. (2023, November). Country Climate and Development Report: Uzbekistan.

[95] Statistics Agency under the President of the Republic of Uzbekistan. (2024). National accounts, quarterly.

[96] Central Bank of Uzbekistan. (2024). Statistical bulletin for 2023.

VII. Pathways to Strengthen Macroprudential Policy Frameworks

7.1. Necessity and Mechanisms for the Introduction of a Countercyclical Capital Buffer

The introduction of a countercyclical capital buffer (CCyB) in Uzbekistan is essential. Core and additional indicators used to assess the need for such a buffer reveal increasing financial vulnerabilities, justifying capital buffer requirements. Furthermore, the financial cycle index suggests that implementing this measure is particularly critical during the current financial crisis, especially as risk levels have not significantly shifted. Macro stress tests and historical loss analyses further confirm that positive capital buffers are essential for maintaining the stability of the banking system.

Future macroprudential measures will include the introduction of a positive CCyB to reinforce the banking sector's stability against various shocks. Analyses of the necessary capital buffer requirements for ensuring the stable functioning of Uzbekistan's banking system indicate that a capital buffer of 5.6% of risk-weighted assets is required. This figure represents the total capital buffer needed and ensures alignment with other macroprudential capital buffer requirements when determining the appropriate level of the CCyB. In this context, the CCyB strengthens banks' resilience and provides additional high-quality capital to mitigate financial cycle-related risks and unforeseen shocks.

The regulatory capital required for RWA in Uzbekistan aligns with the total capital burden outlined in the Basel III standards. According to Basel III, a bank's total CAR should be at least 8%, the capital conservation buffer (CCoB) should be 2.5%, and CCyB should be up to 2.5%. Considering the current stability of Uzbekistan's banking system and the additional capital buffer requirements recommended by Basel III, CAR has been set at 13%[97]. As of January 1, 2024, financial stability indicators in Uzbekistan's banking system remain at a stable level. In particular, commercial banks fully comply with the minimum capital requirements set by the CBU (see Appendix 10).

The CCyB is an effective macroprudential tool for enhancing banks' resilience to cyclical systemic risks. To strengthen banks' capital in both quantity and quality, Basel III standards recommend implementing CCoB and CCyB composed of high-quality capital[98]. The CCyB helps mitigate losses during financial downturns, ensures the continuity of lending to the real economy, and enhances the banking system's tolerance to systemic risks that accumulate during periods of excessive credit growth. CCyB can be formed in the form of Tier 1 capital and be in the range of 0–2.5% of RWA (see Appendix 11).

[97] O'zbekiston Respublikasi Markaziy banki boshqaruvining 2021 yil 11 yanvardagi "Tijorat banklari kapitalining monandligiga qo'yiladigan talablar to'g'risidagi nizomga o'zgartirish va qo'shimchalar kiritish haqida"gi 28/22–sonli qarori.

[98] Basel Committee on Banking Supervision. (2010, December). Basel III: A global regulatory framework for more resilient banks and banking systems.

The CBU routinely evaluates the appropriate CCyB rate. Given that banks need sufficient time to accommodate additional capital requirements and develop capital plans, international best practices recommend that any decision by the competent authority to raise the buffer be enforced up to 12 months after its announcement. To support a steady flow of credit during the downturn of the financial cycle, any decision to reduce or eliminate this buffer requirement will take effect immediately upon announcement[99] (see Appendix 12).

Recent crises highlight the need for a positive neutral CCyB to strengthen the banking system's resilience to unexpected economic downturns. This approach aims to accumulate sufficient capital during financial cycle booms before serious shocks threaten stability. Given the complexity of assessing cyclical systemic risks and the impact of data lags, the adoption of such a buffer is increasingly necessary. Additionally, ensuring banks hold high-quality capital is crucial in addressing non-financial cycle shocks, including pandemics, climate change risks, and geopolitical tensions[100].

The adoption of a positive neutral CCyB at moderate risk levels is becoming increasingly common. The United Kingdom pioneered this approach by establishing a CCyB with a positive neutral rate. In 2016, the Bank of England set this rate at 1% of risk-adjusted assets, acknowledging the inherent challenges of systemic risk assessment and rising financial risks. Following this precedent, Australia (1%)[101], the Netherlands (2%)[102], Sweden (2%)[103], Estonia (1%)[104] and Georgia (1%)[105] have implemented similar policies. This positive neutral CCyB serves as a tool that can be partially or fully released in response to cyclical systemic risks or unexpected financial disturbances.

A sectoral CCyB is a macroprudential tool designed to address vulnerabilities in a specific sector. The Basel III CCyB is determined based on the total amount of RWA. Unlike general macroprudential tools, the sectoral CCyB directly addresses risks in a particular sector, making it more targeted and flexible.

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[99] Basel Committee on Banking Supervision. (2010, December). Guidance for national authorities operating the countercyclical capital buffer.

[100] Eesti Pank. (2021). Financial Stability Review. 2/2021.

Under this approach, the total level of the countercyclical capital buffer is found by the following formula:

$$CCyB_{general} = CCyB_{main} + CCyB_{periodic}$$

Here,

$CCyB_{main}$ – a constant positive buffer level that is established under conditions of moderate systemic risks;

$CCyB_{periodic}$ – a buffer rate that is set according to the boom or bust periods of the financial cycle.

[101] Australian Prudential Regulation Authority. (2021, November). An Unquestionably Strong Framework for Bank Capital. Information Paper.

[102] De Nederlandsche Bank. (2022, February). Analytical framework for setting the Countercyclical Capital Buffer in the Netherlands.

[103] Finansinspektionen. (2021). Finansinspektionen's approach to setting the countercyclical capital buffer.

[104] Eesti Pank. (2021). Financial Stability Review 2/2021.

[105] National Bank of Georgia. (2023, March). Financial Stability Committee's Decision.

The financial cycle index is a valuable tool for analyzing economic fluctuations in a country. In particular, it facilitates an assessment of the country's current financial condition through a combination of comprehensive indicators that reflect changes in the financial system. One key measure used in financial cycle analysis is the deviation of the credit-to-GDP ratio from its long-term trend[106]. However, as no single indicator can provide a complete evaluation of the financial condition, many countries employ a multi-indicator approach to identify financial cycle phases more effectively.

Figure 155. CCyB Rate During Financial Cycle Phases

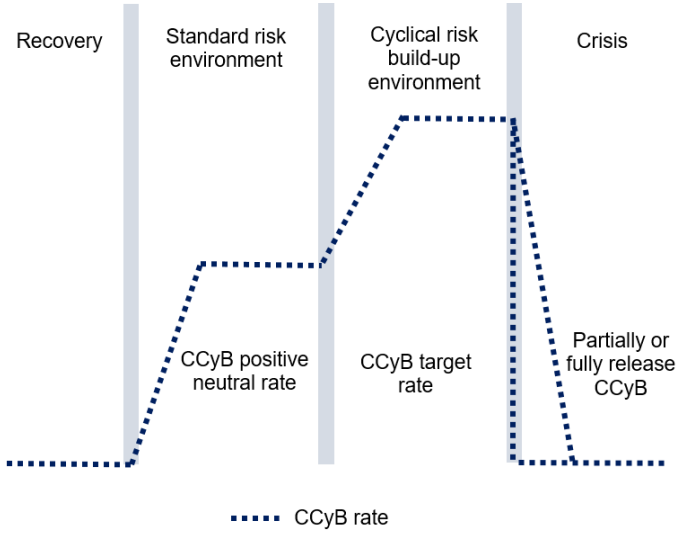


Figure 156. Uzbekistan's Financial Cycle Index

Sources: European Central Bank and CBU staff calculations.

Note: An increase in the financial cycle index signals a period of economic growth, while a decrease indicates economic contraction.

Uzbekistan's Financial Cycle Index indicates the need for implementing a CCyB. The expansion and contraction phases of the financial cycle are determined using quantitative indicators of cyclical systemic risks. The index suggests that the country is in a period of financial stability, necessitating additional capital accumulation by banks to mitigate future economic risks. The CBU aims to increase the CCyB rate during expansion and lower it during contraction to support new lending to the real economy.

[106] European Systemic Risk Board. (2014). Recommendations.

Table 1. Core and Additional Indicators for CCyB Activation

	Indicators	2019				2020				2021				2022				2023			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Core	Credit to private sector-to-GDP gap																				
Additional	Growth in credit-to-GDP ratio																				
	Total credit growth (YoY)																				
	GDP growth (YoY)																				
	Real house prices																				
	Leverage ratio																				
	CAB (percent of GDP)																				
	Tier 1 capital-to-RWA ratio																				
	Household DSR																				

Source: CBU staff calculation.

Note: A shift from green to red indicates escalating financial risks.

Core and additional indicators highlight growing risks and vulnerabilities in the country's financial system. In 2023, the household DSR, the credit-to-GDP ratio, and total credit growth increased. Real estate prices also continued to rise, fueling concerns about the market. Although the Tier 1 capital ratio to RWA in the banking sector rose slightly in Q4 2023, it exhibited a downward trend throughout the year.

Implementing an additional capital buffer of 5.6% of RWA may be considered in Uzbekistan. To determine the appropriate level, various analytical approaches have been applied. The Basel Committee recommends using the credit-to-GDP gap as a core indicator for adjusting the CCyB[107]. Additionally, macro stress tests on solvency have been conducted to assess the required buffer for banking system stability, alongside historical losses approaches.

[107] Basel Committee on Banking Supervision. (2010, December). Guidance for national authorities operating the countercyclical capital buffer.

Figure 157. Benchmark CCyB Rate

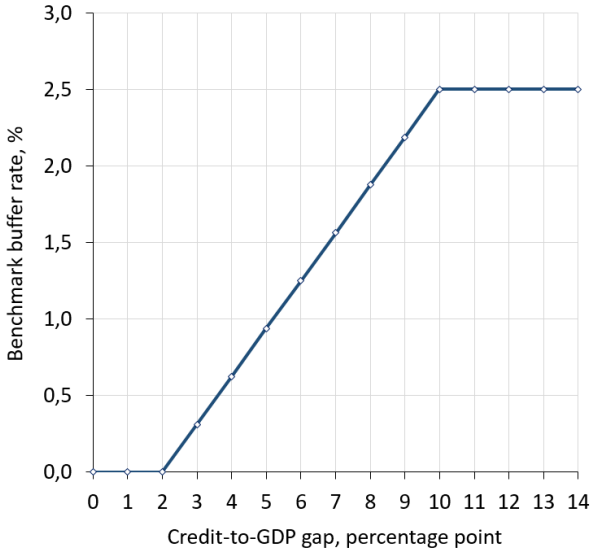
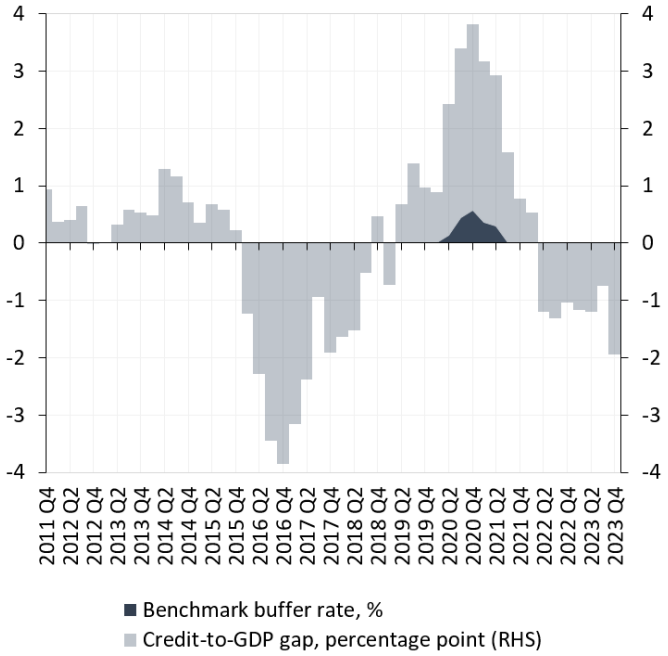


Figure 158. Credit to the Private Sector-to-GDP Gap and Benchmark Buffer Rate



Sources: Basel Committee and CBU staff calculations.

