Financial Stability Report

2022

May 2023

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, 2023.

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

AE	Advanced economies
AUROC	Area under the Receiver Operating Characteristic Curve
CAR	Capital adequacy ratio
CBU	Central Bank of Uzbekistan
CCoB	Capital conservation buffer
CCyB	Countercyclical capital buffer
CET1	Common Equity Tier 1 capital
D-SIB	Domestic systemically important bank
DSR	Debt service ratio
ELA	Emergency liquidity assistance
EM	Emerging markets
FDIC	Federal Deposit Insurance Corporation
Fed	US Federal Reserve System
FGDCB	Fund for guaranteeing deposits of citizens in banks
FSI	Financial stress index
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GDP	Gross domestic product
GSADF	Generalized supremum augmented Dickey-Fuller
G-SIB	Global systemically important bank
HP	Hodrick-Prescott
IMF	International Monetary Fund
LCR	Liquidity coverage ratio
LTV	Loan-to-value
NGFS	Network of Central Banks and Supervisors for Greening the Financial System
NSFR	Net stable funding ratio
OLS	Ordinary least squares
PCA	Principal component analysis
PTI	Payment-to-income
ROA	Return on assets
ROE	Return on equity
RORWA	Return on risk-weighted assets
RWA	Risk-weighted assets
SIB	Systemically important bank
SOB	State-owned bank
SSM	State-space model
SyRB	Systemic risk buffer
USD	United States dollar
UZS	Uzbek soum

Financial Stability Report for 2022

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Executive Summary

In 2023, global financial stability risks have increased. Uncertainty in the US and European financial systems led to financial losses for some banks, resulting in panic and increased volatility in financial markets. This caused some banks to fail and decreased investors' risk appetite.

In contrast, Uzbekistan's banking system remained resilient in 2022. Its capital adequacy ratio (CAR) was higher than the minimum requirements set by the Central Bank of Uzbekistan (CBU). Banks had sufficient capital for lending and absorbing potential losses.

By the end of 2022, the financial stress conditions of the banking system improved. The financial stress index trended downward starting from Q2 2022 owing to the recovery in economic activity, a stable financial market, and the improvement in financial soundness indicators.

The share of non-performing loans (NPLs) in total loans decreased in 2022. The NPL ratio decreased because of the decline in the volume of NPLs at private banks and the growth of state-owned banks' (SOBs) credit outstanding. Uzbekistan's NPL ratio was lower than the average for Central Asia and the Caucasus countries.

However, household credit activity increased significantly. This could lead to an increase in their debt burden and the deterioration of their financial condition.

The debt service ratio (DSR) for consumer loans remained elevated. The DSR for car loans to individuals increased sharply in 2022. The average car loan amount per borrower increased by 41 percent. A high share of car loans in banks' loan portfolios could increase the concentration risk.

In 2022, the share of mortgage loans with a loan-to-value (LTV) ratio of 76–85 percent increased significantly. Their share in total mortgage loans was almost two-thirds, which could make mortgage borrowers more sensitive to changes in their income.

Despite these risks, macro stress test results for 2023–2025 indicate the banking system's resilience to various shocks. In the baseline and adverse scenarios, the banking system's CAR was significantly higher than the regulatory minimum. In the adverse scenario, the potential default of banks that failed to meet the minimum CAR would have a weak negative impact on other banks.

Financial Vulnerabilities Heatmap for Uzbekistan's Banking System

The financial vulnerabilities heatmap shows an increase in household debt burden and growing vulnerabilities in the real estate market (Appendix 1).

Household sector credit activity increased significantly. That may result in defaults due to the accumulation of risks in this sector and the borrowers' financial deterioration. In Tashkent, there has been a significant increase in residential housing prices due to structural issues and imbalances between actual and fundamental prices. This could lead to a decline in collateral values and difficulties in loan repayment if the gap between actual and fundamental prices changes. The leverage on outstanding mortgage loans to individuals indicates a rise in household indebtedness, making borrowers more vulnerable to shocks.

The high level of dollarization is the main vulnerability in the corporate sector, despite a decreasing trend in the share of FX loans to Uzbekistan's corporate sector in recent years. A sharp exchange rate fluctuation could negatively impact companies' solvency and even put pressure on the entire financial system.

The banking system assets-to-GDP ratio suggests that the importance of the banking system for the real economy is increasing. Therefore, the failure of a systemically important bank (SIB) could cause negative consequences for the economy, such as a deposit run and credit crunch.

Key risks to financial stability and measures to mitigate them	Risk level and its change	
	In the short term	In the medium term
External risks		
Growing instability in the global banking system. Further monetary policy tightening to tame inflation may amplify the banking system's vulnerabilities and can lead to further bank defaults. The default risk of other banks has increased following the failure of several US banks, such as Silicon Valley Bank, Signature Bank, and First Republic Bank, as well as the state-supported takeover of Credit Suisse by UBS. **Risk mitigation measures:** - strengthening the deposit insurance system and bank resolution framework; - reducing financial linkages with foreign banks that may likely fail; - providing emergency liquidity assistance (ELA) to solvent banks facing temporary liquidity problems.		
Secondary sanctions on companies and banks operating in Uzbekistan. Secondary sanctions, which the US and the European Union may impose against Uzbek companies and banks, can hurt the operation of banks and increase transaction costs. Compliance risks may also arise when conducting international transactions due to the deteriorated external geopolitical situation. **Risk mitigation measures:** - developing effective international sanctions compliance programs that take into account the restrictions of the US Office of Foreign Assets Control (OFAC), the Department of Commerce, and the European Union; - constant monitoring of changes in sanctions and periodic assessment of the risk materialization probability.		

Key risks to financial stability and measures to mitigate them	Risk level and its change	
	In the short term	In the medium term
Lower availability of external funding for banks and business entities due to the increased country risk premium. An increase in the risk premium may drive up interest rates on foreign loans. This may restrain new lending, and banks may come under pressure to use foreign currency liquidity to pay off external obligations. Ultimately, lending and economic activity may decline. **Risk mitigation measures:** - speeding up the transformation of SOBs; - deploying macroprudential measures to limit banks' dependence on external funding.		
Internal risks		
High car loan growth. The banks' exposure concentration in a particular sector increases their vulnerability to shocks and can cause considerable loan losses in times of crisis. An economic downturn makes borrowers with relatively lower income more likely to default on their car loans and can increase the share of NPLs in the banking system. **Risk mitigation measures:** - introducing a payment-to-income (PTI) limit for car loans; - raising risk weights for car loans.		

Key risks to financial stability and measures to mitigate them	Risk level and its change	
	In the short term	In the medium term
Increasing divergence between market and fundamental house prices. During economic downturns, this can increase the probability of bank loan losses owing to the sharp decline in the prices of houses serving as collateral. **Risk mitigation measures:** - tightening an LTV limit for mortgage loans relative to risk-weighted assets (RWA); - introducing a PTI limit for mortgage loans; - introducing a sectoral countercyclical capital buffer (CCyB) for mortgage loans.		

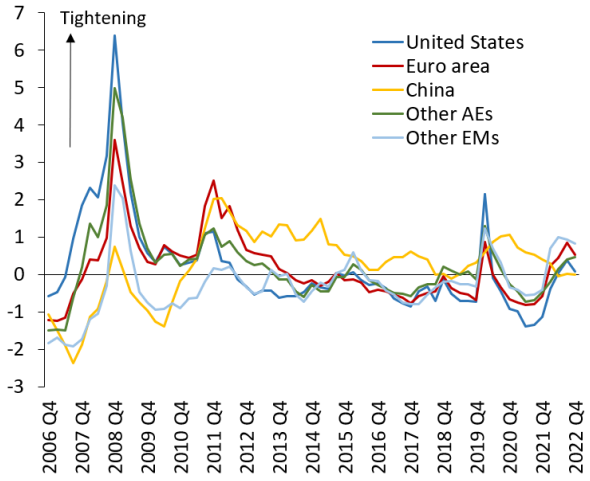
Low risk	Medium risk	High risk

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

I. Macro-Financial Vulnerabilities

In 2022, global macro-financial conditions developed amid the worsening external geopolitical situation, supply chain disruptions, high inflation, rising energy prices, and a slowdown in economic growth. Global financial conditions tightened disorderly due to the pandemic-era vulnerabilities and the geopolitical tensions. According to the International Monetary Fund (IMF) Staff Financial Conditions Index (FCI), financial conditions in advanced economies (AEs) and emerging markets (EMs) tightened significantly after the US Federal Reserve System (Fed) raised the federal funds rate multiple times in response to high inflation.

Figure 1. IMF Staff Financial Conditions Index (standard deviations from the mean)



Source: IMF.

However, in Q4 2022, global financial conditions eased as stock prices rose, mortgage interest rates declined, high-yield corporate bond prices fell, and market volatility declined. Furthermore, global bond yields decreased and corporate bond spreads narrowed as market expectations for interest rates changed[1]. Despite this, risks related to the tightening of financial conditions and recession remain high, mainly due to uncertainty about the duration of monetary policy tightening to curb high inflation and rising energy prices, given the unstable geopolitical situation.

Some countries eased their macroprudential policies to encourage lending during an economic downturn, but central banks in developed countries faced difficulties balancing monetary and macroprudential policies' objectives. This is because maintaining financial stability at a time of high inflationary pressures is challenging, since monetary policy tightening may amplify vulnerabilities. Given that monetary policy is focused on cyclical systemic risks[2], monetary and macroprudential policies must be conducted in a mutually consistent manner to ensure price and financial stability.

In spring 2023, the bankruptcies of Silicon Valley, Signature, and First Republic banks revealed some weaknesses in the banking system[3]. A sharp increase in the Fed fund rate negatively impacted banks with a high share of fixed-income securities in total assets, which in turn had a significant negative impact on financial markets[4].

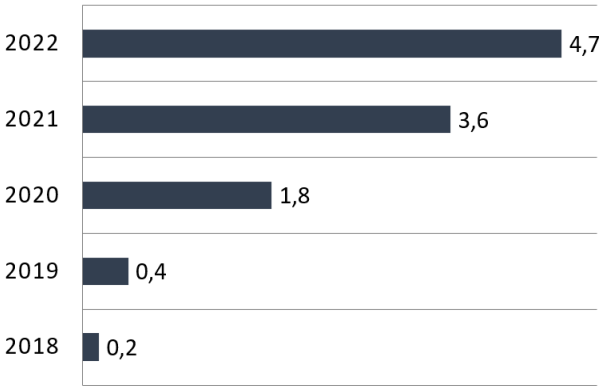
[1] International Monetary Fund. (2023, April). Global Financial Stability Report.

[2] Agenor, P., & Silva, L. (2013). Inflation Targeting and Financial Stability: A Perspective from the Developing World.

[3] International Monetary Fund. (2023). Global Financial Stability Report.

[4] There is an inverse relationship between bank interest rates and the market value of bonds. When bank deposit rates increase, the demand for bonds decreases. This is because bonds typically have fixed interest rates and are long-term investments. As a result, the supply and demand in the capital market cause bond prices to fall.

Figure 2. Share of Securities in Bank Assets in Uzbekistan, %

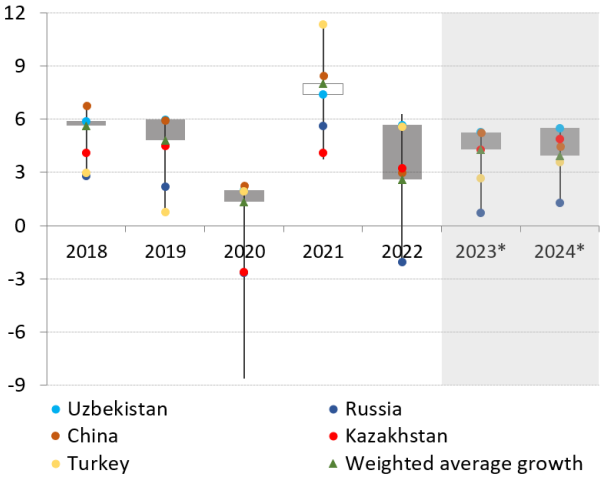


Source: CBU.

Contrarily, in Uzbekistan, the share of government securities in banks' total assets is small. By the end of 2022, commercial banks' securities portfolio accounted for only 4.7 percent of total assets, indicating that the banking system's financial stability is not sensitive to price fluctuations in the securities market, which may occur due to changes in the interest rate.

Despite global price pressures and tighter global financial conditions, Uzbekistan's GDP grew by 5.7 percent in 2022, and cross-border remittances more than doubled in the same year.

Figure 3. Growth Distribution of Main Trading Partners of Uzbekistan[5], %



Sources: IMF, CBU staff calculations.

Note: * Forecast.

In 2023 and 2024, Uzbekistan's GDP will grow by 5.3 and 5.5 percent[6], respectively, according to the IMF forecast, and by 4.9 and 5.1 percent[7], according to the World Bank forecast. In 2022, the average economic growth rate for Uzbekistan and its main trading partners was 2.6 percent, which is 5.4 percentage points lower than in 2021. Based on IMF data, Uzbekistan's main trading partners are expected to grow by 3.9 and 4.3 percent in 2023 and 2024, respectively.

[5] The rectangle in the chart shows the difference between Uzbekistan's GDP growth rate and the weighted average of GDP growth rates for selected countries (China, Kazakhstan, Kyrgyzstan, Russia, South Korea, Turkey, and Uzbekistan). The length of the rectangle indicates the extent of 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.

[6] International Monetary Fund. (2023, April). World Economic Outlook.

[7] World Bank. (2023, January). Global Economic Prospects.