The credit-to-GDP gap can be a benchmark for CCyB[108]. To establish an optimal benchmark level, the Basel Committee calculated the lower and upper bounds of the credit-to-GDP ratio gap. If the gap is 2 percentage points or less, the benchmark level of the buffer is set at 0% of RWA. Conversely, if the gap reaches 10 percentage points or more, the maximum benchmark level of the buffer is set at 2.5%. The benchmark level of the buffer varies linearly from 0 to 2.5%[109] when the credit-to-GDP ratio gap is between the lower and upper bounds.

The credit-to-GDP ratio gap is below the lower bound for CCyB activation, with its negative trajectory keeping the benchmark rate at 0%. Nonetheless, some countries have set a positive buffer despite a negative credit-to-GDP gap, illustrating that this metric alone does not offer a complete basis for decision-making[110]. Core indicators serve as an initial guide in determining the CCyB rate, but a thorough evaluation of financial vulnerabilities, incorporating analytical judgment, is necessary.

The results of macro stress tests highlight the importance of maintaining positive macroprudential buffer rates. One method for determining an appropriate CCyB rate is to base it on macro solvency stress test outcomes. Under this approach, the required level of total macroprudential capital buffers is derived from the gap between the CAR under the adverse scenario and its initial level at the start of the stress test, ensuring the

[108] This buffer guide indicates a specific level of CCyB and aids in drawing preliminary conclusions regarding the activation of this tool.

[109] Benchmark levels of the countercyclical capital buffer between 0 and 2.5%. It is determined using the formula (0.3125 * credit-to-GDP ratio difference – 0.625).

[110] Arbatli-Saxegaard, E. C., & Muneer, M. A. (2020). The countercyclical capital buffer: A cross-country overview of policy frameworks.

banking system's resilience. A macro stress test conducted at the end of 2023 indicates that, in an adverse scenario, the Tier I capital adequacy ratio could decline from 14.1% to 8.5% by the end of 2026. Using this approach, the appropriate macroprudential buffer rate is calculated at 5.6%.

Figure 159. Tier I Capital Ratio of Banking System in Baseline and Adverse Scenarios, %

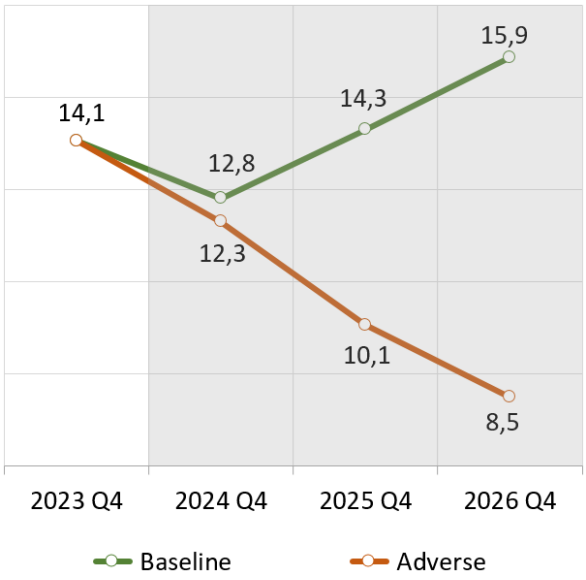
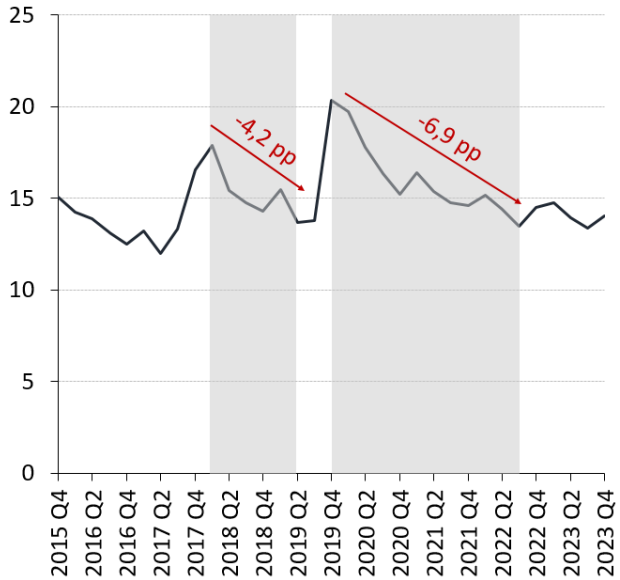


Figure 160. Tier I Capital Ratio of Banking System[111], %



Source: CBU staff calculations.

The historical losses approach underscores the critical need for stronger capital buffers. By assessing historical capital utilization to absorb banking system losses, the appropriate CCyB rate can be determined[112]. Despite additional capital injections, the banking system's CAR declined due to various contributing factors, reflecting covered losses. This reinforces the necessity of setting capital buffers above the minimum to safeguard financial stability. The Tier I capital ratio peaked at 17.9% in Q1 2018 and 20.4% in Q4 2019 but later declined sharply to 13.7% in Q2 2019 and 13.5% in Q3 2022. The respective differences of 4.2 and 6.9 percentage points highlight the need for an additional 5.6% capital buffer to mitigate potential risks.

[111] Considering the availability of time series data and the fact that Tier I capital accounted for almost 100% of total regulatory capital by the end of 2023, the analysis focused on the Tier I capital ratio.

[112] Bank for International Settlements. (2022, October). Buffer usability and cyclicality in the Basel framework.

Box 6. Methodology for Calculating the Financial Cycle

Drawing on international experience and the specific features of Uzbekistan's financial system, the financial cycle index is calculated using the following indicators:

1. Corporate and Household Loan-to-GDP Ratios
2. Annual growth rates of corporate and household loans
3. Spread between loan and treasury bond interest rates
4. CAB-to-GDP Ratio
5. Bank capital-to-assets ratio
6. ROA
7. Loan-to-deposit ratio

These indicators are standardized using the Z-score method, which assesses how much each value deviates from the mean relative to the standard deviation[113].

To enhance evaluation and analyze interdependencies, the standardized indicators are categorized into groups. Using PCA model, eight financial cycle indexes are constructed from these groups[114].

A concordance index is used to determine how well the financial cycle indexes capture changes in the selected indicators[115]. It measures the degree of consistency between two indicators, ranging from 0% (opposite movements) to 100% (perfect alignment).

---

[113] The standardization of indicators is performed using the following formula:

$$y_z = \frac{y_t - y_\mu}{\sigma_{y_t}}$$

where:
y_z is the standardized value of the indicator;
y_t is the value of the indicator for quarter t;
y_μ is the arithmetic mean of the indicator;
σ_{yt} is the standard deviation of the indicator.

[114] The methodology for principal component analysis is presented in the Financial Stability Report for 2022.

[115] Harding, D., & Pagan, A. (2002). Dissecting the Cycle: A Methodological Investigation. Journal of Monetary Economics.

The concordance index is calculated using the following formula:

$$I_{jr} = n^{-1}\left\{\sum S_{jt}S_{rt} + (1 - S_{jt})(1 - S_{rt})\right\}$$

where:

I_{jr} is the concordance index;

n is the total number of observation periods.

S_{jt} is defined as:

$$S_{jt} = \begin{cases} 0, \text{if in period } t \text{ the value of indicator } j \text{ decreases compared to the previous period} \\ 1, \text{if in period } t \text{ the value of indicator } j \text{ increases compared to the previous period;} \end{cases}$$

S_{rt} is defined as:

$$S_{rt} = \begin{cases} 0, \text{if in period } t \text{ the value of indicator } r \text{ decreases compared to the previous period} \\ 1, \text{if in period } t \text{ the value of indicator } r \text{ increases compared to the previous period.} \end{cases}$$

Table 2. Structural Indicators of Different Financial Cycle Indexes

Indicator	1	2	3	4	5	6	7	8
Corporate Loans-to-GDP Ratio	■	■	■	■	■	■	■	
Household Loans-to-GDP Ratio	■	■	■	■	■	■	■	
Annual Growth Rate of Corporate Loans		■	■	■	■	■	■	
Annual Growth Rate of Household Loans		■	■	■	■	■	■	
Spread Between Average Loan Interest Rates and Treasury Bond Yields in Uzbekistan			■	■	■	■	■	
CAB-to-GDP Ratio				■	■	■	■	
Bank Capital-to-Assets Ratio					■	■	■	■
ROA						■	■	■
Loans-to-Deposits Ratio							■	■

Source: CBU staff calculations.

Note: Each financial cycle index includes indicators corresponding to the rectangles highlighted in the respective columns.

The concordance index for the component indicators of the financial cycle index is calculated by determining the average value of the concordance indexes calculated separately for each component indicator. By assessing the correlation index values between each financial cycle index and the country's GDP gap, the most effective financial cycle index is selected, as it more fully captures the variability in structural indicators and maintains strong synchronization with economic cycles.

Table 3. Structural Indicators of Financial Cycle Indexes and Results of the Concordance Index with the Output Gap, %

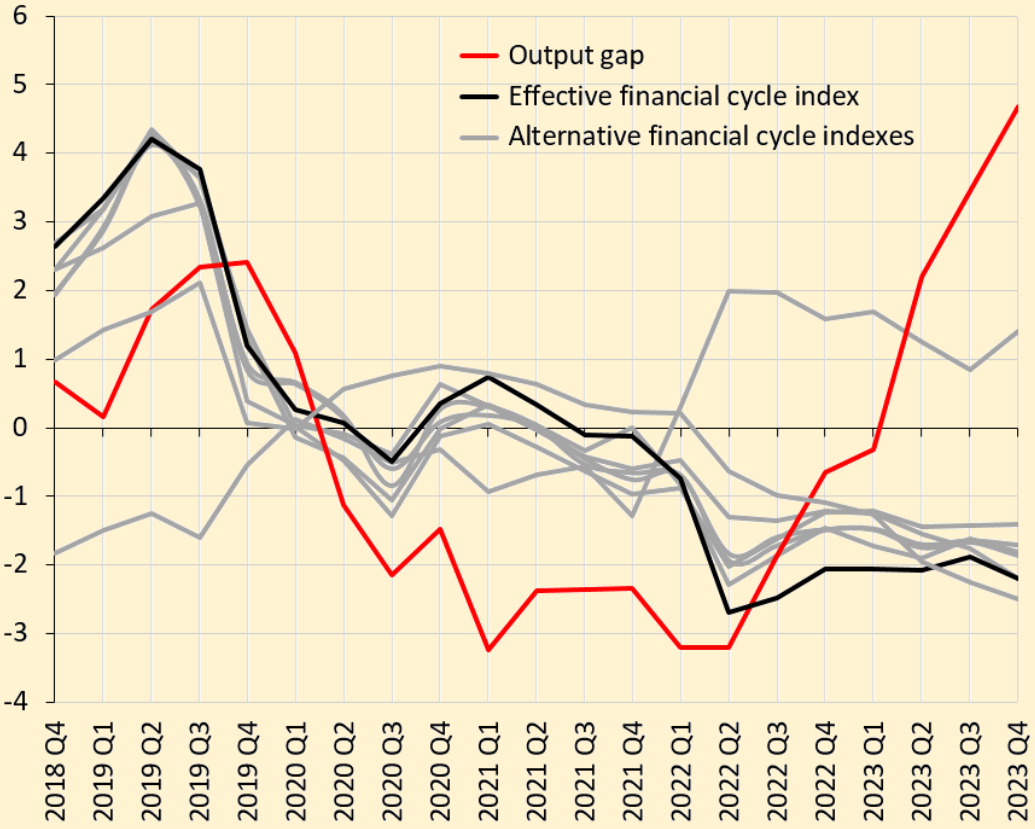
Financial cycle indexes	Structural indicators	Output gap
1	40	35
2	63	45
3	61	50
4	60	50
5	55	55
6	55	55
7	56	55
8	58	50

Source: CBU staff calculations.