Box 1. Spring 2023 Global Banking Turmoil

In spring 2023, there was global turmoil in the banking industry due to uncertainty in the US and European financial systems. This led to financial losses for several banks, causing anxiety and increased volatility in the financial markets. As a result, some banks defaulted and investors' risk appetite reduced.

Figure 4. Largest Bank Failures in US History, billion USD

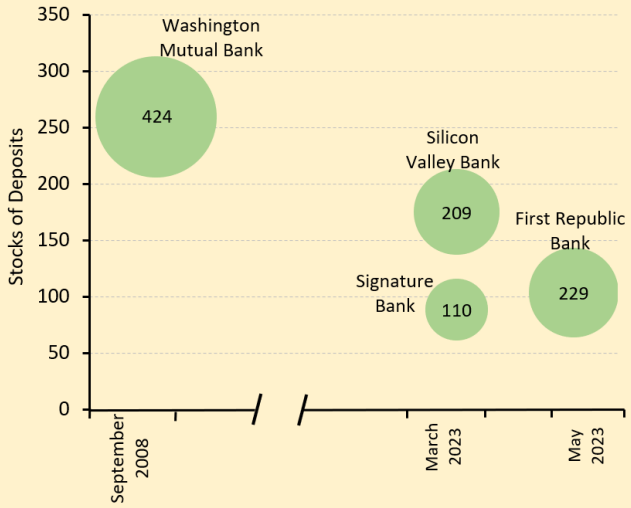
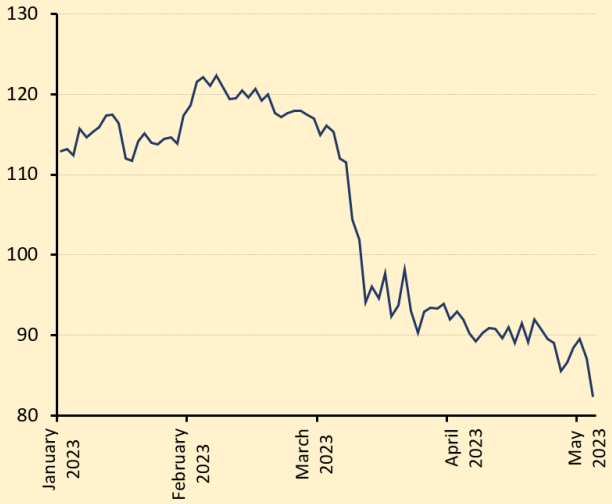


Figure 5. US KBW Regional Banking Index



Sources: Federal Deposit Insurance Corporation, KBW US Regional Bank Index, and CBU staff calculations.

Note: The value of banks' assets and deposits is taken before the period of sharp bank instability, and Washington Mutual Bank's assets and deposits are adjusted for inflation as of April 1, 2023. The bubble size reflects the share of each bank's assets in the total assets of all four failed banks, and the figures inside the bubbles show the volume of bank assets.

Silicon Valley Bank (SVB) had most of its customers as high-tech companies and startups. During the pandemic, bank deposits increased due to the sharp increase in the capitalization of technology companies. SVB reinvested the attracted deposits in liquid, low-risk US Treasuries and mortgage securities with long-term fixed interest rates. However, when the Fed began to raise interest rates to tame inflation, the value of fixed-income securities in the bank's assets declined accordingly. To meet customer demands for deposit withdrawal, SVB took huge losses selling off its assets, including bonds.

Signature Bank had 110 billion USD in assets and 88 billion USD in deposits at the end of 2022. It closed on March 12, 2023, and the Federal Deposit Insurance Corporation (FDIC) was appointed as its receiver[8], taking into account systemic risk considerations[9]. The bank began incurring financial losses in 2022 following the crisis of major high-tech, including crypto-assets, companies. The bank announced in December 2022 that it would reduce its crypto-tied deposits by almost 8–10 billion US dollars[10]. The default and closure of SVB caused a mass withdrawal

[8] Federal Deposit Insurance Corporation. (2023, March). FDIC Establishes Signature Bridge Bank, N.A., as Successor to Signature Bank, New York, NY. Press Release.

[9] Federal Deposit Insurance Corporation. (2023, March). Joint Statement by the Department of the Treasury, Federal Reserve, and FDIC. Press Release.

[10] Coindesk. (2022, December). Signature Bank to Reduce Crypto-Tied Deposits by as Much as $10 Billion.

of deposits from Signature Bank. On March 19, 2022, the FDIC announced that all of Signature Bank's 38.4 billion USD of deposits and a portion of its loan portfolio had been acquired by New York Community Bank for 2.7 billion USD.

First Republic Bank was the 14th largest bank in the US banking system by assets[11]. As of the end of Q1 2023, its deposits were reduced by 41 percent compared to the beginning of the year, as depositors withdrew their funds after the collapse of Silicon Valley and Signature banks in March. On March 9, 2023, bank deposits were around 173.5 billion USD. As of March 31, 2023, they dropped to 104.5 billion USD, including 30 billion USD of deposits provided by the 11 largest US banks[12]. By April 25, 2023, massive deposit withdrawals had caused the bank's share price to drop nearly 90 percent since the beginning of the year. The crisis of confidence that began in March 2023 and the fact that almost 2/3 of First Republic Bank's deposits were not insured by the FDIC as of 2022[13] were probably the main reasons for the deposit withdrawal.

On May 1, 2023, US banking regulators announced that First Republic Bank would be closed and sold to JPMorgan Chase Bank for 10.6 billion USD[14]. According to the deal, JPMorgan Chase Bank would acquire First Republic Bank's 173 billion USD of assets, 30 billion USD of securities, and 92 billion USD of deposits. The transaction would reduce the FDIC's expected losses from the closure of First Republic Bank. Under the deal, the FDIC would provide a five-year fixed-rate loan of 50 billion USD.

Credit Suisse, which has a 166-year history and is considered a global systemically important bank (G-SIB) and domestic systemically important bank (D-SIB) for the Swiss banking system, released a financial report that recorded a loss of 1.5 billion USD in Q4 2022 and an annual loss of 7.3 billion USD[15]. The report noted that the liquidity coverage ratio (LCR) decreased by nearly 60 percentage points in 2022, despite the bank's CAR exceeding minimum regulatory requirements. In Q1 2023, Credit Suisse experienced a net asset outflow of 68.6 billion USD[16].

In recent years, the bank's involvement in various scandals, incurring large losses due to the bankruptcy of Archegos Capital and Greensill Capital investment funds, and data leaks about the bank's clients led to a growing loss of trust among its customers[17]. Customers began withdrawing deposits en masse (about 120 billion USD of deposits were withdrawn from the bank in Q4 2022[18]). In addition, Credit Suisse shares fell to a historic low of 0.8 Swiss francs against the backdrop of SVB and Signature bank failures in the US and the refusal of Credit Suisse's largest shareholder, Saudi National Bank, to provide additional funding for the bank's capital. The Swiss National Bank (SNB) provided Credit Suisse with 54 billion USD in ELA[19] (Appendix 2). Credit Suisse was bought by UBS, a G-SIB and D-SIB, for 3.2 billion USD[20].

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[11] Federal Reserve. Large Commercial Banks. Statistical Release.

[12] Reuters. (2023). Major US banks inject $30 billion to rescue First Republic Bank.

[13] First Republic Bank. (2023). Quarterly report for 1st quarter of 2023. First Republic Bank.

[14] Reuters. (2023). Factbox: JPMorgan's deal for collapsed First Republic explained.

[15] Credit Suisse. (2023, April). First Quarter 2023 Financial Results.

[16] Credit Suisse. (2023). First Quarter 2023 Financial Results.

[17] The Washington Post. (2023, March) Credit Suisse is no more. What went wrong?

[18] Reuters. (2023, February). Credit Suisse warns of more losses, drawing regulatory attention.

[19] Halftermeyer, M., & Balezou, M. (2023). Credit Suisse Seeks Circuit Breaker With $54 Billion Line. Bloomberg.

[20] Union Bank of Switzerland (2023, March). UBS to acquire Credit Suisse.

Box 2. Role of Deposit Insurance in Ensuring Financial Stability

The main purpose of deposit insurance is to ensure financial stability, maintain the confidence of bank depositors in the banking system, and guarantee the return of their funds in the event of a bank failure[21]. If one bank experiences a large number of deposit withdrawals, it can cause panic among depositors in other banks, leading to more withdrawals. As a result, banks are forced to sell their assets at fire sale prices to meet depositors' demands. It worsens the liquidity and solvency of other financial institutions with similar assets due to the decrease in the market value of these assets. This can lead to reduced bank lending and slower economic growth[22].

In many countries, a special organization or receiver is responsible for taking control of a bank that is being liquidated[23]. The receiver's primary objective is to sell the bank's assets at a high value and fulfill obligations to creditors, including the government and the deposit insurance organization. In the US[24] and Canada[25], deposit insurance organizations act as receivers of failed banks and are responsible for managing bank liquidations and fulfilling their obligations. As part of the preparation for the bank liquidation, deposit insurance organizations are mainly required to identify the possible bank bankruptcy and to collect preliminary data on the deposits. After terminating the bank's activities, the deposit insurance organization has to publish information about the depositor compensation procedure and protect information about depositors[26].

A deposit insurance limit defines the maximum coverage. For example, in the US, the standard insurance amount is 250,000 USD per depositor, per insured bank, for each account ownership category[27]. In the European Union, a payout of deposits up to 100,000 euros is guaranteed[28].

Deposit insurance organizations are required to be adequately funded to pay insured deposits on time and maintain public confidence in the insurance system. The primary funding source for deposit insurance organizations is a deposit insurance fund, which is formed from periodic premiums paid by member banks. Premiums are charged based on a flat-rate or risk-based premium system[29]. In the flat-rate premium system, fees are determined by the stock of insured deposits at the same tariff rate set by the deposit insurance organization. In the risk-based premium system, high-risk banks pay higher premiums. The FDIC adopted the risk-based pricing system for banks in 1994[30]. The FDIC assesses the risk level of banks based on their capital levels (well-capitalized, adequately capitalized, or less than adequately capitalized) and

[21] Ketcha, N. (1999). Deposit insurance system design and considerations. Bank for International Settlements.

[22] FDIC. (2023). Options for Deposit Insurance Reform.

[23] Asser, T. M. C. (2001). Legal Aspects of Regulatory Treatment of Banks in Distress. International Monetary Fund.

[24] Federal Insurance Deposit Corporation. Receivership Management Program.

[25] Canada Deposit Insurance Corporation. Bridge bank backgrounder.

[26] Federal Deposit Insurance Corporation. (2010). FDIC Quarterly: 1st Quarter 2010.

[27] Federal Deposit Insurance Corporation. (2023). About FDIC.

[28] European Commission. (2015). European deposit insurance scheme.

[29] Ketcha, N. (1999). Deposit insurance system design and considerations. Bank for International Settlements.

[30] Garnett, E., Henry, L., Hoople, D., & Mihalik, A. (2020). A History of Risk-Based Premiums at the FDIC. Federal Deposit Insurance Corporation.

the CAMELS rating system[31]. If the deposit insurance fund is insufficient to pay depositors, the deposit insurance organization may be authorized to borrow from the government or the private sector[32].

The FDIC follows the principle of least-cost resolution, but if financial stability concerns overwhelm the desire to minimize potential costs to the taxpayer, it may waive this principle. For example, in early March 2023, the US authorities worried that uninsured depositors might withdraw their funds from other banks after the bankruptcy of Silicon Valley and Signature banks. As this situation could negatively affect the banking system and put the financial system at risk, on March 12, 2023, the Treasury, Fed, and FDIC announced that all uninsured deposits of Silicon Valley and Signature banks would be compensated in full[33].

In May 2023, the FDIC proposed three options for deposit insurance reform: limited, unlimited, and targeted coverage. The limited coverage includes an increase in the deposit insurance coverage limit per depositor from the current 250,000 USD while maintaining the existing deposit insurance process. Unlimited coverage offers unlimited deposit insurance coverage to all depositors. Targeted coverage introduces different insurance coverage limits for different types of accounts, particularly applying higher or unlimited coverage for business payment accounts. The FDIC report noted that the targeted coverage option is more consistent with the organization's depositor protection goals than the rest of the proposals, considering financial stability and costs associated with deposit insurance[34].

In Uzbekistan, deposit insurance was established in 2002 through the Fund for Guaranteeing Deposits of Citizens in Banks (FGDCB), which covers all banks licensed by the Central Bank of Uzbekistan. The FGDCB is funded through mandatory premiums paid by banks, income from depositing funds, and other sources per the law[35]. All citizens' bank deposits in Uzbekistan are fully guaranteed by the FGDCB.

[31] The CAMELS rating system assesses banks' performance in six categories, which include capital adequacy, asset quality, management capability, earnings, liquidity, and sensitivity. The rating system uses a scale of one to five, with one being the best and five being the worst.

[32] Federal Deposit Insurance Corporation. (2010). FDIC Quarterly: 1st Quarter 2010.

[33] Labonte, M. (2023). Bank Failures: The FDIC's Systemic Risk Exception. Congressional Research Service.

[34] Federal Deposit Insurance Corporation. (2023, March). Options for Deposit Insurance Reform.

[35] O'zbekiston Respublikasi "Fuqarolarning banklardagi omonatlarini himoyalash kafolatlari to'g'risida"gi 360-II-sonli Qonuni, 2002 yil 5 aprel.

II. Banking Sector

2.1. Banking System Vulnerabilities

Financial Stress Index

Since the 2008 Global Financial Crisis, there has been an increased interest in financial stress indices and early warning indicators. However, indicators that only cover the banking sector or foreign exchange market may not provide a complete picture of stress periods in the entire financial system. To evaluate emerging systemic risks, it is essential to develop an aggregate financial stress index (FSI) that covers different segments of the financial system.

The FSI for Uzbekistan was developed to represent the overall stress level in the country's financial system using a single aggregate index (Appendix 3). The FSI helps analyze the financial system's risk level and identify stress periods[36]. The trends of different economic and financial market indicators typically diverge, while the FSI facilitates analysis by aggregating several indicators into a single index. This makes the FSI a valuable component of the analytical toolkit for conducting macroprudential policy[37].

The Uzbek FSI combines indicators on the banking sector, money market, and foreign exchange market based on the country's financial system characteristics, data availability, and international practice (Appendix 4).

In Q1 2020, the Uzbek FSI surpassed the sum of its mean and one standard deviation due to the imposition of strict quarantine restrictions, which slowed down domestic economic activity and created uncertainties in the financial markets. However, loan deferments were provided for individuals, entrepreneurs, and legal entities facing financial difficulties during the pandemic[38]. As a result of these measures, the economic activity in Uzbekistan began to recover from H2 2020, and GDP growth reached a positive rate by the end of the year. Thanks to the economic recovery and the financial market stabilization, the FSI stayed below the sum of its mean and one standard deviation until Q1 2021.

From Q2 2021, the volume of interbank money market operations and associated interest rates decreased sharply, reaching 8.7 percent in July 2021, below the lower bound of the interest rate corridor[39].

In Q2 2021, the share of NPLs increased by 3.5 percentage points compared to the beginning of 2021 and reached 5.6 percent. During this quarter, the FSI went beyond the sum of its mean and one standard deviation due to fluctuations in the interbank money market.

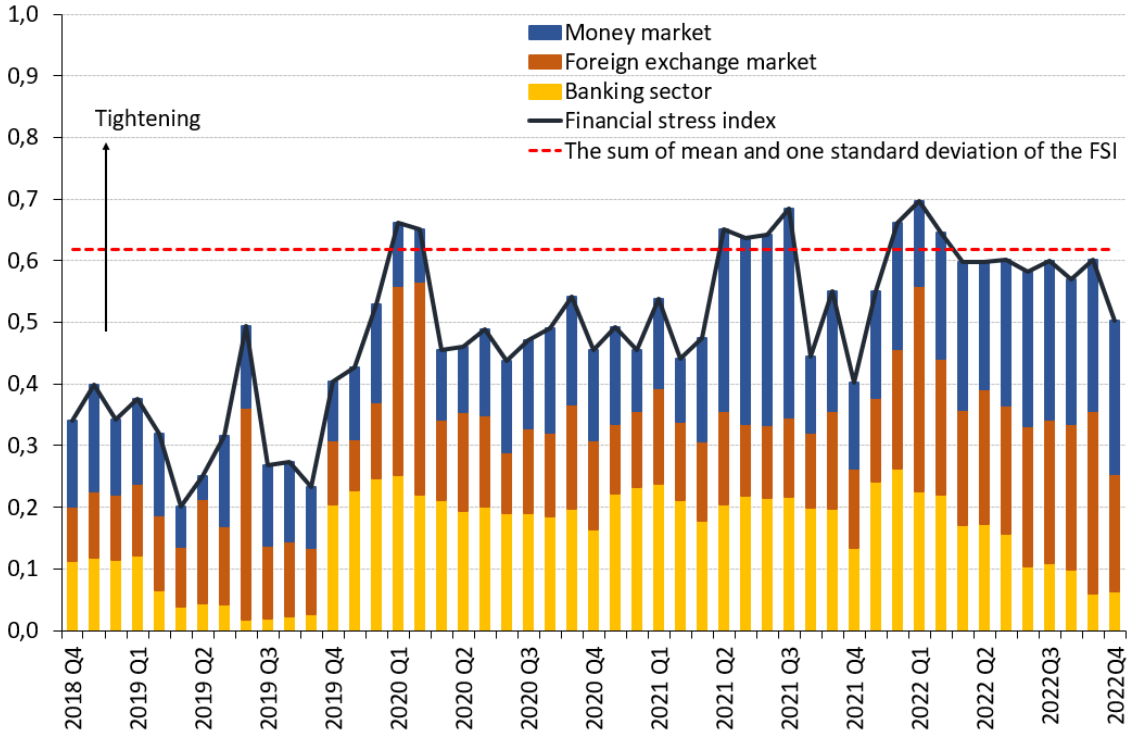
[36] European Central Bank. (2012). CISS - A composite indicator of systemic stress in the financial system.

[37] Bank of Latvia. (2012). Latvian Financial Stress Index.

[38] O‘zbekiston Respublikasi Prezidentining “Koronavirus pandemiyasi davrida aholi, iqtisodiyot tarmoqlari va tadbirkorlik sub’ektlarini qo‘llab-quvvatlashga doir qo‘shimcha chora-tadbirlar to‘g‘risida”gi PF-5978-sonli Farmoni, 2020 yil 3 aprel.

[39] Central Bank of the Republic of Uzbekistan. (2022). Statistical bulletin for 2021.

Figure 9. Financial Stress Index for Uzbekistan



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.

In Q1 2022, there was a 3.2 percent decline in net cross-border money transfers compared to Q1 2021, which was attributed to geopolitical tensions, exchange rate volatility, and a rise in global inflation[40]. The banking sector and foreign exchange market showed signs of stress, leading to an increase in the FSI in Q1 2022.

However, things improved in Q2 2022 as the population's real income increased. This was due to higher cross-border money transfers and increased economic activity, which softened the negative economic impacts of external factors. As bank profitability, liquidity, capital adequacy, and asset quality indicators improved, the FSI trended downwards.

[40] Central Bank of the Republic of Uzbekistan. (2023). Balance of payments of the Republic of Uzbekistan (standard presentation).

Box 3. Methodology of Financial Stress Index for Uzbekistan

The banking sector developments are captured using the differences between actual and potential values of deposits and loans using the Hodrick-Prescott (HP) filter and the ratio of net interest income to bank interest-bearing assets were considered. In analyzing the money market, the spread between money market rates and Uzbekistan treasury bill rates, as well as the volatility indicator for the weighted average interest rate of the interbank money market determined by the generalized autoregressive conditional heteroskedasticity (GARCH) model were used (Appendix 5). To determine risks in the foreign exchange market, the realized volatility[41] of the exchange rates of the US dollar and euro against the soum was used.

All indicators were standardized using the Z-score method, which is based on the difference between current values and the arithmetic mean of indicators from their standard deviation[42]. Standardized indicators were then aggregated into subindices, which capture changes in the banking sector, money market, and foreign exchange market. The principal component analysis (PCA) model was used for this purpose (Appendix 6). Before combining the subindices into the final index, their values were scaled between 0 and 1 using a logarithmic function[43].

The weight of the subindices in the aggregate FSI was determined by evaluating their relative impact on economic growth[44]. Based on the subindex values and determined weights, the final results of the FSI were obtained by computing their weighted average value.

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[41] The realized volatility of currency exchange rates is determined by the following formula:

$$rvol_t = \sqrt{\sum_{i=1}^{n} R_t^2}$$

Where:
$rvol$ - realized volatility
R - the difference between the natural logarithm of current and a day prior value of daily currency exchange rates.
t - months
i - days

[42] Standardization of indicators is carried out by the following formula:

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

Where:
y_z - the standardized value of the indicator
y_t - indicator
y_μ - the arithmetic mean of the indicator
σ_{y_t} - the standard deviation of the indicator
t - months

[43] Subindices are scaled between 0 and 1 by the following logarithmic function:

$$y_{it}{}' = \frac{1}{(1 + \exp(-y_{it}))}$$

[44] The weight of subindices is determined by the following formula:

$$min \sum_{t=1}^{T} \sum_{i=1}^{4} (GDP\_gr_t - w_i y_i)^2$$

$$\sum_{i=1}^{4} w_i = 1; w_i \geq 0$$

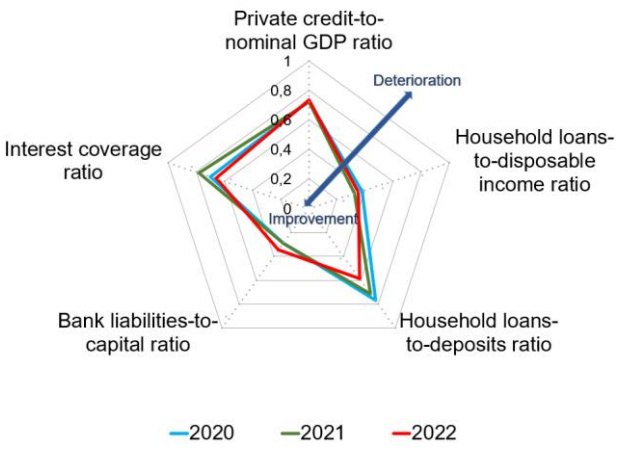
Where:
GDP_gr_t - GDP growth rate
w_i - subindex weight
y_i - subindex
t - quarters

Risk Map

The credit market risk map indicates that the private credit-to-nominal GDP ratio remained stable in 2021–2022. This means that the volume of credit allocated to the private sector increased according to GDP growth. In 2022, the private credit-to-nominal GDP ratio increased by 0.5 percentage points to 35.3 percent. The slow growth of lending volume to the private sector was influenced by the CBU's relatively tight monetary policy and the strengthening of prudential measures.

The household loans-to-disposable income ratio in 2022 increased slightly compared to 2021. Although the volume of loans to individuals grew at a higher rate than the disposable income of the population, it had a negligible negative impact on their ability to service debt.

Figure 7. Credit Market Conditions



Sources: Statistics Committee and CBU staff calculations.

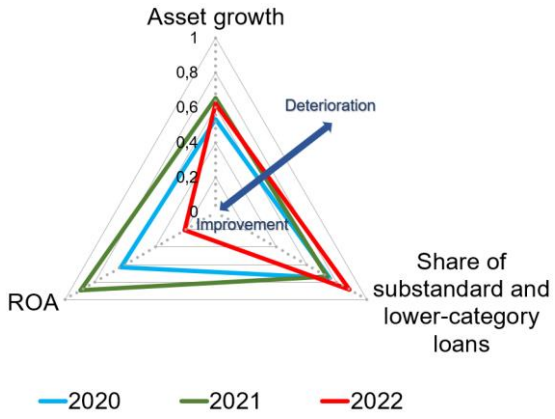
In the credit market risk map, there has been a notable improvement as the household loans-to-deposits ratio decreased by 17 percentage points to 147 percent in 2022 from the previous year. This was due to the increased attractiveness of interest rates on deposits offered by commercial banks to individuals, resulting in the growth rate of deposits taken from the population being slightly higher than the growth of their financial liabilities.

The bank liabilities-to-capital ratio in 2022 was 600 percent, increasing by 72 percentage points compared to 2021. The growth rate of liabilities caused this increase while capital adequacy did not decrease. The banks' liabilities increased due to high rates of growth in demand and term deposits, funds in the accounts of other financial institutions, credit, and leasing operations.

In 2022, the interest coverage ratio was almost two times higher than in 2021, amounting to 0.33. This was because the growth of net profit before tax (135 percent) was higher than the growth of interest expenses (22 percent).

The financial soundness risk map shows that the asset growth in 2022 was slightly higher than in 2021, but slower than in 2020. The total assets of banks reached 557 trillion UZS by the end of 2022, an increase of 112 trillion UZS or 25 percent compared to 2021. Loans and leases, the largest share of assets, increased by 63 trillion UZS or 20 percent, while claims on the CBU and other banks increased by 22 trillion UZS (31 percent) and assets in securities increased by 10 trillion UZS (64 percent).

Figure 8. Financial Soundness Conditions



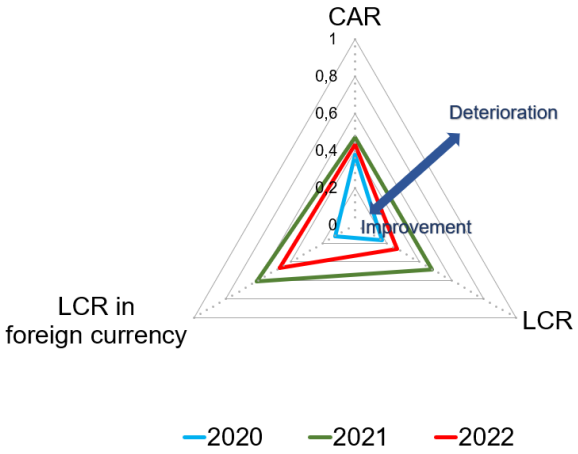
Source: CBU staff calculations.

By the end of 2022, the share of substandard and lower-quality loans was 15.9 percent, an increase of 3.4 percentage points compared to 2021. Substandard loans that were past due for 31 days or more but not more than 90 days were 12 percent and increased by 5 percentage points from 2021. The share of NPLs 91 days or more past due was 3.6 percent and decreased by 1.6 percentage points from 2021.

Commercial banks saw a significant increase in their return on assets (ROA). By the end of 2022, ROA was 2.5 percent, higher by 1.2 percentage points compared to the previous year. This increase was due to a decrease in NPLs and additional income generated by investing freed-up funds (returned reserves for potential losses) in new assets.

The risk map for banking system resilience showed that the resilience of commercial banks to possible financial losses remained stable. CAR, which expresses the ability of banks to cover possible losses, was higher than the established minimum requirements. CAR of commercial banks increased by 0.3 percentage points in 2022 due to the quantitative increase in the bank capital and changes in the methodology of calculating RWA.

Figure 9. Banking System Resilience



Source: CBU staff calculations.