Note: An index value close to 100 indicates a strong correlation between the evaluated indicator variables, while an index value close to 0 suggests significant differences between these variables.

Based on the concordance index results, the 7th financial cycle index demonstrated relatively high values of 55 and 56%, signifying a stronger correlation with the output gap and structural indicators. This index encompasses the growth rate of household and corporate loans and their ratio to GDP, the spread between loan and treasury interest rates, CAB-to-GDP ratio, the bank capital-to-assets ratio, ROA, and the loans-to-deposits ratio. Given its broader scope of indicators and higher concordance level, the 7th financial cycle index was deemed the most suitable for evaluating Uzbekistan's financial cycle.

Figure 161. GDP Gap and Financial Cycle Indexes



Source: CBU staff calculations.

To verify whether the financial cycle index accurately represents periods of financial change in the country, it is essential to analyze its values during past financial crises. However, the absence of financial crises in Uzbekistan limits the ability to fully assess the index's effectiveness. Additionally, since financial cycle phases in other countries typically last between 8 and 30 years, the short time series of indicators in Uzbekistan's financial cycle index further reduces its ability to accurately reflect the country's financial cycle condition.

7.2. Improvement of Borrower-Based Macroprudential Tools

In practice, borrower-based macroprudential policy tools, such as the loan payment-to-income ratio (PTI) and LTV, are used to reduce the debt burden. International experience shows that PTI is predominantly implemented as a direct restriction on borrowers (Appendix 13). Only a limited number of countries, such as Vietnam and Russia[116], employ indirect PTI restrictions. While these indirect measures increase capital requirements for banks issuing high-risk loans, they do not entirely prevent such lending since they do not directly regulate borrowers. As a result, commercial banks, driven by the pursuit of market share and profitability, may continue extending high-risk loans by allocating additional capital despite the associated risks.

In most countries, the LTV ratio is directly used to regulate mortgage lending. Among the countries examined, LTV limits are explicitly defined, with 90% being the most frequently applied upper limit. Some countries, including Kazakhstan[117] and Mexico[118], also employ indirect LTV limits tied to the risk assessment of mortgage loans. By imposing LTV limits, borrowers are required to make an initial payment, which can restrict homeownership opportunities for individuals without savings. However, lower LTV limits strengthen borrowers' financial resilience against housing price fluctuations and reduce banks' exposure to losses in the event of a market downturn[119].

[116] In Vietnam and Russia, mortgage loan risk levels are determined based on debt burden and loan-to-collateral ratios.

[117] Постановление Правления Национального Банка Республики Казахстан № 170 "Об установлении нормативных значений и методик расчетов пруденциальных нормативов и иных обязательных к соблюдению норм и лимитов, размера капитала банка и Правил расчета и лимитов открытой валютной позиции" от 13 сентября 2017 года.

[118] International Monetary Fund. (2022). Macroprudential Policy Survey: Mexico.

[119] Jacome, L., & Mitra, S. (2015). LTV and DTI Limits–Going Granular. IMF Working Paper.

Figure 162. Direct LTV Limits on Mortgage Loans Across Different Countries

Sources: IMF, European Systemic Risk Board and national authorities.

Note: *Since individual loans in Uzbekistan are issued exclusively in the national currency, only national currency restrictions were taken into account when comparing LTV limits across countries.

In cases where multiple LTV limits exist, the highest limit is reported, as it represents a greater level of credit risk and more relaxed lending criteria. A higher LTV limit for mortgages indicates more lenient credit conditions, whereas a lower LTV limit reflects stricter borrowing requirements.

The CBU is enhancing its borrower-based macroprudential policy tools. From H2 2024, the PTI limit, previously applicable only to microloans, will cover all individual loans. Furthermore, LTV limits have been indirectly adjusted based on the risk levels of mortgages and auto loans. The practice of determining risk levels for these loan types using PTI and LTV indicators has also been introduced.

To prevent excessive debt burdens and safeguard financial stability, a phased introduction of the PTI limit will apply to all types of loans for individuals. Effective July 1, 2024, the PTI for all individual loans must not exceed 60%, with a further reduction to 50% from January 1, 2025[120]. Enforcing debt burden limits across all loan types enhances risk management. However, banks may issue up to 15% of their total individual loans and microdebts without assessing or applying the debt burden indicator.

Table 4. Risk Weights for Residential Real Estate Exposures (from July 1, 2024)

Classification		PTI	
		PTI ≤ 60%*	60%* < PTI or PTI if not possible to determine
LTV	LTV < 50%	35%	50%
	50% ≤ LTV < 75%	50%	100%
	75% ≤ LTV < 100%	100%	150%
	100% ≤ LTV	150%	150%

Source: CBU.

Note: *The limit will be set at 50% starting from January 1, 2025.

Effective July 1, 2024, the risk weights for mortgages and car loans will be determined based on LTV and PTI[121]. Higher LTV and PTI levels for these loans correspond to increased credit risk, resulting in higher risk assessments. Additionally, loans granted as exceptions to the direct household debt burden limit carry elevated risk levels, placing additional pressure on capital requirements.

[120] Decision No. 42/16 of the Board of the Central Bank of the Republic of Uzbekistan dated January 26, 2024 "On Amendments and Additions to the Regulations on Regulation of the Debt Burden of Individual Borrowers".

[121] O‘zbekiston Respublikasi Markaziy banki boshqaruvining 2024 yil 31 yanvardagi “Tijorat banklari kapitalining monandligiga qo‘yiladigan talablar to‘g‘risidagi nizomga o‘zgartirish va qo‘shimchalar kiritish haqida” 42/14–sonli qarori.

Table 5. Risk Weights for Car Exposures (from July 1, 2024)

Classification		PTI	
		PTI ≤ 60%*	60%* < PTI or PTI if not possible to determine
LTV	LTV ≤ 75%	100%	150%
	75% < LTV	150%	200%

Source: CBU.

Note: *The limit will be set at 50% starting from January 1, 2025.

The risk weights for loans allocated as exceptions to direct PTI limits are being increased. Starting from July 1, 2024, all loans except car loans, mortgage loans to individuals, loans issued under family entrepreneurship development and education programs, and microdebts will be subject to a 100% risk weight when applying direct PTI requirements. In exceptional cases where PTI limits are exceeded, these loans will carry a 150% risk weight. This adjustment specifically applies to loans issued by commercial banks under direct PTI limits.

Risks for the financial stability of Uzbekistan

Key financial stability risks and mitigation measures	Risk level and its change	
	In the short term	In the medium term
External risks		
Climate change risks. Risks stemming from climate change can lead to significant losses for businesses and individuals, ultimately impacting the financial system. In particular, the vulnerability of key sectors of the national economy to physical and transition risks associated with climate change may increase. **Risk mitigation measures:** - continuous monitoring of the impact of physical and transition risks of climate change on the financial health of banks through climate stress testing; - implementing stricter capital requirements for sectors vulnerable to climate change risks while applying lower capital requirements for green investment projects; - tightening liquidity requirements for banks with a high concentration of exposure to sectors vulnerable to climate change risks.		
The risk of imposing secondary sanctions on participants in Uzbekistan's financial and non-financial sectors. The risk of secondary sanctions being imposed by the USA and the European Union on enterprises and banks operating in Uzbekistan could restrict the country's access to international financial markets, hinder the attraction of foreign investments, and increase transaction costs. **Risk mitigation measures:** - expanding and diversifying partnerships beyond the influence of sanctions in foreign trade and international financial relations; - enhancing measures to ensure compliance with international sanctions and strengthening the legal framework to prevent their imposition.		

Key financial stability risks and mitigation measures	Risk level and its change	
	In the short term	In the medium term
Internal risks		
Housing price overvaluation. When housing market prices exceed their fundamental values, there's a heightened risk of banks incurring loan losses. This is because the value of housing, used as collateral, may plummet during economic downturns. Additionally, the population's debt burden on mortgage loans will increase. **Risk mitigation measures:** - tightening the LTV limit for mortgage loans relative to RWA; - introducing a systemic risk buffer or a sectoral CCyB for mortgage loans.		
An increase in the probability of liquidity risks in the banking system. A decrease in the share of HQLA in the structure of total bank assets may cause difficulties in timely fulfillment of obligations of banks. A decrease in liquidity indicators in banks leads to an increase in the vulnerability of the banking system to unexpected economic shocks. **Risk mitigation measures:** - employing the Emergency Liquidity Assistance (ELA) tool for solvent banks facing short-term liquidity constraints.		

Key financial stability risks and mitigation measures	Risk level and its change	
	In the short term	In the medium term
Heightened concerns about the negative impact of domestic currency market volatility on the financial system. An increase in the negative balance of the foreign trade deficit and the observed current account shortfall may lead to higher domestic demand for foreign currency. In particular, imbalances between demand and supply in the domestic currency market can cause fluctuations in the national currency exchange rate. Furthermore, a high level of dollarization may heighten Uzbekistan's vulnerability to external shocks, potentially undermining financial stability. **Risk mitigation measures:** - introducing a systemic risk buffer to mitigate the dollarization of loans; - establishing higher requirements for liquidity indicators in foreign currencies.		
Increase in interest rates on loans and deposits. An increase in the gap between interest rates on loans and deposits offered by banks and the policy rate can indicate interest rate risk. Higher bank interest rates raise loan servicing costs, deteriorating loan quality. **Risk mitigation measures:** - deducting the amount of high-interest deposits from capital adequacy indicators; - determining the higher fee amount for high-interest deposits in Deposit Guarantee Fund for Individuals.		

Note: The direction of the arrow indicates the change in the risk level.