The LCR, which reflects the ability of a bank to finance the growth of assets and ensure the timely fulfillment of obligations without unforeseen losses, was 212 percent at the end of 2022, 22 percentage points higher than in 2021. LCR in foreign currency increased by 35 percentage points to 202 percent in 2022, following a sharp decline in 2021. This increase in LCRs was due to highly liquid assets consisting of government and CBU securities, vault cash, and banks' funds in the CBU (except for required reserves).

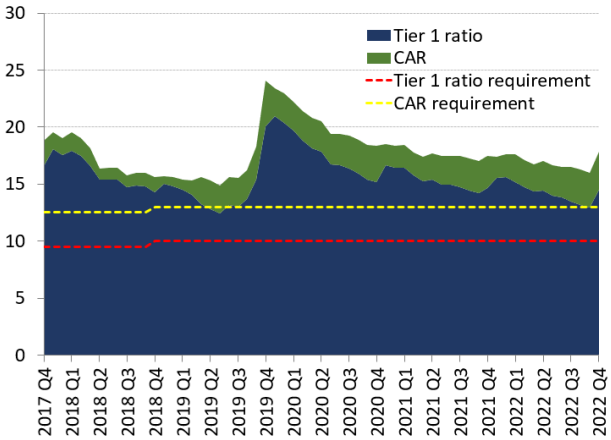
2.2. Financial Soundness Indicators

The banking system of Uzbekistan demonstrated resilience to internal and external risks in 2022, as indicated by its financial soundness indicators. The minimum requirements set by the CBU were surpassed by the banking system's CAR, providing sufficient capital to cover losses due to potential shocks and provide loans to the economy. Stable

profitability of banks and gradual improvement of the CBU's requirements for CAR allowed commercial banks to meet capital adequacy requirements. By the end of 2022, the total capital in the banking system was 83.4 trillion UZS and CAR was 17.8 percent, 0.3 percentage points higher compared to the beginning of 2022.

According to the current regulations in Uzbekistan, CAR should not be less than 13 percent, and Tier 1 capital ratio, including a capital conservation buffer of 3 percent, should not be less than 10 percent. Additionally, the Common Equity Tier 1 (CET1) should not be less than 8 percent, and the leverage ratio for banks is set at 6 percent.

Figure 10. CAR in Banking Sector, %



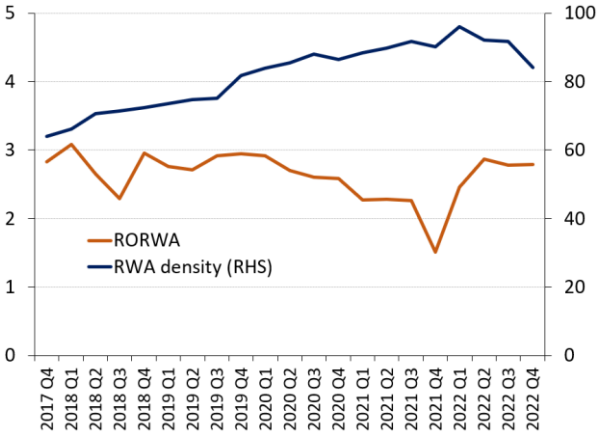
Source: CBU.

In Q4 2022, CAR increased sharply. Decreasing risk weights for government securities (including collateral in the form of guaranteed securities or guaranteed by them) from 20 to 0 percent and setting the risk level at 200 percent for the relevant part of the net stock in the balance sheet accounts reflecting NPL outstanding caused a decrease in RWA[45].

The share of Tier 1 capital in the total regulatory capital was 81 percent as of January 1, 2023. The total regulatory capital in the banking system is mainly made up of high-quality capital (common shares, capital surplus, retained earnings), which provides sufficient loss-absorbing capacity.

The RWA density[46] ratio has been constantly growing, with 96 percent of the total assets of commercial banks consisted of high-risk assets. This was caused by a constant increase in the volume of allocated loans, leading to an increase in the amount of banks' RWA. However, there was a decrease in RWA density to 84 percent at the end of 2022 due to the purchases of low-risk government and CBU securities by banks.

Figure 11. RWA Density and Return on Risk-Weighted Assets (RORWA), %

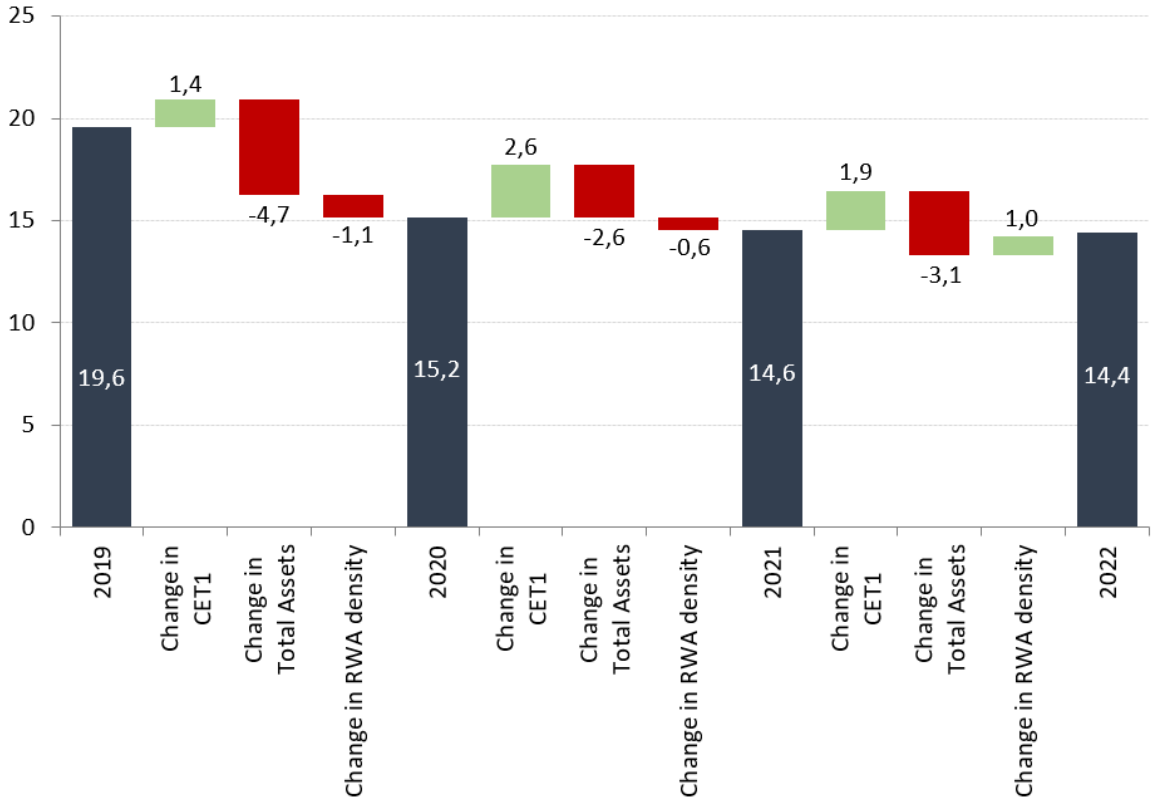


Source: CBU staff calculations.

[45] O'zbekiston Respublikasi Markaziy banki boshqaruvining "Tijorat banklari kapitalining monandligiga qo'yiladigan talablar to'g'risidagi nizomga o'zgartirish va qo'shimchalar kiritish haqida"gi 8/11-sonli qarori, 2023 yil 28 mart.

[46] To calculate RWA density, the amount of RWA is divided by total assets. 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 RWA density indicates an improvement in risk quality of assets.

Figure 12. Changes in CET1 Capital Ratio, %



Source: CBU staff calculations.

The decline in economic activity during the pandemic caused a slowdown in net profit growth for banks. In 2021, banks' net profit before tax fell by 23 percent. In 2021, RORWA declined due to an increase in RWA volume and a sharp decline in the income of banks. However, with the bank's increased income due to the recovery in economic activity and a lower RWA density, RORWA returned to pre-pandemic levels (2.8 percent by the end of 2022).

Despite the constant growth of CET1 capital in recent years, the increase in the amount of total assets affected the reduction of the CET1 capital ratio by 3.1 percentage points in 2022.

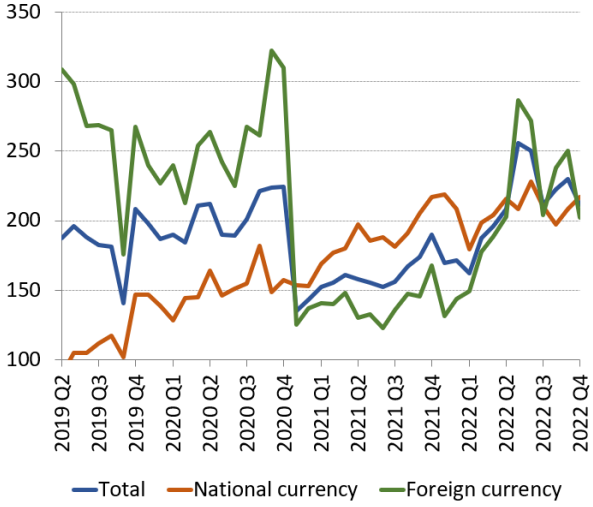
In 2022, the improved quality of banking system assets, resulting in a 1 percentage point decrease in RWA density and a 1.9 percentage point increase in CET1 capital, positively impacted the CET1 capital ratio. The 25 percent increase in total assets during 2022 slightly decreased the CET1 capital ratio. Overall, in 2022, the ratio decreased by 0.2 percentage points to 14.4 percent compared to 2021 but still exceeded the regulatory requirement.

Banks have a strong ability to handle short-term liquidity shocks, as shown by the steady growth of liquidity indicators. To improve this further, the CBU has established separate minimum requirements for the LCR for national and foreign currencies[47] to ensure that there are enough high-quality liquid assets to cover short-term liquidity needs. This will

[47] Effective from September 1, 2019.

increase the resilience of banks and decrease the dollarization level in the economy.

Figure 13. LCR in Banking System, %

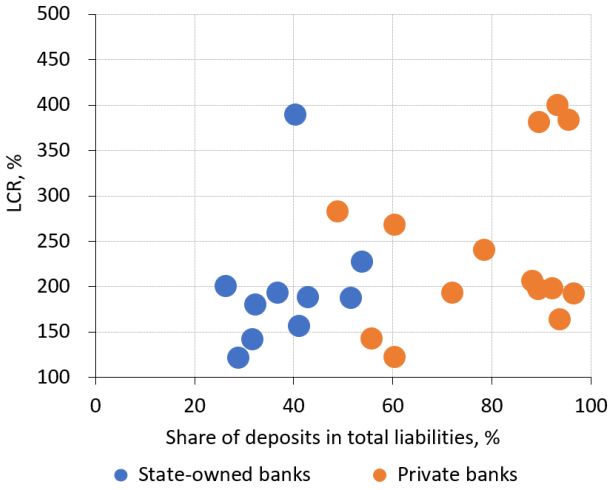


Source: CBU.

In 2022, the total LCR was higher than in 2021, reaching 212 percent. The national currency LCR remained stable, while the foreign currency LCR increased by 35 percentage points. Banks' highly liquid assets mainly increased in securities issued by the government and the CBU (68 percent or 10.5 trillion UZS), cash (81 percent or 8.6 trillion UZS), and claims on the CBU except for required reserves (16 percent or 4.5 trillion UZS).

By January 1, 2023, SOBs held 36 percent of their liabilities in deposits, while private banks held 78 percent. Private banks rely heavily on deposits to finance their operations. While their LCRs are above the minimum requirement of 100 percent, having a high proportion of deposits in their liabilities increases the likelihood of liquidity issues for these banks. In times of financial instability, large-scale withdrawals of customer deposits could lead to liquidity problems for private banks.

Figure 14. LCR in Banks and Share of Deposits in Total Liabilities (%)

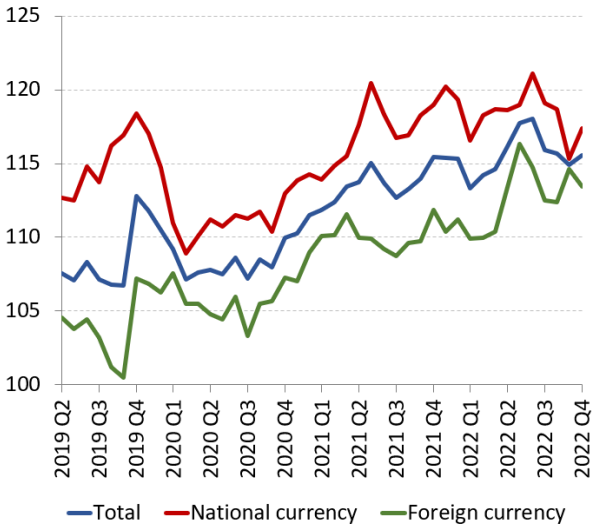


Source: CBU.

In 2022, the net stable funding ratio (NSFR) remained consistent and exceeded the minimum requirement set by the CBU. This indicates that banks have a steady flow of funding for their long-term assets. Specifically, as of January 1, 2023, the NSFR was 116 percent, the same level as the previous year. Having an NSFR above 100 percent helps prevent a mismatch between a bank's assets and liabilities. Due to improvements in LCR and NSFR[48] requirements, the difference in their indicators differentiated by currency has decreased.

[48] Starting from September 1, 2019, all currency types are required to have a minimum LCR and NSFR of 100 percent.

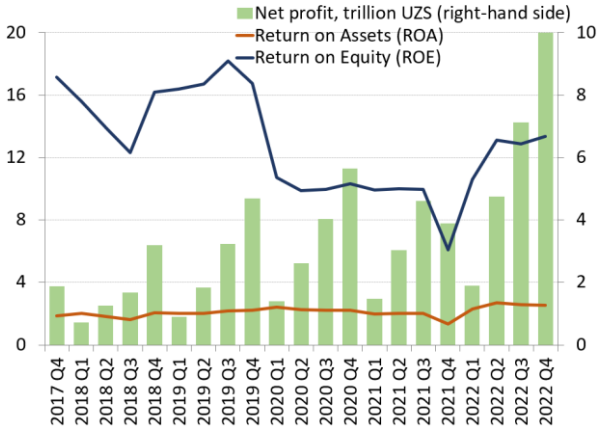
Figure 15. NSFR in Banking System, %



Source: CBU.

In 2021, the banking system experienced a decline in profitability indicators. However, in 2022, these indicators improved due to better quality of assets and increased interest income on loans. As of January 1, 2023, the return on assets (ROA) and return on equity (ROE) were 2.5 and 13.3 percent, respectively, with a net profit of 10 trillion UZS. These figures are higher than those of 2021, with a difference of 1.2 and 7.2 percentage points, respectively, and the net profit increased by 6.1 trillion UZS.

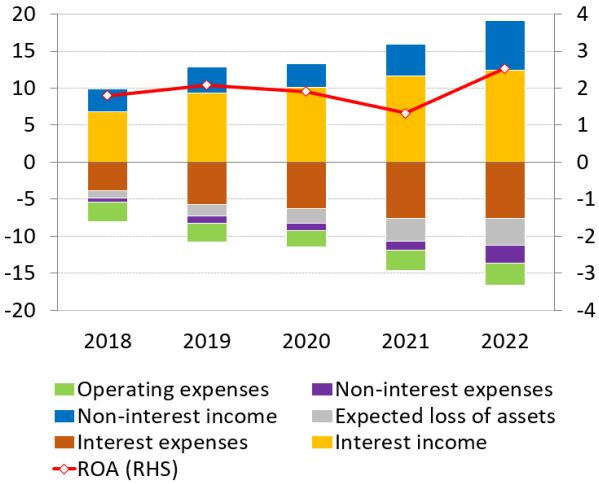
Figure 16. Profitability in Banking Sector



Source: CBU.

Net interest and non-interest income (4.9 and 4.3 percent, respectively) contributed to the increase in ROA in the banking system in 2022, while expected loss of assets (-3.6 percent) and operating expenses (-3.0 percent) had the opposite effect. The growth of net interest income in the banking system was due to an increase in commercial services, a decrease in preferential and direct loans, and an improvement in asset quality.

Figure 17. ROA Decomposition for Banking Sector, %

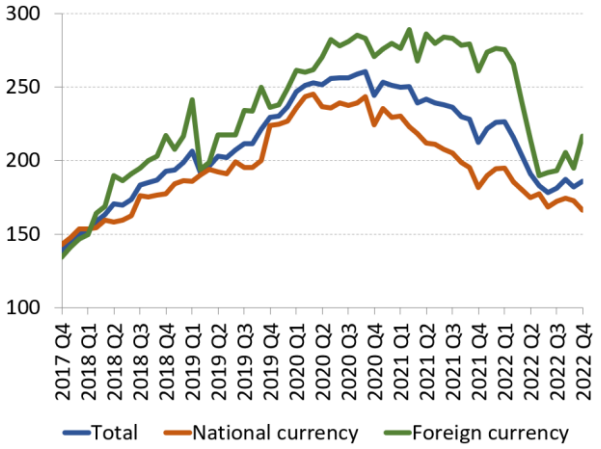


Source: CBU.

The downward trend of the loan-to-deposit ratio observed in 2021 slowed down in 2022. As of January 1, 2023, the total loan-to-deposit ratio was 180 percent, 32.5 percentage points lower than a year before. During this time, the volume of deposits increased by 39 percent, while the volume of loans increased by 18 percent. The decrease in the loan-to-deposit ratio can be attributed to the stabilization of liquidity in banks. This indicates that banks are not relying primarily on deposits for funding, and loans remain a traditional source of income. In 2022, higher weighted average interest rates on time deposits in national currency (20.7 percent for

individuals, 16.7 percent for legal entities) made deposits more appealing.

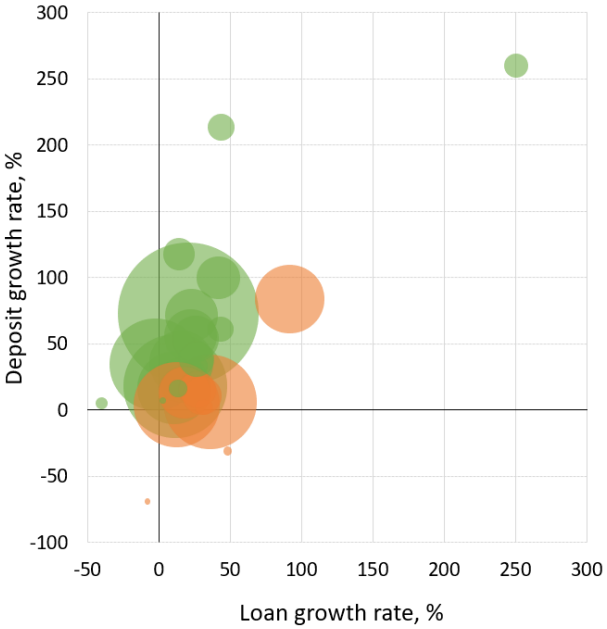
Figure 18. Loan-to-Deposit Ratio, %



Source: CBU.

The banking sector experienced a significant rise in deposit growth in 2022, double the growth rate of loans. Some small and medium-sized banks (based on the share of a bank's assets in the banking system's assets) saw a higher increase in the volume of loans compared to deposits. This indicates that these banks rely on additional funding sources besides deposits to provide loans. However, such reliance on unstable funding sources may increase their liquidity risk.

Figure 19. Annual Growth Rate of Loans and Deposits by Banks in 2022

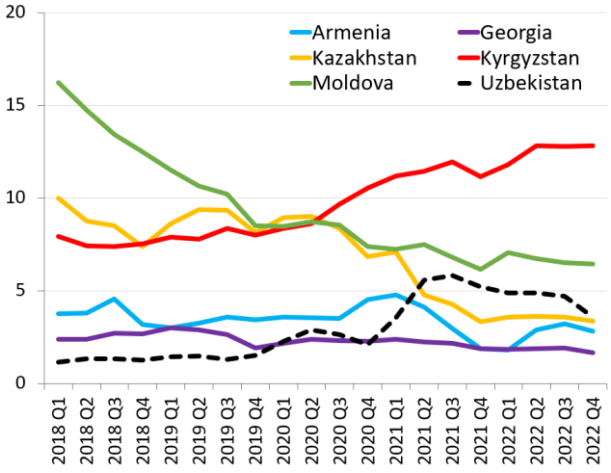


Source: CBU staff calculations.

Note: The green color on the chart represents banks with a faster growth rate of deposits compared to loans, while brown indicates banks with a lower growth rate of loans. The bubble size represents the share of a bank's assets in all banks' assets.

In Q3 2021, Uzbekistan's NPL ratio reached its highest point at 5.8 percent. However, it has been showing a decreasing trend lately.

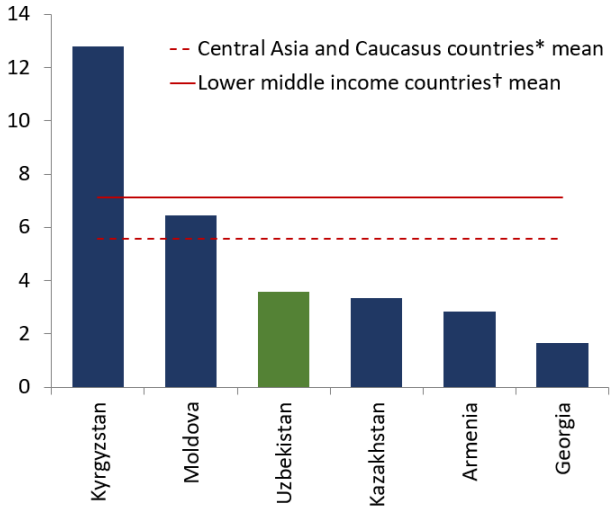
Figure 20. NPL Ratio in Selected Countries, %



Sources: National authorities, IMF, and CBU.

At the end of 2022, the NPL ratio in Uzbekistan was 3.6 percent, which was 1.1 percentage points lower than the average of Central Asia and Caucasus countries.

Figure 21. NPL Ratio in Selected Countries, % (as of January 1, 2023)



Sources: National authorities, IMF, and CBU.

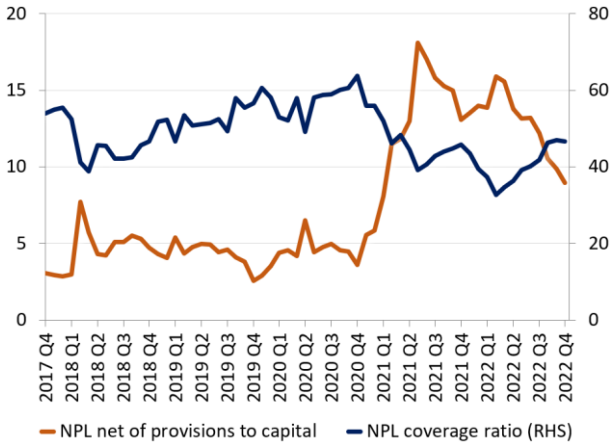
Note: * Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan are taken into account. Turkmenistan is not included due to a lack of data.

† Based on data availability, 29 countries in this category have been considered.

The improvement in the NPL coverage ratio during H2 2022 was due to an increase in the volume of reserves against loan losses by 7 percent, as well as a decline in the stock of NPLs.

A significant depreciation of the national currency could lead to a rise in the foreign currency NPL ratio. This is because foreign currency loan borrowers earn in national currency, except for export-oriented businesses. As a result, if the exchange rate depreciates sharply, borrowers may struggle to repay their loans, and the share of foreign currency NPLs may increase.

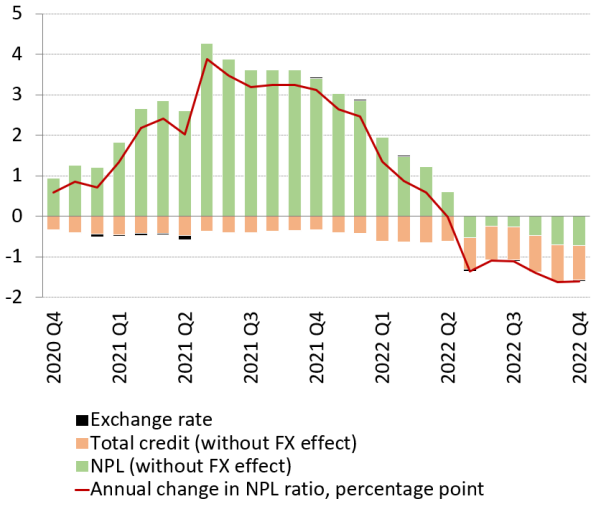
Figure 22. NPL and Provisions in Banking Sector, %



Source: CBU staff calculations.

The high growth of total loans and a stable exchange rate contributed to reducing the NPL ratio in H2 2022. Additionally, foreign currency loans have only been issued to legal entities in Uzbekistan, which has helped limit the impact of exchange rate depreciation on the NPL ratio.

Figure 23. Decomposition of Annual Change in NPL Ratio, %

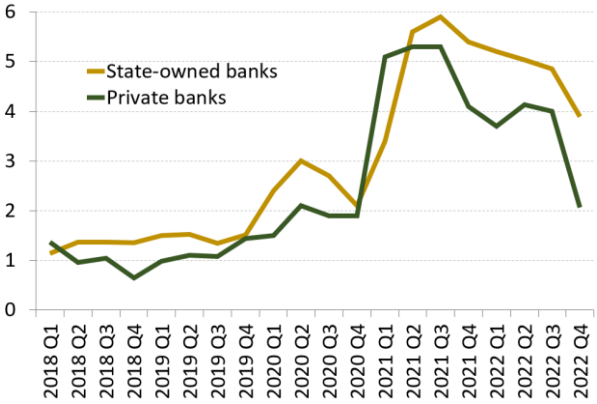


Source: CBU staff calculations.

During Q4 2022, private banks experienced a significant decrease in their NPL ratio. The CBU announced the bankruptcy of two banks, Turkiston and Hi-tech banks, in October 2022. These

banks had high shares of NPLs in their loan portfolios, at 95 and 94 percent respectively. This event served as a basis for the decrease in the private banks' NPL ratio. The suspension of these banks' activity resulted in a 1.1 percentage point decrease in the share of NPLs in total loans of private banks. Additionally, the increase in the loan portfolio of SOBs by almost 20 percent in 2022 also contributed to the decrease in the share of NPLs.

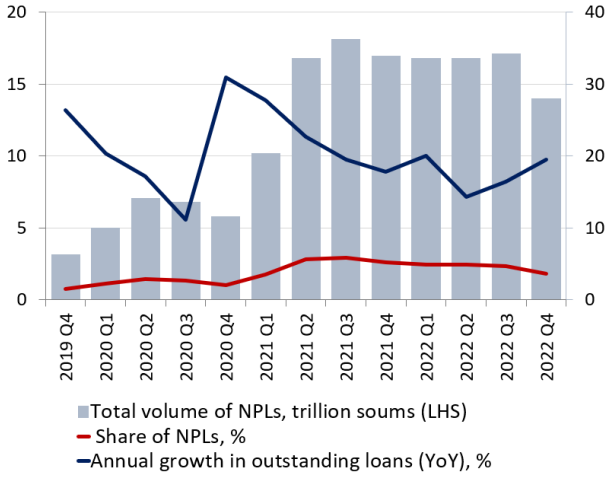
Figure 24. Share of NPLs in Total Loans of SOBs and Private Banks, %



Source: CBU.