Appendices

Appendix 1

Table 6. Uzbekistan's Financial Conditions Index (FCI)

The essence of the FCI	The purpose of the FCI is to capture the relationship between the financial system and the real economy, allowing for an early assessment of how changes in the financial system may impact the country's economy. In calculating the index, key indicators representing the banking sector, domestic currency market, external sector, and overall financial conditions were selected based on the characteristics of the country's financial system and international experience. The initial measurement period for the FSI began in April 2019, using monthly data.
Indicators	Banking sector: – The spread between interest rates on bank loans in the national currency and treasury bond yields. – The ratio of total outstanding credit to total outstanding deposits. FX market: – The annual change in the UZS-USD exchange rate. – The Exchange Market Pressure Index (EMPI) based on the annual percentage change in international reserves, excluding gold. External sector: – VIX index. – The country's risk premium, measured as the spread between the yield on Uzbekistan's foreign currency sovereign Eurobonds and benchmark U.S. Treasury bonds. Macrofinancial indicators: – The annual inflation rate. – The annual real growth rate of demand deposits within the broad money supply.
Selection of indicators	– The area under the receiver operating characteristic (AUROC) curve. – A significant correlation with the country's economic growth. – Not weak correlation between the time-lagged differences of the indicators and the country's economic growth. – The absence of multicollinearity.
Standardization of indicators	Z-score method.

Aggregation of indicators into a sub-index	The sub-index values are calculated as the arithmetic average of the indicators, assigning equal weights to the standardized indicators.
Consolidation of sub-indices into the final index	PCA.
Evaluation of index performance	– AUROC curve. – Correlation between the time-lagged differences of the indicators and the country's economic growth.
Interpretation of results	Positive FCI values indicate tighter financial conditions, while negative values signify easing financial conditions.

Algorithm for FCI Development

The main difference between FCI and FSI lies in their objectives. Specifically, the FCI aims to assess the impact of changes in the financial system on the country's economy, highlighting the connection between the financial system and the real economy. In contrast, the primary purpose of the FSI is to identify periods of crisis or instability in the financial system, without explicitly considering the impact of financial stress on the real economy over a given period[122].

Additionally, unlike the FSI, the FCI incorporates quantitative indicators, prices, and other macroeconomic variables that help predict a country's future economic activity[123].

The calculation of the FCI involves selecting and standardizing effective indicators that can anticipate the effects of financial system changes on the economy. These standardized indicators are then grouped into subindices, with their respective weights determined based on their significance. Finally, the values and weights of the subindices are used to compute the FCI.

Selection of Effective Indicators

The selection of effective indicators that represent the relationship between the financial system and the real economy is the first and most crucial step in calculating the FCI. These indicators can be chosen based on the specific characteristics of a country’s financial system or the experiences of other countries.

Additionally, in line with the purpose of the FCI, indicators that reflect changes in the financial system and exhibit a non-weak correlation with real economic growth are used in the index calculation (e.g., Colombia[124], Austria[125]). Furthermore, assessing the significance of indicators using econometric models enhances the effectiveness of the FCI. In particular, the AUROC model[126] is widely applied to evaluate how well the indicators provide early warnings of crisis periods.

Standardization of Indicators

To enable comparison and aggregation, indicators are first standardized using various methods.

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[122] Monin, P. (2017). The OFR Financial Stress Index. Office of Financial Research in U.S. Department of the Treasury.

[123] Hatzius, J., Hooper, P., Mishkin, F., Schoenholtz, K., & Watson, M. (2010). Financial Conditions Indexes: A Fresh Look after the Financial Crisis. National Bureau of Economic Research.

[124] Esteben, G., Andres, M., & Nancy, Z. (2011). Financial Conditions Index: Early and Leading Indicator for Colombia. Central Bank of Colombia.

[125] Ernest, G., Maria, T., & Walter, W. (2019). Financing conditions in Austria since the introduction of the euro. Oesterreichische Nationalbank.

[126] The AUROC model methodology is presented in the Financial Stability Report for H1 2023.

The Z-score method (used in Chile[127], Colombia, and Germany[128]) is the most common approach for standardizing indicators in the FCI. It measures how much an indicator's current value deviates from its arithmetic mean in terms of standard deviations.

Alternatively, indicators can be standardized using the cumulative distribution function (CDF) method (used in Uruguay[129]). This method involves ranking indicator values in ascending order and assigning ordinal numbers based on their position. The standardized value is then obtained by dividing the assigned order number by the total number of observations in the time series[130].

Aggregation of Indicators into a Subindex

Standardized indicators are grouped into subindices based on their representation of different financial system sectors. The value of subindices can be determined using PCA (used in Germany and France[131]) or by calculating the arithmetic mean of the indicators.

PCA applies a linear transformation to reduce the dimensionality of multiple correlated indicators while preserving maximum variance[132]. This process merges multiple indicators into a single representative measure.

Alternatively, standardized indicators can be directly incorporated into the final index without forming subindices (as seen in Uruguay and Chile). However, dividing indicators into subindices allows for a more detailed analysis of which financial system sectors impact the index, improving its overall efficiency.

Estimating the Weights of Subindices

To compute the final FCI, subindices representing different financial system segments must first be weighted. Various models can be used for this purpose:

- PCA (applied in Malaysia[133], Norway[134], Greece[135])

[127] Nicolas, A., Antonia, F., & Andres, S. (2021). Economic Growth at Risk: An Application to Chile. Central Bank of Chile.

[128] Norbert, M. (2022). Technical Paper. A composite indicator of Financial Conditions for Germany. Deutsche Bundesbank.

[129] Elizabeth, B. (2017). Financial conditions and monetary policy in Uruguay: An MS-VAR Approach. Inter-American Development Bank.

[130] Hollo, D., Kremer, M., & Lo Duca, M. (2012). CISS – A composite indicator of systemic stress in the financial system. European Central Bank.

[131] Anna, P., & Jean-Guillaume, S. (2019). A new Banque de France Financial Conditions Index for the euro area. Banque de France.

[132] James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An Introduction to Statistical Learning: With Applications in R.

[133] Zul-Fadzli, A. B., & Imam, B. (2017). Financial Conditions Index for Malaysia. Central Bank of Malaysia.

[134] Frida, B., Karsten, R., Nicolo, M., & Helene, O. (2023). A high-frequency financial conditions index for Norway. Central Bank of Norway.

[135] Jonathan, M., & Maral, S. (2015). A Financial Conditions Index for Greece. International Monetary Fund.

- Dynamic factor model (DFM) (used in Romania[136])
- Vector autoregression (VAR) (used in Poland[137]).

Additionally, subindex weights in the final index can be determined by considering the number of indicators in each subindex or by assigning equal weights (as done in Sweden)[138].

The original IMF methodology for the global financial conditions index used time-varying weights from the DFM. However, these were later replaced with fixed weights derived from PCA. This adjustment simplified the process of determining each indicator's influence on the final index and improved the stability of parameters when updating the index[139].

Aggregation of Subindices into the Final Index

In the final step of FCI calculation, subindices are aggregated into the final index. This is done using PCA (as applied by IMF[140], Singapore[141], Turkey[142], Chile) and DFM (used in Australia[143], Brazil[144], Mexico[145]). Alternatively, the final index can be calculated by summing or averaging the weighted subindices (as seen in Iceland[146]).

[136] Andreea, M. (2015). Building a financial conditions index for Romania. National Bank of Romania.

[137] Giang, H., & Yinqiu, L. (2013). A Financial Conditions Index for Poland. International Monetary Fund.

[138] Jan, A., Magnus, L., & Tommy, B. (2020). An index for financial conditions in Sweden. Riksbank.

[139] International Monetary Fund. (2018, October). Global Financial Stability Report, Online Annex 1.1 Technical Note.

[140] International Monetary Fund. (2018, October). Global Financial Stability Report, Online Annex 1.1 Technical Note

[141] Monetary Authority of Singapore. (2019, November). Financial Stability Review.

[142] Abdullah, K., Halil, I., & Muhammed, H. (2019). Composing High-Frequency Financial Conditions Index and Implications for Economic Activity. Central Bank of Türkiye.

[143] Luke, H., & Michelle, W. (2021). Financial Conditions and Downside Risk to Economic Activity in Australia. Reserve Bank of Australia.

[144] Wagner, P., & Waldyr, D. (2017). Financial Conditions Indicator for Brazil. Inter-American Development Bank.

[145] Julio, C., & Ana Laura, G. (2021). The COVID-19 Economic Crisis in Mexico through the Lens of a Financial Conditions Index. Banco de México.

[146] Eysteinn, E., Stella, E., Tomas, D., & Vedis, S. (2023). A Financial Conditions Index for Iceland. Central Bank of Iceland.

Appendix 3

Selection of Effective Indicators for Uzbekistan's FCI

The effective indicators used to calculate Uzbekistan's FCI were selected based on the following criteria from over 350 indicators included in 44 FCIs developed by international financial organizations and central banks:

1. Ability to capture the specific features of Uzbekistan's financial system.
2. Availability of a sufficient time series of data.
3. Effectiveness in providing early warnings of crises, as measured by the AUROC model.
4. Direct correlation with the country's economic growth[147].
5. Presence of a non-weak correlation ($r_{i,j} > 0{,}5$) between indicator time lags and economic growth.
6. Absence of strong correlation ($r_{i,j} > 0{,}7$) between selected indicators to prevent multicollinearity[148].

Using the AUROC model[149], indicator performance was assessed based on error rates—specifically, whether an indicator failed to warn of an actual crisis or gave misleading warnings during stable periods. The AUROC value ranges from 0 to 1, where a higher value indicates better crisis prediction accuracy. An AUROC value of 0.5 suggests that the indicator provides only random crisis warnings.

To evaluate the effectiveness of indicators, it was necessary to define crisis periods. Since Uzbekistan has not experienced a full-scale financial crisis, the significant economic downturn from Q2 2020 to Q1 2021, when real GDP growth lagged considerably due to the COVID-19 pandemic, served as a reference.

The AUROC model was applied to test whether indicators with sufficient data and relevance to Uzbekistan's financial system signaled crises effectively. The results showed that the most effective indicators for signaling a crisis two quarters in advance were:

a. Loan-to-deposit ratio (AUROC=0.84)
b. Difference between interest rates on loans and treasury bonds (AUROC=0.84)
c. Consumer price index (AUROC=0.83)
d. VIX index (AUROC=0.73)

[147] The direct correlation sign is the same as the direction of the correlation between indicators based on the economic characteristics of a certain indicator.

[148] Multicollinearity refers to a high correlation between two or more variables in a regression model.

[149] The AUROC model methodology is presented in the Financial Stability Report for H1 2023.

For crisis prediction four quarters in advance, the most effective indicators were:

a. Spread between interest rates on loans and treasury bonds (AUROC=0.98)
b. Exchange market pressure index (AUROC=0.93)
c. Consumer price index (AUROC=0.93)
d. Annual real growth rate of demand deposits within the broad money supply (AUROC=0.86)
e. Loan-to-deposit ratio (AUROC=0.73)

These results indicate that these indicators provide reliable early warnings of financial crises.

On the other hand, indicators such as changes in loan volume, gold price growth, real effective exchange rate, NPL volume and share in total loans, return on capital and assets, and LCR had AUROC values below 0.5, suggesting they do not offer meaningful crisis warnings.

A key criterion for selecting effective indicators was the existence of a non-weak and direct correlation between changes in these indicators and economic growth, with real GDP growth showing an inverse relationship with CAR, NPL volume and its share in total loans, ROE and ROA, annual growth of total loans and deposits, and LCR two and four quarters prior.

In addition, an inverse relationship was observed between the real GDP growth and the real effective exchange rate, the realized volatility of the UZS-USD exchange rate, which represents changes in the domestic FX market, and as financial indicators, the values of the annual growth of the gold price two and four quarters earlier.

Cubic Spline Interpolation

Cubic spline interpolation[150] is a method of generating a third degree continuous piecewise function that passes through multiple points. The function determined by this method serves to more accurately represent the data between the points.