The correlation between the credit growth rate and the NPL ratio in Uzbekistan is relatively weak. However, a high credit growth rate could potentially have a negative impact on asset quality in the future.

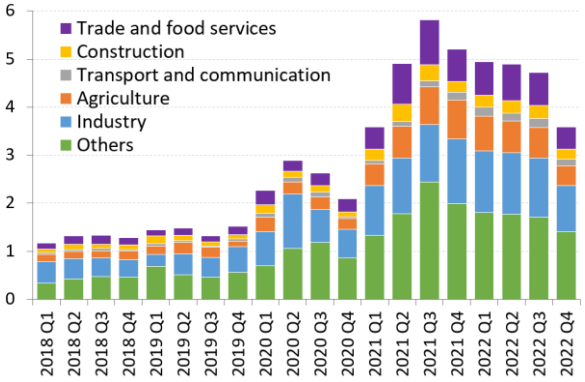
Figure 25. Share of NPLs in Total Loans; Annual Growth in NPL Ratio and Outstanding Loans



Source: CBU.

In 2022, the industrial sector had the highest amount of NPLs, according to the breakdown of the NPL ratio by economic sectors. However, there was an overall decrease in the NPL ratio across all sectors. Specifically, NPLs decreased by 40 percent in agriculture, 18 percent in trade and food services, and 15 percent in industry. Moreover, the share of NPLs in total loans to individuals has accounted for a large proportion in other sectors.

Figure 26. NPL Decomposition by Sectors, %

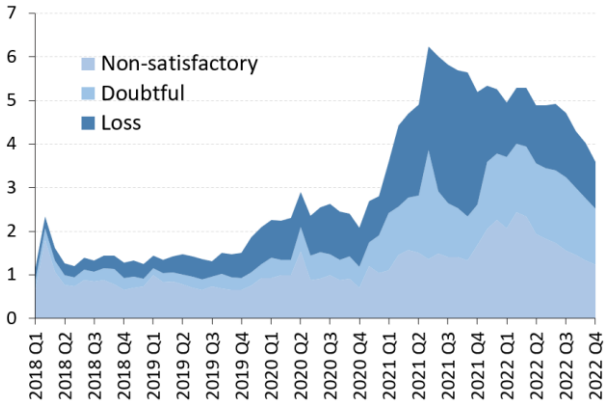


Source: CBU.

By the end of 2022, 34 percent of total NPLs were classified as "non-satisfactory" and 36 percent were classified as "doubtful." Loans

categorized as “loss” comprised 30 percent of NPLs, a 20 percent reduction from 2021.

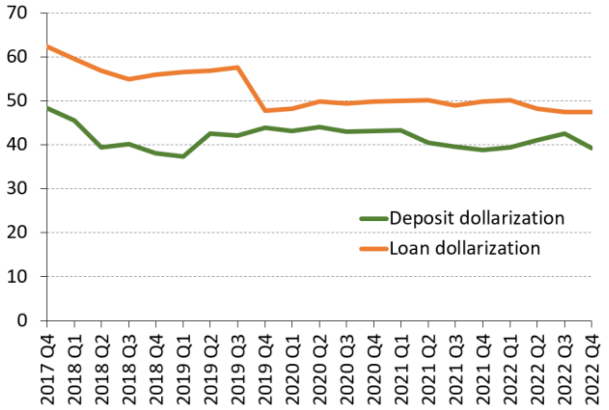
Figure 27. NPL Composition, %



Source: CBU.

Between 2020 and 2022, approximately 50 percent of loans provided by banks and 40 percent of attracted deposits were dollarized.

Figure 28. Dollarization, %



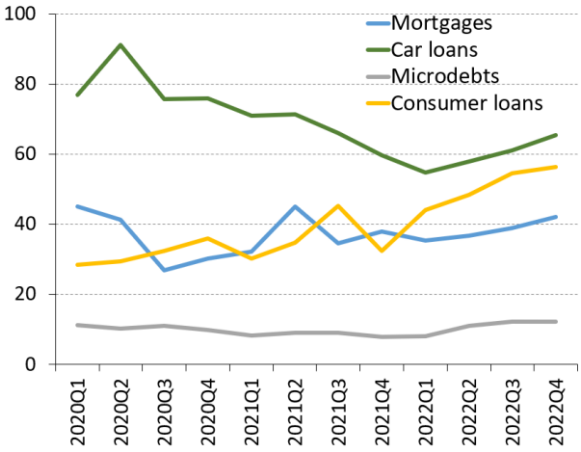
Source: CBU.

To reduce dollarization, the CBU has implemented various prudential measures. These include repealing the practice of giving loans in foreign currency to individuals, imposing reserve requirements that vary by currency type, and implementing the LCR and NSFR by currency type. Additionally, the CBU has differentiated risk weights by currency type and set limits on net open foreign currency positions, among other measures.

2.3. Debt Burden Risks

According to a debt service ratio (DSR)[49] categorized by loan types, the population's debt burden remains high. In 2022, those with mortgage and consumer loans had to use 60–70 percent of their disposable income to repay their debts. Over 2019–2022, the DSR for consumer loans allocated by the banking system has been increasing, indicating that borrowers are now directing a higher share of their income toward paying off the principal and interest payments.

Figure 29. DSR by Types of Loans to Individuals, %



Source: CBU staff calculations.

By the end of 2022, the DSR for consumer loans had risen by 24 percentage points compared to the same period in 2021, reaching 56 percent. This increase can be attributed to doubling the average loan size per borrower.

[49] The DSR methodology is presented in “Debt Service Ratio Analysis for Individuals of the Central Bank of the Republic of Uzbekistan.”

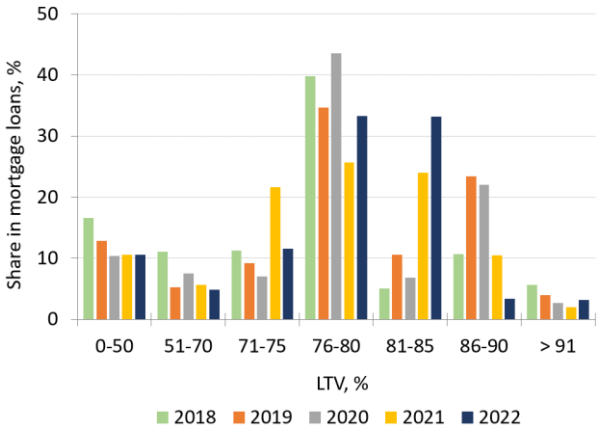
The DSR for microdebts had also increased by 4 percentage points by the end of 2022 compared to the same period in 2021, standing at 12 percent. This slight rise in the debt burden can be attributed to the higher volume growth rate in allocated microdebts (81 percent) compared to the growth rate in quarterly income for microdebt borrowers (16 percent), as well as an increase in annual interest rates (1.8 percentage points).

Furthermore, the DSR for mortgage loans to individuals had increased by 4 percentage points by the end of 2022 compared to the same period in 2021 due to an increase in the average loan volume per borrower (39 percent) and an increase in annual interest rates (1.5 percentage points).

Additionally, the DSR for car loans to individuals had increased to 65 percent by the end of 2022, an increase of 5.7 percentage points compared to the same period in 2021. In 2022, the average volume of car loans per borrower increased by 41 percent. The DSR for car loans to individuals may remain high due to the new procedure that allows lending for cars manufactured abroad[50].

In 2022, there was a significant increase in the share of mortgage loans with an LTV of 76–85 percent. Almost two-thirds of all mortgage loans fell within this range. Furthermore, the share of mortgage loans with an LTV of over 75 percent in total mortgage loans increased by 11 percentage points compared to 2021, accounting for 73 percent. It is worth noting that mortgage borrowers' solvency may become more sensitive to changes in their income.

Figure 30. Distribution of LTV Ratio for Mortgage Loans



Source: CBU staff calculations.

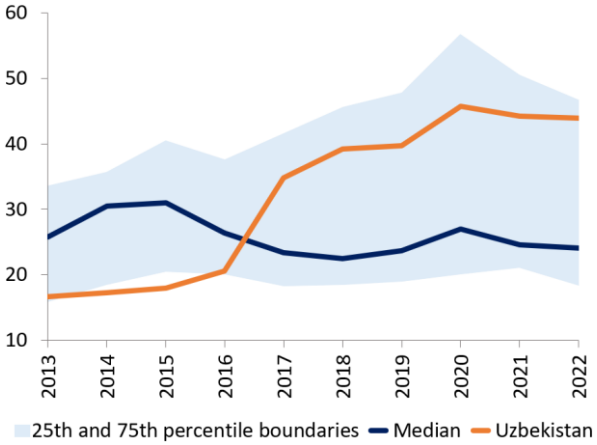
In 2022, lending in Uzbekistan picked up speed, causing the total loans-to-GDP ratio to exceed the median for Central Asia and the Caucasus countries, but remain within the interquartile range[51]. Lending was encouraged in many countries during the pandemic by easing macroprudential policy[52]. As a result, the total loans-to-GDP ratio across the region increased in 2020 due to higher credit growth than the GDP growth rate.

[50] O'zbekiston Respublikasining Moliyaviy iste'mol krediti berish tizimi takomillashtirilishi munosabati bilan "Iste'mol krediti to'g'risida"gi O'zbekiston Respublikasi qonunining 15-moddasiga o'zgartish kiritish haqida"gi O'RQ-828-sonli qonuni, 2023 yil 10 aprel.

[51] 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 percent of all indicators.

[52] Teodoru, I., & Akepanidtaworn, K. (2022). Managing Financial Sector Risks from the COVID-19 Crisis in the Caucasus and Central Asia. International Monetary Fund.

Figure 31. Total Loans-to-GDP Ratio in Central Asia and Caucasus Countries, %

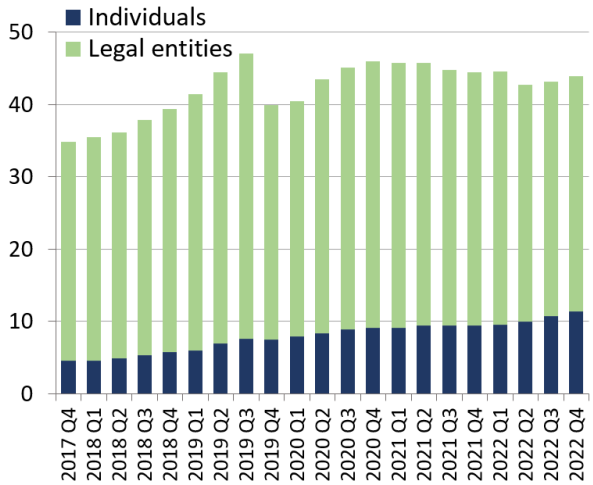


Sources: National authorities, CBU.

Note: Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan are taken into account. Turkmenistan is not included due to a lack of data.

Uzbekistan's total loans-to-GDP ratio remained almost unchanged from 2020 to 2022 and is approaching the 75th percentile boundary. In 2022, the high GDP growth rate from increased economic activity caused a slight decrease in the total loans-to-GDP ratio compared to the Covid-19 quarantine period. Specifically, the total loans-to-GDP ratio amounted to 44 percent by the end of 2022.

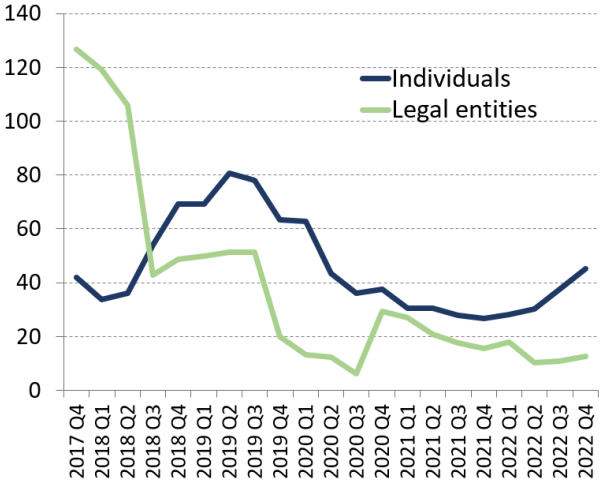
Figure 32. Decomposition of Total Loans-to-GDP, %



Source: CBU.

Moreover, due to the continuous growth of loans to individuals, the share of these loans in total loans is increasing. As of January 1, 2023, the share of loans to individuals in the total loan portfolio increased by 4.6 percentage points compared to the beginning of 2022, almost reaching 26 percent.

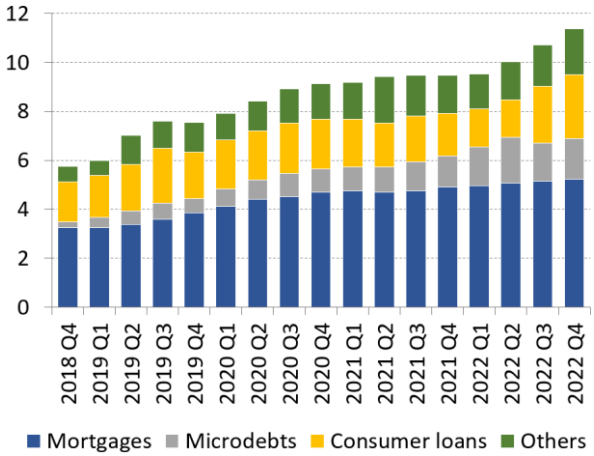
Figure 33. Annual Credit Growth (YoY), %



Source: CBU.

When borrowers have too much debt, it can make it harder for them to repay loans. This can have a negative impact on bank assets. In 2022, the growth rate of bank loans to the real sector decreased by 3 percentage points compared to 2021. However, due to a sharp increase in mortgage loans, car loans, and microdebts, which make up 84 percent of retail loans, the total outstanding loans to individuals grew by 45 percent annually by the end of 2022.

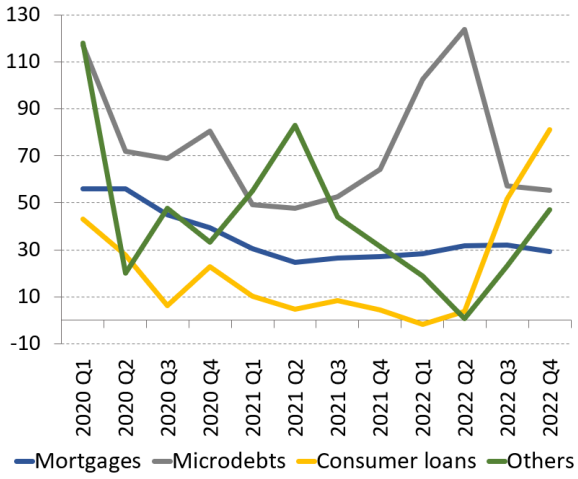
Figure 34. Loans to Individuals, % of GDP



Source: CBU staff calculations.

After the pandemic, the demand for real estate and cars increased, leading to easier bank lending conditions. As a result, the annual growth rate of outstanding loans to individuals remained high. Most of these loans were mortgage loans, which made up 5.2 percent of GDP as of January 1, 2023. Government programs promoting these loans have contributed to the increase in demand, with mortgage loans allocated to the population increasing by almost 30 percent in 2022 to reach 46.5 trillion UZS.

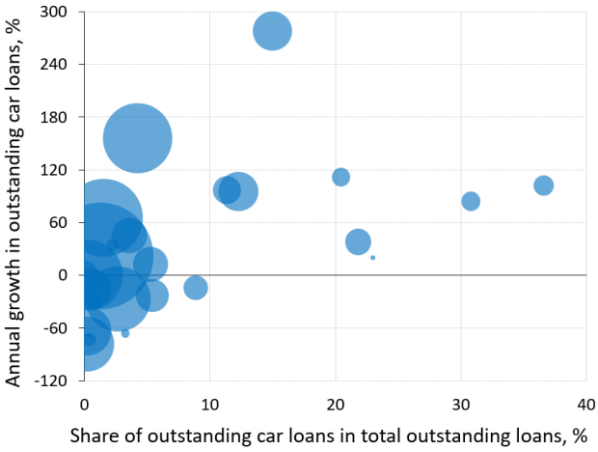
Figure 35. Annual Growth (YoY) of Outstanding Loans to Individuals, %



Source: CBU staff calculations.

Consumer loans saw a rapid annual growth rate of 81 percent in 2022. By January 1, 2023, car loans had become the dominant type of a consumer loan, accounting for 96 percent. This can be attributed to the banks' promotion of car loans and the increased access for lending for used cars. In 2022 alone, car loans amounting to 19.6 trillion UZS were granted, a 2.3-fold increase from 2021. However, the high concentration of car loans in banks' loan portfolios poses a risk. A new consumer loan issuance procedure[53] allows for extending loans for goods and services produced not only in Uzbekistan but also abroad. This provision could further bolster the demand for such loans among households.

Figure 36. Car Loans to Individuals by Banks, 2022



Source: CBU staff calculations.

Note: The bubble size reflects the proportion of a bank's assets to the total assets of all banks. Banks with an annual growth rate of outstanding car loans exceeding 300 percent or outstanding car loans accounting for over 60 percent of their total outstanding loans were excluded.

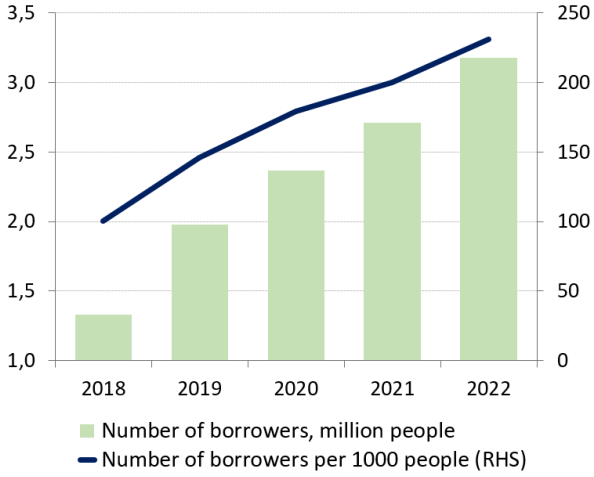
When economic activity declines, household income usually also decreases. Borrowers may struggle to

[53] O'zbekiston Respublikasining 2023-yil 10-apreldagi "Moliyaviy iste'mol krediti berish tizimi takomillashtirilishi munosabati bilan "Iste'mol krediti to'g'risida"gi O'zbekiston Respublikasi qonunining 15-moddasiga o'zgartish kiritish haqida"gi O'RQ-828-sonli qonuni.

repay consumer loans when their wages are reduced, resulting in higher debt levels during economic downturns. This can lead to an increase in NPLs and potential loan losses.

An additional metric of debt burden is the number of borrowers and loan agreements per borrower. By the end of 2022, the total number of borrowers had increased by almost 18 percent, reaching 3.3 million. As of January 1, 2023, 3.2 million or 95 percent of these borrowers were individuals.

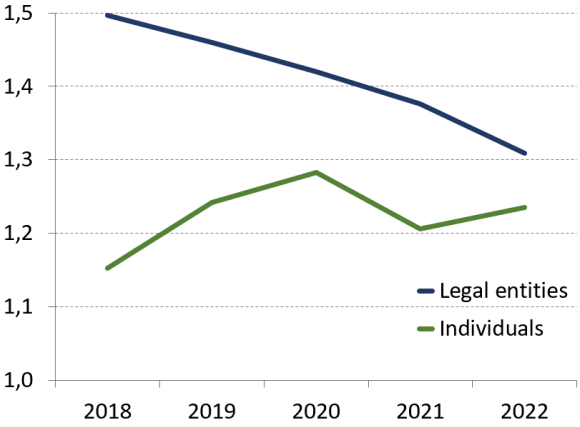
Figure 37. Total Number of Borrowers and Number of Borrowers per 1,000 employed individuals



Source: CBU.

The number of borrowers per 1,000 employed individuals in the economy has been rising, indicating an increase in indebted individuals among the creditworthy population. This has been driven by a surge in bank lending activity and a simplification of lending procedures. As of the end of 2022, there were 231 borrowers for every 1,000 employed individuals in the economy. The current value is still relatively low, indicating that those who are employed have the ability to take on additional loans in the future.

Figure 38. Number of Loan Agreements per Borrower



Source: CBU staff calculations.

Between 2018 and 2022, borrowers had more than one loan agreement each. The number of loan agreements per legal entity borrower decreased, reaching 1.3 in 2022. On the other hand, the number of loan agreements per individual borrower slightly increased to 1.2 in 2022. The loan agreements per borrower greater than 1 shows that the debt burden of some borrowers may be significantly higher than the overall debt burden determined by the total credit-to-GDP ratio.

It should be noted that household debt burden calculations only take into account bank loans. However, purchases made through installment plans for consumer goods, cars, and real estate outside the banking system add to households' debt burden. As a result, the actual DSR for households may be higher than the calculated indicators suggest.

III. Real Estate Market

3.1. Real Estate Market Price Bubble

When housing prices rise without being backed by fundamental factors, a price bubble is formed[54]. This happens when there is a sudden surge in demand in the real estate market due to non-fundamental factors, and the supply fails to match the demand in the short-term[55]. As the price bubble expands, people expect further increases in housing prices, leading to a rise in demand. This attracts investors who want to profit from future increases in housing prices. As a result, prices continue to rise, irrespective of changes in fundamental factors[56].

Several methods were used to determine the fundamental house price in Uzbekistan, such as the State-space model (SSM), ordinary least squares (OLS), quantile regression, and price-income models. Additionally, the generalized supremum augmented Dickey-Fuller (GSADF) model was used to identify the periods when housing prices exceed the fundamental price (Appendix 7). The fundamental house price obtained through these methods represents the price level in the real estate market when systemic risks are low. If housing prices increase above this fundamental price, it indicates the emergence of risks in the real estate market, potentially creating a price bubble.

Most models require long time series of housing prices and various econometric tests. However, based on the characteristics of the model implementation, the price-income model was used to analyze the real estate market in Uzbekistan. This model considers factors such as interest rates, maturity of mortgage loans, and disposable income of borrowers to determine the maximum attainable amount of a mortgage loan[57]. The average fundamental house price was calculated based on the attainable mortgage loan and LTV ratio[58].

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[54] For example, the US real estate market experienced a price bubble in 2007–2008 due to low real interest rates and increased investments from institutional investors. Banks repackaged mortgage loans into liquid products, such as collateralized debt obligations, and sold them to investors on the secondary market. This led to an overall increase in the volume of investments made in the real estate market.

[55] Baily, M., Litan, R., & Johnson, M. (2008). The origins of the financial crisis. Brookings Institution.

[56] Case, K.E., & Shiller, R.J. (2003). Is there a bubble in the housing market? Brookings Institution.

[57] The maximum attainable amount of a mortgage loan is calculated using the following formula:

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

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

Where:

L_t – the maximum attainable amount of a mortgage loan;

i_t^m – the weighted average monthly interest rate on flows of mortgage loans;

N – the duration of a mortgage in years;

α – the portion of household disposable income to cover the monthly instalment;

Y_t – household disposable income;

t – years.

[58] The fundamental house price is calculated using the following formula:

From 2021 to 2022, Tashkent city accounted for approximately 25 percent of all housing sales contracts signed in Uzbekistan. Due to the large portion of the real estate market in this area and the availability of longer time series data, the differences between the housing market and fundamental prices were determined for Tashkent city.

Table 1. Current Applicability of Different Models in Uzbekistan

Model	Applicability
SSM	No
OLS	No
Price-income	Yes
Quantile regression	No
GSADF	No

Source: CBU staff calculations.

The fundamental house price is determined by the population's ability to obtain an attainable mortgage loan. It represents a stable level of housing prices when the level of systematic risks in the real estate market is low, and the probability of loan repayment is high.

In the initial months of 2020, strict quarantine measures caused a decrease in demand for real estate. In April 2020, the number of housing sales contracts decreased by 87 percent in Uzbekistan and by 94 percent in Tashkent compared to the same period in 2019[59]. As a result, Q1 2020 had the lowest difference between market and fundamental house prices between 2018 and 2022. The demand for housing in Tashkent city and Tashkent region increased later in 2020 due to improved purchasing practices and the abolition of restrictions[60]. As a result, the housing market prices in Tashkent city increased compared to their fundamental prices from Q2 2020.

In 2021, the government's new procedure for allocating mortgage loans provided subsidies to cover part of the down payment and made available preferential mortgage loans from public funds[61], stimulating the demand for housing. Due to unsatisfied demand after the pandemic and the government's programs, the difference between the market and fundamental prices for one housing unit in Tashkent city reached around 120 million UZS.

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

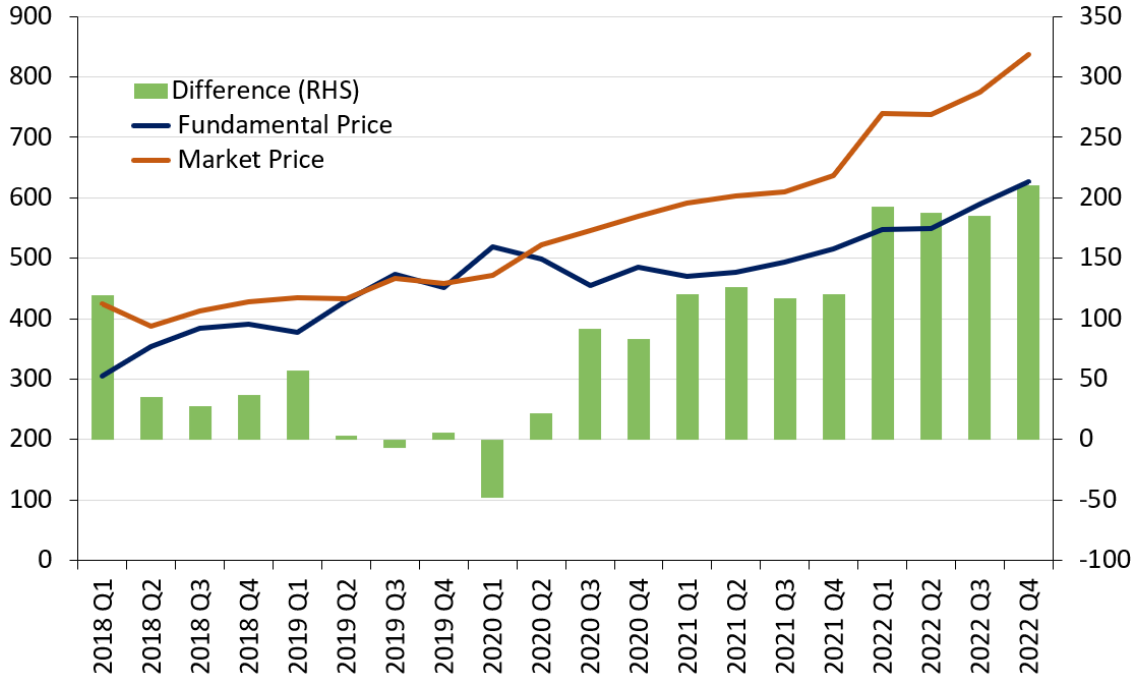
Where:
PH_t – the fundamental house prices;
L_t – the maximum attainable amount of a mortgage loan;
LTV – a loan-to-value ratio;
t – years.