A continuous piecewise function passing through several points according to the cubic spline interpolation methodology[151] is expressed as:

$$S(x) = \begin{cases} s_1(x) \; if \; x_1 \leq x \leq x_2 \\ s_2(x) \; if \; x_2 \leq x \leq x_3 \\ \vdots \\ s_{n-1}(x) \; if \; x_{n-1} \leq x \leq x_n \end{cases}$$

$$s_i(x) = a_i(x - x_i)^3 + b_i(x - x_i)^2 + c_i(x - x_i) + d_i$$
$$i = 1, 2, \dots, n-1$$

Here, s_i is a third degree polynomial, n is number of points, x_n are data points, $a_i, b_i, \; c_i$ and d_i are coefficients.

The first and second derivatives are obtained from the above third degree polynomial:

$$s_i'(x) = 3a_i(x - x_i)^2 + 2b_i(x - x_i) + c_i$$
$$s_i''(x) = 6a_i(x - x_i) + 2b_i$$
$$i = 1, 2, \dots, n-1$$

Also, when determining the coefficients in the function, the properties of cubic spline interpolation are used: the piecewise function $S(x)$ will interpolate at all data points, the function $S(x)$, and the first and second derivatives of this function will be continuous on the interval $[x_1, x_n]$.

Due to the fact that the function $S(x)$ will interpolate at all of the data points, the following equality holds:

$$s_i(x_i) = a_i(x_i - x_i)^3 + b_i(x_i - x_i)^2 + c_i(x_i - x_i) + d_i$$
$$s_i(x_i) = d_i$$

According to the property that a piecewise function must be continuous across its entire interval, each sub-function must join at the data points:

[150] A third order continuous curve with continuous derivatives passing through a given set of points.

[151] McKinley, S., & Levine, M. (1998). Cubic Spline Interpolation.

$$s_i(x_i) = s_{i-1}(x_i)$$
$$i = 2, \dots, n$$
$$s_{i-1}(x_i) = a_{i-1}(x_i - x_{i-1})^3 + b_{i-1}(x_i - x_{i-1})^2 + c_{i-1}(x_i - x_{i-1}) + d_{i-1}$$
$$d_i = a_{i-1}(x_i - x_{i-1})^3 + b_{i-1}(x_i - x_{i-1})^2 + c_{i-1}(x_i - x_{i-1}) + d_{i-1}$$
$$i = 2, \dots, n-1$$
$$h = x_i - x_{i-1}$$
$$d_i = a_{i-1}h^3 + b_{i-1}h^2 + c_{i-1}h + d_{i-1}$$

According to the property that the first-order derivative of the function $S(x)$ must be continuous on the interval $[x_1, x_n]$, the following equations are formed:

$$s_i'(x_i) = s_{i-1}'(x_i)$$
$$s_i'(x_i) = 3a_i(x_i - x_i)^2 + 2b_i(x_i - x_i) + c_i$$
$$s_i'(x_i) = s_{i-1}'(x_i) = c_i$$
$$c_i = 3a_{i-1}(x_i - x_{i-1})^2 + 2b_{i-1}(x_i - x_{i-1}) + c_{i-1}$$
$$c_i = 3a_{i-1}h^2 + 2b_{i-1}h + c_{i-1}$$

Based on the property of the second derivative of the function $S(x)$ must be continuous on the interval $[x_1, x_n]$, that is defined as:

$$s_i''(x_i) = s_{i-1}''(x_i)$$
$$s_i''(x_{i+1}) = s_{i+1}''(x_{i+1})$$
$$s_i''(x_i) = 6a_i(x_i - x_i) + 2b_i$$
$$s_i''(x_i) = s_{i-1}''(x_i) = 2b_i$$
$$2b_i = 6a_{i-1}(x_i - x_{i-1}) + 2b_{i-1}$$
$$2b_i = 6a_{i-1}h + 2b_{i-1}$$
$$2b_{i+1} = 6a_ih + 2b_i$$

The above expressions are simplified by substituting M_i for $s_i''(x_i)$:

$$s_i''(x_i) = 2b_i$$
$$M_i = 2b_i$$
$$b_i = \frac{M_i}{2}$$

The value d_i is equal to the value of the function $S(x)$ at the point x_i ($s_i(x_i) = d_i$). Also, the value of a_i is re-written by the above designations:

$$2b_{i+1} = 6a_ih + 2b_i$$
$$6a_ih = 2b_{i+1} - 2b_i$$
$$a_i = \frac{2b_{i+1} - 2b_i}{6h}$$
$$a_i = \frac{2\left(\frac{M_{i+1}}{2}\right) - 2\left(\frac{M_i}{2}\right)}{6h}$$

$$a_i = \frac{M_{i+1} - M_i}{6h}$$

The value of c_i is re-written by the entered designations:

$$d_{i+1} = a_i h^3 + b_i h^2 + c_i h + d_i$$
$$c_i h = d_{i+1} - a_i h^3 - b_i h^2 - d_i$$
$$c_i = \frac{d_{i+1} - a_i h^3 - b_i h^2 - d_i}{h}$$
$$c_i = (-a_i h^2 - b_i h) - \frac{d_i - d_{i+1}}{h}$$
$$c_i = \frac{d_{i+1} - d_i}{h} - (\frac{M_{i+1} - M_i}{6h} h^2 - \frac{M_i}{2} h)$$
$$c_i = \frac{y_{i+1} - y_i}{h} - \left(\frac{M_{i+1} + 2M_i}{6}\right) h$$

The following expressions are formed to calculate the coefficients of the function through the defined equations:

$$\begin{cases} a_i = \dfrac{M_{i+1} - M_i}{6h} \\ b_i = \dfrac{M_i}{2} \\ c_i = \dfrac{y_{i+1} - y_i}{h} - \left(\dfrac{M_{i+1} + 2M_i}{6}\right) h \\ d_i = y_i \end{cases}$$

Determining the second derivative of third degree polynomials ($s_i''(x_i) = M_i$) is enough to calculate the coefficients. The expressions can be handled more conveniently by putting them into matrix form as follows:

$$c_{i+1} = 3a_i h^2 + 2b_i h + c_i$$

$$3\left(\frac{M_{i+1} - M_i}{6h}\right) h^2 + 2\left(\frac{M_i}{2}\right) h + \frac{y_{i+1} - y_i}{h} - \left(\frac{M_{i+1} + 2M_i}{6}\right) h$$
$$= \frac{y_{i+2} - y_{i+1}}{h} - \left(\frac{M_{i+2} + 2M_{i+1}}{6}\right) h$$
$$h\left(\frac{3M_{i+1} - 3M_i}{6} + \frac{6M_i}{6} - \left(\frac{M_{i+1} + 2M_i}{6}\right) + \left(\frac{M_{i+2} + 2M_{i+1}}{6}\right)\right) = \frac{y_i - 2y_{i+1} + y_{i+2}}{h}$$
$$\frac{h}{6} * (M_i + 4M_{i+1} + M_{i+2}) = \frac{y_i - 2y_{i+1} + y_{i+2}}{h}$$
$$M_i + 4M_{i+1} + M_{i+2} = 6\left(\frac{y_i - 2y_{i+1} + y_{i+2}}{h^2}\right)$$
$$i = 1,2,3, \dots, n-1$$

$$\begin{bmatrix} 1 & 4 & 1 & 0 & \dots & 0 & 0 & 0 & 0 \\ 0 & 1 & 4 & 1 & \dots & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 4 & \dots & 0 & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \dots & 4 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 1 & 4 & 1 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 0 & 1 & 4 & 1 \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \\ M_n \end{bmatrix} = \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

The resulting matrix equation contains *n* unknowns ($M_1, M_2, \dots, M_{n-1}, M_n$) and $n-2$ equalities. This does not allow to fully determining the coefficients. Therefore, the coefficients are determined by introducing natural splines, parabolic runout splines, and cubic runout splines for polynomials at the endpoints.

The condition of natural splines includes that the second derivative of the third degree polynomials ($s_i''(x_i) = M_i$) is equal to zero at the endpoints ($M_1 = M_n = 0$). As a result, the above matrix equation becomes:

$$\begin{bmatrix} 1 & 4 & 1 & 0 & \dots & 0 & 0 & 0 & 0 \\ 0 & 1 & 4 & 1 & \dots & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 4 & \dots & 0 & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \dots & 4 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 1 & 4 & 1 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 0 & 1 & 4 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \\ 0 \end{bmatrix} = \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

For reasons of convenience, the first and last columns of this matrix can be eliminated, as they correspond to the M_1 and M_n values, which are both zero.

$$\begin{bmatrix} 4 & 1 & 0 & \dots & 0 & 0 & 0 \\ 1 & 4 & 1 & \dots & 0 & 0 & 0 \\ 0 & 1 & 4 & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & 4 & 1 & 0 \\ 0 & 0 & 0 & \dots & 1 & 4 & 1 \\ 0 & 0 & 0 & \dots & 0 & 1 & 4 \end{bmatrix} \begin{bmatrix} M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \end{bmatrix} = \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

It can be seen from the resulting matrix that there are $n-2$ unknowns ($M_2, M_3, \dots, M_{n-2}, M_{n-1}$) and $n-2$ equalities. As a result, unknown values for M_2 through M_{n-1} will be determined. Based on the determined M_i values, the coefficients of the third degree polynomials are calculated, and the continuous piecewise function passing through several points is determined.

The condition of parabolic runout spline that the second derivatives of the third degree polynomials ($s_i''(x_i) = M_i$) at the endpoints are equal to the second and one point

before the end, respectively ($M_1 = M_2$ and $M_n = M_{n-1}$). As a result, the matrix equation above becomes the following:

$$\begin{bmatrix} 5 & 1 & 0 & \dots & 0 & 0 & 0 \\ 1 & 4 & 1 & \dots & 0 & 0 & 0 \\ 0 & 1 & 4 & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & 4 & 1 & 0 \\ 0 & 0 & 0 & \dots & 1 & 4 & 1 \\ 0 & 0 & 0 & \dots & 0 & 1 & 5 \end{bmatrix} \begin{bmatrix} M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \end{bmatrix} = \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

By solving the matrix equation, the unknown values for M_2 through M_{n-1} are determined. Based on the determined M_i values, the coefficients of the third degree polynomials are calculated, and the continuous piecewise function passing through several points is determined.

Cubic runout spline condition contains certain relations ($M_1 = 2M_2 - M_3$ and $M_n = 2M_{n-1} - M_{n-2}$) of the second derivative ($s_i''(x_i) = M_i$) and the above matrix equation becomes:

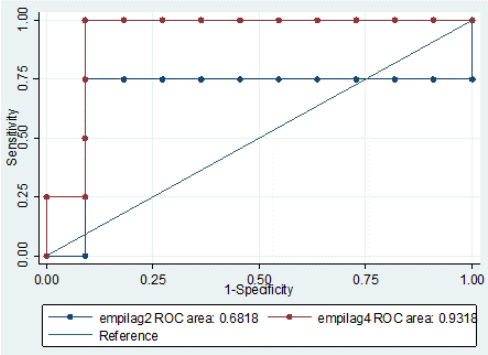
$$\begin{bmatrix} 6 & 0 & 0 & \dots & 0 & 0 & 0 \\ 1 & 4 & 1 & \dots & 0 & 0 & 0 \\ 0 & 1 & 4 & \dots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \dots & 4 & 1 & 0 \\ 0 & 0 & 0 & \dots & 1 & 4 & 1 \\ 0 & 0 & 0 & \dots & 0 & 0 & 6 \end{bmatrix} \begin{bmatrix} M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \end{bmatrix} = \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

The resulting matrix contains $n - 2$ unknowns ($M_2, M_3, \dots, M_{n-2}, M_{n-1}$) and $n - 2$ equalities. In this way, unknown values for M_2 through M_{n-1} are determined.

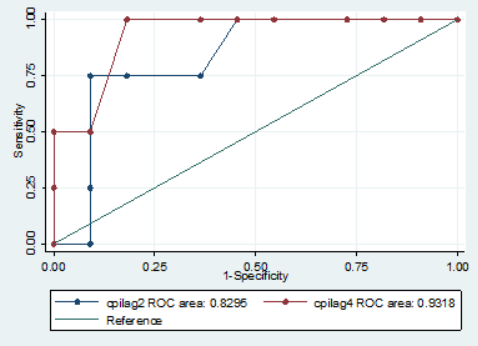
The unknown coefficients of the third degree polynomials $s(x)$ are calculated based on the values of M_i determined according to the above conditions of cubic spline interpolation. As a result, a third order continuous piecewise function passing through several points is found.

Figure 163. AUROC Model: Efficacy of Selected Indicators in Providing a 2- and 4-Quarter Advance Crisis Warning

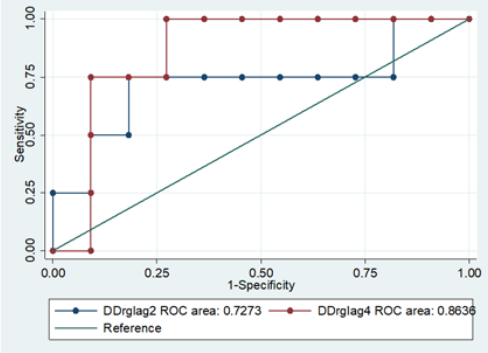
Exchange market pressure index



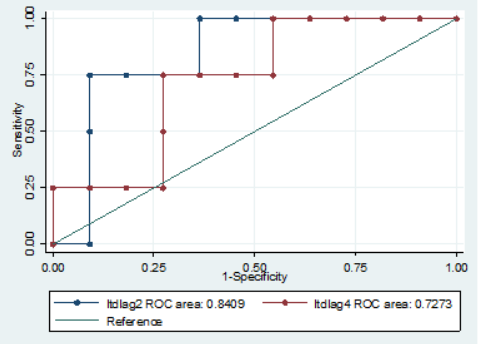
Consumer price index



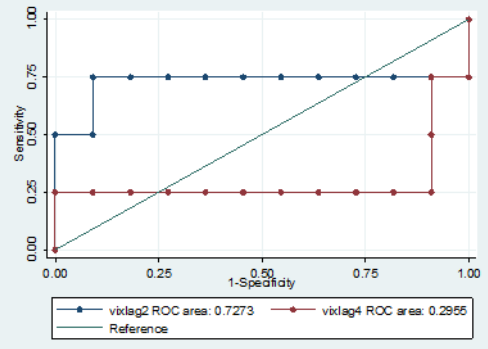
Annual real growth in demand deposits



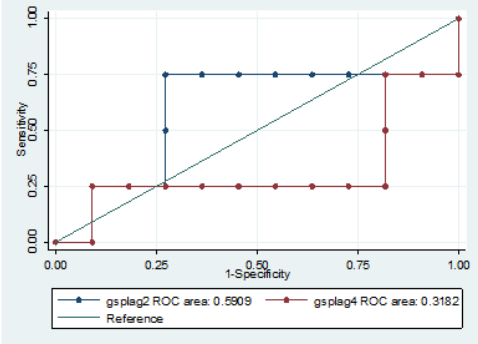
Loan-to-deposit ratio



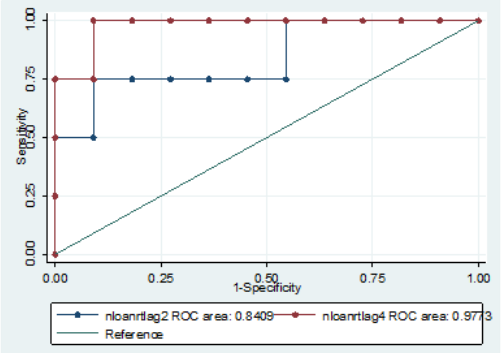
VIX index



Country risk premium



The difference between interest rates on bank loans and treasury bonds



Sample of CBU Systemic Risk Survey

1. Main systemic risks

1.1. List the top five risks that could significantly impact the financial system of Uzbekistan in descending order of importance.

Risks	Time Horizon of Materialization		Probability of Materialization		Impact	
1	Short-term (0–12 months)	☐	High	☐	Strong	☐
	Medium-term (1–3 years)	☐	Medium	☐	Moderate	☐
			Low	☐	Weak	☐
2	Short-term (0–12 months)	☐	High	☐	Strong	☐
	Medium-term (1–3 years)	☐	Medium	☐	Moderate	☐
			Low	☐	Weak	☐
3	Short-term (0–12 months)	☐	High	☐	Strong	☐
	Medium-term (1–3 years)	☐	Medium	☐	Moderate	☐
			Low	☐	Weak	☐
4	Short-term (0–12 months)	☐	High	☐	Strong	☐
	Medium-term (1–3 years)	☐	Medium	☐	Moderate	☐
			Low	☐	Weak	☐
5	Short-term (0–12 months)	☐	High	☐	Strong	☐
	Medium-term (1–3 years)	☐	Medium	☐	Moderate	☐
			Low	☐	Weak	☐

2. Probability of financial system risks

2.1. In your opinion, what is the likelihood of a shock triggering a financial crisis in Uzbekistan within the following time frames?

	Very High	High	Moderate	Low	Very Low
Short-term (0–12 months)	☐	☐	☐	☐	☐
Medium-term (1–3 years)	☐	☐	☐	☐	☐

2.2. How has this probability changed over time?

	Increased	Unchanged	Decreased
Short-term (0–12 months)	☐	☐	☐
Medium-term (1–3 years)	☐	☐	☐

2.3. How confident are you in the stability of Uzbekistan's financial system over the next three years?

Very High	High	Moderate	Low	Very Low
☐	☐	☐	☐	☐

3. To what extent do you think the following factors have changed over the past six months? (Select one response for each factor)

3.1. Demand for credit

a) Significantly decreased	b) Slightly decreased	c) Remained unchanged	d) Slightly increased	e) Significantly increased
☐	☐	☐	☐	☐

3.2. Availability of short-term financing

a) Considerably deteriorated	b) Slightly deteriorated	c) Remained unchanged	d) Slightly improved	e) Considerably improved
☐	☐	☐	☐	☐

3.3. Availability of long-term financing

a) Considerably deteriorated	b) Slightly deteriorated	c) Remained unchanged	d) Slightly improved	e) Considerably improved
☐	☐	☐	☐	☐

3.4. Interbank liquidity

a) Considerably deteriorated	b) Slightly deteriorated	c) Remained unchanged	d) Slightly improved	e) Considerably improved
☐	☐	☐	☐	☐

Financial systemic risks

- Decline in economic growth in Uzbekistan
- Geopolitical risks
- High exchange rate volatility
- High inflation
- Increasing household debt burden
- Rapid loan growth
- High loan concentration in specific segments (e.g., car loans)
- Default of large borrowers
- Funding (liquidity) risk
- Risk of refinancing bank debt obligations to foreign creditors
- Risk of sanctions
- Sharp decline in real estate prices
- Sharp decline in car prices
- Major disruptions in financial infrastructure (e.g., payment systems)
- Cyberattacks
- Climate risk

Table 7. Selected 70 Largest Enterprises

No.	Joint stock company
1	Agro finans lizing
2	Andijon biokimyo zavodi
3	Andijonkabel JV
4	Angren Issiqlik Elektr Stansiyasi
5	Bag‘doddonmahsulotlari
6	Biokimyo
7	Bog‘ot don
8	Buxoro hududiy elektr tarmoqlari korxonasi
9	Buxorodonmahsulotlari
10	Do‘stlik don mahsulotlari
11	Don-xalq rizqi
12	Dori-Darmon
13	Dunyo-M
14	Farg‘ona HETK
15	Farg‘onaazot
16	Indorama Kokand fertilizers and chemicals
17	Inter-Rohat JV
18	Jizzaxdonmahsulotlari
19	Juma elevatori
20	Kattaqo‘rg‘on yog‘-moy
21	Kogon paxta tozalash
22	Kvarts
23	Maxsuselektrtarmoqqurilish
24	Maxsusenergogaz
25	Navoiyazot
26	Navoiydonmahsulotlari
27	No‘kis vinozavodi
28	Ohangaron don
29	Ohangaronsement
30	Olmaliq KMK
31	Oq oltin don mahsulotlari
32	Oqtosh-don
33	Peshku paxta tozalash
34	Qizilqumsement
35	Qo‘qon biokimyo
36	Qo‘qon don mahsulotlari
37	Qo‘qon yog‘-moy
38	Surxondaryodonmahsulotlari
39	Tahiatosh don mahsulotlari
40	Toshkent yo‘lovchi vagonlarini qurish va ta’mirlash zavodi
41	Toshkentdonmahsulotlari
42	Uchqo‘rg‘on don mahsulotlari
43	Urganch yog‘-moy

44	UZBAT JV
45	Uzbek Leasing International
46	Uzkabel JV
47	Yangi angren issiqlik elektr stansiyasi
48	O‘zagrolizing
49	O‘zavtosanoat
50	O‘zbekenergota'mir
51	O‘zbekgeofizika
52	O‘zbekgidroenergoqurilish
53	O‘zbekiston pochtasi
54	O‘zbekiston rangli metall parchalari, chiqindilarini tayyorlash va qayta ishlash zavodi
55	O‘zbekko'mir
56	O‘zdonmahsulot
57	O‘zelektroapparat-electroshield
58	O‘zenergota'minlash
59	O‘zkimyosanoat
60	O‘zmetkobinat
61	O‘zneftgazquduqta'mirlash
62	Uzbek Commodity Exchange
63	O‘z-Tong Hong Kompani Uzbekiston-Korea JV
64	G‘alla-Alteg
65	G‘ijduvon paxta tozalash
66	Sharg‘un ko‘mir
67	Bektemir-spirt eksperimental zavodi
68	Toshkentvino kombinati
69	Chilonzor buyum savdo kompleksi
70	Chirchiq transformator zavodi

State space model (SSM)

The SSM[152] serves to theoretically estimate the value of a endogenous variable by determining the linear correlation function between the variables. This model consists of an observable or measurement equation representing the level of interdependence of observable and unobservable variables and a transition equation representing dynamic state variables:

$$y_t = H_t z_t + G_t x_t + v_t$$
$$z_t = B_{t-1} z_{t-1} + F_{t-1} x_{t-1} + w_{t-1}$$

Here, y_t is a vector of observable endogenous variables, x_t is a vector of observable exogenous variables, z_t is a state vector, v_t is a vector of measurement errors, w_t is a vector of transition equation errors, H_t, G_t, B_t and F_t are matrices of estimated coefficients.

The estimated coefficients representing the relationships between endogenous, exogenous and state variables in this model are estimated by maximum likelihood using the Kalman filter.

Kalman filter

A Kalman filter is a mathematical algorithm that recursive estimates unobservable variables with observable ones. In this case, the values of conditional expected unobserved state variables $z_{t|t}$ and conditional covariance matrix $\Omega_{t|t}$ depending on the data up to this period are determined for each t period through the Kalman filter.

The following additional notation in stating the Kalman filter recursions:

$$z_{t|s} \coloneqq E(z_t | y_1, \ldots, y_s),$$
$$\sum_z (t|s) \coloneqq Cov(z_t | y_1, \ldots, y_s),$$
$$y_{t|s} \coloneqq E(y_t | y_1, \ldots, y_s),$$
$$\sum_y (t|s) \coloneqq Cov(y_t | y_1, \ldots, y_s),$$
$$(z|y) \sim N(\mu, \sum).$$

Under the previously stated conditions, the normality assumption implies:

$$(z_t | y_1, \ldots, y_{t-1}) \sim N(z_{t|t-1}, \sum_z (t|t-1)),\ t = 2, \ldots, T$$
$$(z_t | y_1, \ldots, y_t) \sim N(z_{t|t}, \sum_z (t|t)),\ t = 1, \ldots, T$$
$$(y_t | y_1, \ldots, y_{t-1}) \sim N(y_{t|t-1}, \sum_y (t|t-1)),\ t = 2, \ldots, T$$
$$(z_t | y_1, \ldots, y_T) \sim N(z_{t|T}, \sum_z (t|T))$$
$$(y_t | y_1, \ldots, y_T) \sim N(y_{t|T}, \sum_y (t|T)),\ t > T.$$

[152] Lütkepohl, H. (2005). New Introduction to Multiple Time Series Analysis. Springer Science & Business Media.

The unobservable variables and covariance matrices are determined by the prediction, correction and forecasting steps after running the Kalman filter.

A Kalman filter is run by entering the initial values of the unobservable variables and covariance matrices:

$$z_{0|0} \coloneqq \mu_0 \ , \sum_z \ (0|0) \coloneqq \sum_0$$

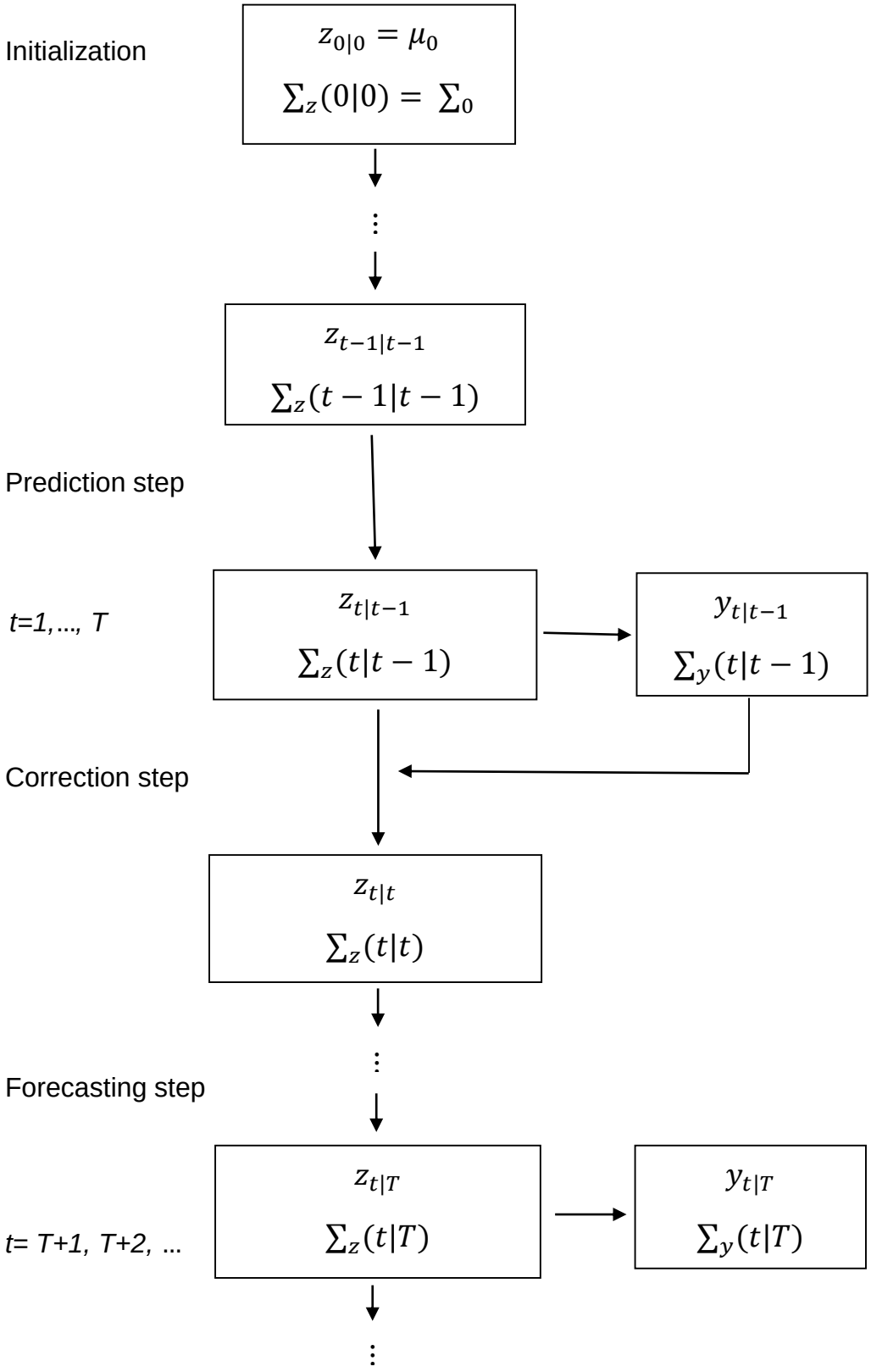
The prediction step of the Kalman filter $(1 \leq t \leq \ T)$:

$$z_{t|t-1} = \mathrm{B} z_{t-1|t-1} + \mathrm{F} x_{t-1},$$
$$\sum_z (t|t-1) = \mathrm{B} \sum_z (t-1|t-1) \mathrm{B}' + \sum_w,$$
$$y_{t|t-1} = \mathrm{H}_t \, z_{t|t-1} + \mathrm{G} x_t,$$
$$\sum_y (t|t-1) = \mathrm{H}_t \sum_z (t|t-1) \mathrm{H'}_t + \sum_v.$$

The correction step of the Kalman filter $(1 \leq t \leq \ T)$:

$$z_{t|t} = \ z_{t|t-1} + \mathrm{P}_t (y_t - \ y_{t|t-1}),$$
$$\sum_z (t|t) = \sum_z (t|t-1) - \mathrm{P}_t \ \sum_y (t|t-1) \mathrm{P'}_t,$$
$$\mathrm{P}_t \coloneqq \sum_z (t|t-1) \mathrm{H'}_t \sum_y (t|t-1)^{-1}.$$

Figure 164. Kalman filter recursions



Source: Lütkepohl, H. (2005). New Introduction to Multiple Time Series Analysis. Springer Science & Business Media.

After running the Kalman filter, the prediction and correction steps are performed for the period $t = 1$. The steps of prediction and correction are repeated successively for subsequent periods as well.

The last forecasting step of the Kalman filter is $t > T$:

$$z_{t|T} = \mathrm{B} z_{t-1|T} + \mathrm{F} x_{t-1},$$
$$\sum_z (t|T) = \mathrm{B} \sum_z (t-1|T) \mathrm{B}' + \sum_w,$$
$$y_{t|T} = \mathrm{H}_t \, z_{t|T} + \mathrm{G} x_t,$$
$$\sum_y (t|T) = \mathrm{H}_t \sum_z (t|T) \mathrm{H}'_t + \sum_v.$$

The forecasting step may be carried out recursively for $= T + 1, T + 2, \ldots$.

The vectors of estimated coefficients used in the steps of the Kalman filter are estimated using the maximum likelihood function.

Maximum likelihood estimation

The time invariant vector $\delta(B, F, G, H_t, \sum_w, \sum_v, \sum_0, \mu_0)$ are uniquely determined and at least twice continuously differentiable with respect to elements of δ.

To determine the unknown parameters, a log-likelihood function is first created and the maximum value of this function is estimated.

According to Bayes' theorem, the sample density function has the following form:

$$\begin{aligned} f(y_1, \ldots, y_T; \delta) &= f(y_1; \delta) f(y_2, \ldots, y_T | y_1; \delta) \\ &\vdots \\ &= f(y_1; \delta)\, f(y_1 | y_2; \delta) \cdots f(y_T | y_1, \ldots, y_{T-1}; \delta). \end{aligned}$$

Also, the Gaussian log-likelihood function for K dimensional y_t is expressed by the logarithmic value of the multiplication of density functions as follows:

$$\begin{aligned} \ln l\,(\delta | y_1, \ldots, y_T) &= \ln f(y_1, \ldots, y_T; \delta) \\ &= \ln f(y_1; \delta) + \textstyle\sum_{t=2}^{T} \ln f(y_t | y_1, \ldots, y_{t-1}; \delta) \\ &= -\frac{KT}{2} \ln(2\pi) - \frac{1}{2} \textstyle\sum_{t=1}^{T} \ln|\, \Sigma_y (t|t-1)| \\ &\quad -\frac{1}{2} \sum_{t=1}^{T} \left(y_t - y_{t|t-1}\right)' \Sigma_y (t|t-1)^{-1} \left(y_t - y_{t|t-1}\right) \end{aligned}$$

This log-likelihood function uses the following as starting values:

$$y_{1|0} \coloneqq E(y_1)$$
$$\Sigma_y (1|0) \coloneqq Cov(y_1)$$
$$(y_t | y_1, \ldots, y_{t-1}) \sim \mathcal{N}\left(y_{t|t-1}, \Sigma_y (t|t-1)\right)$$
$$t = 1, \ldots, T$$

After determining the parameter vector δ, all the quantities in the log-likelihood function can be computed with the Kalman filter recursions.

To simplify the representation of the log-likelihood function, the following notation is introduced:

$$e_t(\delta) \coloneqq y_t - y_{t|t-1}$$
$$\Sigma_t(\delta) \coloneqq \Sigma_y(t|t-1)$$

The log-likelihood function will have the following form through the given notations:

$$ln\, l\,(\delta) = -\frac{KT}{2}\, ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}[ln|\Sigma_t(\delta)| + e_t(\delta)'\Sigma_t(\delta)^{-1}e_t(\delta)]$$

There are different ways to estimate the unknown parameters at their maximum values of the log-likelihood function. In particular, the values of the parameters that maximize the log-likelihood can be determined by taking special derivatives with respect to the unknown parameters and equalizing them to zero.

Appendix 9

Table 8. Climate change dashboard for Uzbekistan

	Indicator	Unit	The value of before the reference period	The value of the reference period	Reference period	Change
Real economic indicators	Total greenhouse gas emissions	million metric tons of carbon dioxide (CO_2)* equivalent	218,2	223,8	2022	↑
	Total carbon dioxide emissions	million metric tons	124,3	129,1	2022	↑
	Total greenhouse gas emissions per capita	metric tons of carbon dioxide (CO_2) equivalent	6,2	6,2	2022	→
	Total greenhouse gas emissions per unit of GDP	metric kilogram of carbon dioxide (CO_2) equivalent per 1 million UZS	335,6	286,9	2022	↓
	Total greenhouse gas emissions from agriculture	million metric tons of carbon dioxide (CO_2) equivalent	49,7	51,1	2022	↑
	Total greenhouse gas emissions from industrial processes and product use	million metric tons of carbon dioxide (CO_2) equivalent	9,3	9,0	2022	↓
	Total greenhouse gas emissions from energy sectors	million metric tons of carbon dioxide (CO_2) equivalent	152,1	156,3	2022	↑
	Total greenhouse gas emissions from waste	million metric tons of carbon dioxide (CO_2) equivalent	9,6	9,8	2022	↑
	Effects of land-use and forestry on greenhouse gas emissions	million metric tons of carbon dioxide (CO_2) equivalent	-3,4	-3,4	2022	→
	Other greenhouse gas emissions	million metric tons of carbon dioxide (CO_2) equivalent	0,3	0,4	2022	↑
	Total methane emissions	million metric tons of carbon dioxide (CO_2) equivalent	79,8	80,4	2022	↑
	Total methane emissions from agriculture	million metric tons of carbon dioxide (CO_2) equivalent	35,4	36,4	2022	↑
	Total methane emissions from industrial processes and product use	million metric tons of carbon dioxide (CO_2) equivalent	0,9	1,0	2022	↑
	Total methane emissions in energy sectors	million metric tons of carbon dioxide (CO_2) equivalent	34,8	34,1	2022	↓
	Total methane emissions from waste	million metric tons of carbon dioxide (CO_2) equivalent	9,6	9,8	2022	↑
	Total energy efficiency**	percent		5,0	2022	
	The share of renewable energy sources in the total volume of electricity production	percent	10,5	8,4	2021	↓
	Share of industry in total electricity consumption	percent	24,9	27,9	2022	↑
	Share of agriculture in total electricity consumption	percent	12,9	9,0	2022	↓

Mobilization indicators	Volume of "green" sovereign international bonds	million USD	0,0	348,4	2023	↑
	Environmental protection expenditure as percent of GDP	percent	0,04	0,04	2021	→
	Exports of low carbon technology products as percent of GDP	percent	0,0	0,1	2022	↑
	Imports of low carbon technology products as percent of GDP	percent	2,0	1,9	2022	↓
	Total trade in low carbon technology products as percent of GDP	percent	2,0	1,9	2022	↓
Risk indicators	ND-GAIN index	index	51,1	52,2	2021	↑
	Vulnerability level according to the ND-GAIN index	index	0,4	0,4	2021	→
	Readiness level according to the ND-GAIN index	index	0,4	0,4	2021	→
	Climate-driven INFORM Risk Indicator	index	3,9	3,9	2022	→
	Climate altering land cover index (CALCI)***	index	99,4	99,5	2020	↑
	Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980	Celsius	1,5	2,6	2022	↑

Sources: IMF, University of Notre Dame, Statistics Agency, and CBU staff calculations.

Note: Positive changes in the indicator are represented by green symbols, negative changes by red symbols, and unchanged states by yellow symbols. In addition, the direction of these signs means changes in the value of indicators.

*Carbon dioxide (CO2) equivalent is a metric measure used to compare the emissions from greenhouse gases on the basis of their global-warming potential (GWP), by converting the amounts of other gases to the equivalent amounts of carbon dioxide with the same global-warming potential. Carbon dioxide equivalents are usually expressed as million metric tons of carbon dioxide equivalents. The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated global warming potential.

**Total energy efficiency determines the amount of GDP per unit of consumption of total fuel and energy resources.

***The Climate Altering Land Cover Index (CALCI) is used to assess changes in land cover that may have a significant impact on climate change. It takes into account changes in land cover such as deforestation, level of urbanization and expansion of agricultural land. The year 2015 was selected as the base for the index since all countries reported land cover data for that year (2015 = 100).

Table 9. Financial Stability Measures in Uzbekistan as of January 1, 2024

Measure	Tool	Applicable norm
Ensuring liquidity in the banking system	Share of HQLA in total assets	10%
	Current liquidity ratio	25%
	LCR	100%
	NSFR	100%
Maintaining capital adequacy in the banking system	Regulatory capital ratio	13%
	Tier 1	10%
	CET 1	8%
	CCoB	3% (as part of regulatory requirements)
Reducing leverage and risk appetite in the banking system	RWA	Based on the annual interest rate and other indicators
	Leverage ratio	6%
Reducing dollarization	Ban on issuing foreign currency loans to individuals	Loans in foreign currency are not granted
	Differentiated mandatory reserve requirements	4% for the national currency 18% for foreign currencies
	LCR in foreign currencies	100%
	NSFR in foreign currencies	100%
Regulating of debt burden	PTI	50% (only for microdebts)
	Daily limit on interest payments on a loan or microloan in relation to the principal outstanding	0.3%
	Differentiated RWA	In line with the LTV ratio on mortgages and car loans
Mitigating key risks	Bank's maximum exposure limit for one borrower or a group of interconnected borrowers	25% of the bank’s Tier 1 capital
	The maximum amount of unsecured credit risk of a bank attributable to a single borrower or a group of related borrowers	5% of bank's Tier 1 capital
	A limit on the total amount of all major risks of the bank	Up to 5 times the bank's Tier 1 capital
	A limit on the maximum amount of risk per affiliated person	25% of the bank’s Tier 1 capital
	Maximum exposure limit for all affiliated persons	50% of the bank’s Tier 1 capital

Source: CBU.

Table 10. Capital Adequacy Requirements and Buffers Across Countries as of January 1, 2024, % of RWA

Country	Minimum capital requirements			Capital buffer requirements			
	CET1[153]	Tier1[154]	CAR	CCoB	CCyB	SyRB	D-SIB buffer
Albania	6,75	9	12	2	0	0	0,5–1,5
Belgium	4,5	6	8	2,5	0	9	0,75–1,5
Canada	4,5	6	8	2,5	0	0	0,25–1
Croatia	4,5	6	8	2,5	0,75	2	0,25–2
Cyprus	4,5	6	8	2,5	1	0	1–3,5
Czech	4,5	6	8	2,5	0	0	1
Estonia	4,5	6	8	2,5	0	0	1,0–2,5
Finland	4,5	6	8	2,5	0	0–2	0,5–2,5
France	4,5	6	8	2,5	1	0	0,5–1,5
Georgia	4,5	6	8	2,5	0	0	0,25–1,25
Germany	4,5	6	8	2,5	0	0	0,25–1,5
Greece	4,5	6	8	2,5	3,5	0	0
Hong Kong	4,5	6	8	2,5	0,5	0	0,25–1,875
Hungary	4,5	6	8	2,5	0	0	0,25–2
Ireland	4,5	6	8	2,5	0	1	2
Italy	4,5	6	8	2,5	0	0	0,5–1
Kazakhstan	5,5	6,5	8	2,5	0	1	0,25–2
Latvia	4,5	6	8	2,5	2,5	4,5	1–2
Liechtenstein	4,5	6	8	2,5	0	0	0,25–2
Malaysia	4,5	6	8	2,5	1	0–2	0,5–2
Malta	4,5	6	8	2,5	0	0	0,5–2,5
New Zealand	4,5	6	8	2,5	0,5	0,5–1	0,25–1,25
North Macedonia	4,5	6	8	2,5	0	0	0,5–2,5
Norway	4,5	6	8	2,5	0,5	3	0,25–1,5
Poland	4,5	6	8	2,5	1	1,5	0,5–2
Romania	4,5	6	8	2–3	0	0	1
Saudi-Arabia	4,5	6	8	2,5	2,25	0	0,5–2,5
Slovenia	4,5	6	8	2,5	1	0	1–3,5
South Africa	4,5	6	8	2,5	1,5	0	2
Spain	4,5	6	8	2,5	0	0	2

Sources: National authorities and European Systemic Risk Board.

[153] The minimum requirement for Tier 1 capital, which is 6%, includes the minimum requirement for CET1 capital, 4.5%.

[154] The minimum requirement for regulatory capital, 8%, includes the minimum requirement for Tier 1 capital, 6%.

Table 11. Current and Announced Positive CCyB Rates, % of RWA

Country	Buffer rate as of January 1, 2024	Scheduled buffer rate in the upcoming period
Australia	↑ 1	
Austria	→ 0	
Albania	→ 0	
Armenia	↑ 1,5	
Belgium	→ 0	01.04.2024: ↑ 0,5 01.10.2024: ↑ 1
United Kingdom	↑ 2	
Bulgaria	↑ 2	
Hungary	→ 0	01.07.2024: ↑ 0,5
Germany	→ 0,75	
Hong Kong	→ 1	
Greece	→ 0	
Georgia	→ 0	15.03.2024: ↑ 1
Denmark	↑ 2,5	
South Korea	→ 0	01.04.2024: ↑ 1
Ireland	↑ 1	07.06.2024: ↑ 1,5
Iceland	↑ 2	16.03.2024: ↑ 2,5
Spain	→ 0	
Italy	→ 0	
Cyprus	↑ 0,5	02.06.2024: ↑ 1
Lithuania	↑ 1	
Luxembourg	→ 0,5	
Moldova	→ 0	
Netherlands	→ 1	31.05.2024: ↑ 2
Norway	↑ 2,5	
Poland	→ 0	
Portugal	→ 0	
Romania	↑ 1	
Singapore	→ 0	
Slovakia	↑ 1,5	
Slovenia	↑ 0,5	01.01.2025: ↑ 1
France	↑ 1	
Croatia	↑ 1	30.06.2024: ↑ 1,5
Montenegro	→ 0	
Czech	↑ 2	
Chili	→ 0	23.05.2024: ↑ 0,5
Switzerland	↑ 2,5	
Sweden	→ 2	
North Macedonia	→ 1	01.11.2024: ↑ 1,25 01.01.2025: ↑ 1,5
Estonia	↑ 1,5	

Sources: National authorities.

Table 12. Direct Limits on PTI/DSTI Across Countries as of January 1, 2024, % of income

Country	Mortgage loans	Car loans	Consumer loans (except car loans)	Others
Austria	40	40	40	40
Angola	40	40	40	40
Bangladesh		33	33	
Belarus		40	40	
Columbia	30			
Cyprus	80 (in the national currency) 65 (in foreign currencies)	80 (in the national currency) 65 (in foreign currencies)	80 (in the national currency) 65 (in foreign currencies)	80 (in the national currency) 65 (in foreign currencies)
Czechia	45 50 (for those under 36)			
Estonia	50			
Finland	60			
France	35			
Georgia	20–50	20–50	20–50	20–50
Hungary	25–60	50	50	50
Iceland	40 (first time buyers) 35 (other mortgages)			
Kazakhstan		50	50	
Kuwait	40 30 (retired individual)	40 30 (retired individual)	40 30 (retired individual)	40 30 (retired individual)
Latvia	40	40	40	
Lithuania	60	60	60	60
Malta	40	40	40	40
Moldova		40 30 (in foreign currencies)	40 30 (in foreign currencies)	
Mongolia	45	60	60	
Netherlands	3,5–41,5			
Oman	60	50	50	50
Portugal	50	50	50	50
Romania	40 (in the national currency) 20 (in foreign currencies)	40 (in the national currency) 20 (in foreign currencies)	40 (in the national currency) 20 (in foreign currencies)	40 (in the national currency) 20 (in foreign currencies)
Slovakia	60	60	60	60
United Arab Emirates	50	80	50	50

Sources: IMF, European Systemic Risk Board and national authorities.

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