[59] Ministry of Justice of the Republic of Uzbekistan, Statistics.

[60] O'zbekiston Respublikasi Prezidentining "Doimiy propiska qilish hamda turgan joyi bo'yicha hisobga olish tartibini isloh qilish chora-tadbirlari to'g'risida"gi PF-5984-sonli Farmoni, 2020 yil 22 aprel.

[61] O'zbekiston Respublikasi Prezidentining "Bozor tamoyillariga asoslangan ipoteka kreditlarini ajratish orqali aholini uy-joy bilan ta'minlashga oid qo'shimcha chora-tadbirlar to'g'risida"gi PF-6186-sonli Farmoni, 2021 yil 11 mart.

Figure 39. Market and Fundamental Prices of Housing Unit in Tashkent City According to Price-Income Model, in million UZS



Sources: Center for Economic Research and Reform and CBU staff calculations.

Note: The average housing area was determined by multiplying the average number of people in households (5) by the social norm of 16 square meters per person. This resulted in an average housing area of 80 square meters.

Migration processes driven by external geopolitical tensions, easing the procedure for purchasing real estate for non-residents[62], and a significant increase in cross-border personal transfers[63] increased the demand for housing in Tashkent city in 2022[64]. As a result, market prices had a higher growth rate than fundamental prices.

To meet the population's housing needs, the government maintained interest rates on resource funds allocated to banks for mortgage loans at 13 percent until the end of 2022[65] and disbursed budget loans[66] to provide stable financing for

[62] Starting May 1, 2022, individuals from 108 countries, including Russia, can buy real estate in Uzbekistan without a residence permit. In Tashkent region, Tashkent city, and Samarkand city, the value of the property must be at least 150,000 USD (or 70,000 USD in other regions) for contracts signed during the construction period and 180,000 USD (or 85,000 USD in other regions) for properties already available. Additionally, the required value of a real estate to obtain a residence permit in Uzbekistan for foreign citizens through the purchase of property has been lowered from 400,000 USD to 300,000 USD in Tashkent region and Tashkent city.

[63] Central Bank of the Republic of Uzbekistan. (2023). Balance of payments of the Republic of Uzbekistan (standard presentation).

[64] O'zbekiston Respublikasi Prezidentining "Tadbirkorlik muhitini yaxshilash va xususiy sektorni rivojlantirish orqali barqaror iqtisodiy o'sish uchun shart-sharoitlar yaratish borasidagi navbatdagi islohotlar to'g'risida"gi PF-101-sonli Farmoni, 2022 yil 8 aprel.

[65] O'zbekiston Respublikasi Prezidentining "Markazlashgan manbalar hisobidan ipoteka va ta'lim kreditlari uchun ajratiladigan mablag'lar bo'yicha foiz stavkalarini belgilash to'g'risida"gi PQ-199-sonli qarori, 2022 yil 8 aprel.

[66] O'zbekiston Respublikasi Prezidentining "Ipoteka kreditidan foydalanishda aholiga qo'shimcha qulayliklar yaratish chora-tadbirlari to'g'risida"gi PQ-377-sonli qarori, 2022 yil 22 sentabr.

mortgage loans[67]. Mortgage loans to the population increased by almost 1.5 times compared to 2021[68], reaching 14.4 trillion UZS by the end of 2022. Additionally, an inflation rate of 12.3 percent, including an 11.8 percent[69] increase in prices for investments in fixed assets and construction work, put price pressure on the housing market in 2022.

As a result of these factors, in Q4 2022, the difference between the market and fundamental house prices for Tashkent city reached its highest value (210 million UZS) during the observation period. The difference between market and fundamental house prices increased by 1.6 times in 2022 compared to 2021, indicating that factors other than the population's stable income influenced the price increase in the real estate market.

It should be noted that the "price-income" model used to determine the fundamental house price has a shortcoming of not considering long time series. Creating a continuous database of housing prices will enable a more accurate analysis of the real estate market using other models in the future.

[67] To assist with the refinancing of mortgage loans provided by banks to the population, a budget loan of up to 300 billion UZS has been granted to JSC "Uzbekistan Mortgage Refinancing Company" for 3 years. The loan has an interest rate of 12 percent and requires interest payments every 6 months. The funds for this loan were sourced from international financial organizations to support the State budget.

[68] Central Bank of the Republic of Uzbekistan. (2023). Statistical bulletin of the Central Bank – January–December 2022.

[69] Statistics Agency under the President of the Republic of Uzbekistan, Dynamics of the price index for investments in fixed assets and construction works.

Box 4. Causes of Price Bubble

Various factors can negatively impact the demand in the real estate market, such as a decrease in economic activity, a reduction in the population's real income, and an increase in real interest rates. These factors can lead to unexpected housing price drops and even cause a price bubble to burst when high housing prices are formed due to non-fundamental factors.

For instance, Norway and Sweden experienced banking crises related to the price bubble in the real estate market during 1992–1993. Before the crisis, the volume of mortgage loans and housing prices had significantly increased. However, the economic slowdown, rise in real interest rates, and tax reforms caused a sharp decline in housing prices, leading to insufficiently collateralized mortgage loans and an increased risk of losses[70].

In a thematic note to EU banks, the European Banking Authority highlighted that heightened geopolitical uncertainty, high energy prices, and increasing interest rates might decrease housing prices in 2022[71]. This is because high interest rates can reduce the demand for mortgage loans, while increasing energy prices can decrease the population's discretionary income, making it challenging to service debt.

In Uzbekistan, external geopolitical tensions increased demand for housing from migrants in 2022.

[70] European Central Bank. (2000). Asset prices and banking stability.

[71] European Banking Authority. (2022). Thematic note – Residential Real Estate Exposures of EU Banks: Risks and Mitigants.

3.2. Risks in Real Estate Market

Starting from January 1, 2023[72], the government is implementing programs[73] for preferential mortgage loans and subsidies that boost demand for housing. However, a moratorium on new construction until the master plan of Tashkent city is approved reduces the housing supply. This could cause an imbalance between the demand and supply of housing, leading to a widening gap between the market and fundamental prices of housing.

If housing prices continue to increase above their fundamental prices, there is a higher probability of materialization of systemic risks in the real estate market. A significant decrease in demand would result in a sharp decline in housing prices. This would make allocated mortgage loans undercollateralized and increase banks' mortgage losses. Additionally, the LTV ratio would increase due to the decrease in the market value of real estate taken as collateral for mortgage loans issued by banks.

Three conditional scenarios of a sharp decrease in housing prices (20, 30, and 40 percent) in the local real estate market were analyzed based on 2022 data. As a result of the sharp drop in housing prices, it is assumed that loans with an LTV ratio of more than 120 percent would be more likely to be defaulted by borrowers.

A 20 percent decrease in housing prices would mean that about 40 percent of mortgage loans would have an LTV ratio above 100 percent in 2022. However, mortgage loans with an LTV ratio above 120 percent account for 3 percent of total mortgage loans issued in 2022. This means that the proportion of borrowers more likely to give up collateral rather than pay off their mortgages is very low. In the event of a 30 and 40 percent decrease in housing prices, respectively, 85 and 87 percent of the mortgage loans issued in 2022 would not have sufficient collateral (LTV ratio above 100 percent). Moreover, under a 30 and 40 percent decrease in housing prices, the share of mortgage loans with an LTV ratio of more than 120 percent would be 32 and 84 percent, respectively. If these borrowers default on their mortgages, it would result in substantial bank losses.

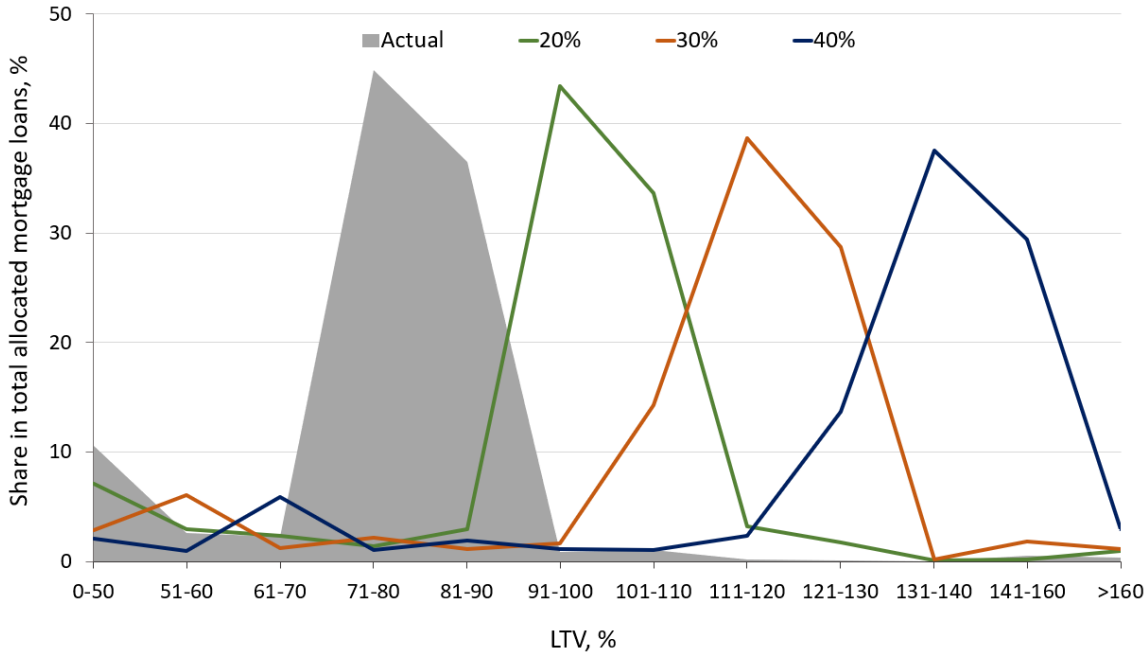
The impact of a sharp decline in housing prices on banks' asset quality was analyzed by scenarios. A 20 percent decrease in housing prices did not significantly affect the current value of the share of NPLs in total loans. However, a 30 and 40 percent decrease in housing prices might cause the NPL ratio to increase to 4.8 and 6.7 percent, respectively, by the end of 2022. This would lead to a significant increase in mortgage-related bank losses.

Recently, there has been an increase in the share of mortgage loans in total loans to individuals (22 percent in 2022), which may have a more significant effect on the quality of loan portfolios due to changes in real estate prices.

[72] O‘zbekiston Respublikasi Prezidentining “Ipoteka kreditidan foydalanishda aholiga qo‘shimcha qulayliklar yaratish chora-tadbirlari to‘g‘risida”gi PQ-377-sonli qarori, 2022 yil 22 sentabr.

[73] Starting from January 1, 2023, citizens who received subsidies to cover part of the down payment and interest on their mortgage loans will no longer have to pay personal income tax on their salary and other income that goes toward their mortgage payments.

Figure 40. Distribution of LTV Ratio for Allocated Mortgage Loans under Housing Price Decline Scenarios, 2022



Source: CBU staff calculations.

The default of banks with a high share of mortgage loans in the total loan portfolio due to a sharp decrease in housing prices might create additional structural systemic risks for the banking system, resulting from financial interdependence between banks.

IV. Macro Stress Test for Banking System

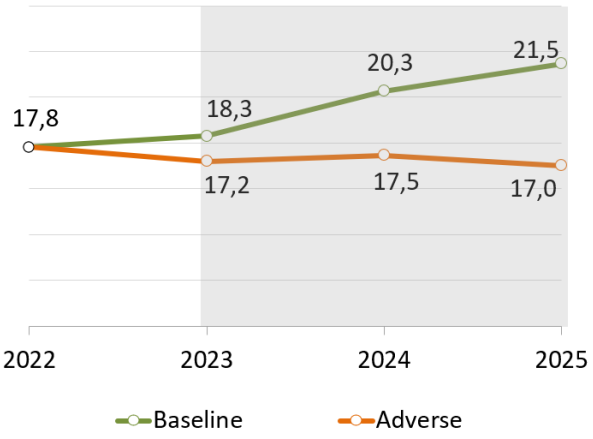
4.1. Macroeconomic Scenarios

The resilience of the banking system was analyzed through a macro stress test based on the CBU's macroeconomic scenarios for 2023–2025. Two scenarios were developed—baseline and adverse—that take into account key indicators such as GDP growth, interest rates, and the exchange rate. The baseline scenario assumes that current economic trends will continue, while the adverse scenario considers possible internal and external economic shocks. In the adverse scenario, the GDP growth rate is calibrated considering unfavorable geopolitical conditions, increased risk of global recession, and instability in the global financial system. High interest rates are expected in 2023 due to inflationary pressures in Uzbekistan and globally, with rates decreasing in subsequent periods. The adverse scenario includes the potential negative effects of the main trading partners' national currencies depreciation on the Uzbek soum's exchange rate. Indicators such as GDP growth and loan interest rates for both scenarios were used to estimate the share of NPLs in total loans.

4.2. Macro Stress Test Results

The top-down solvency macro stress test shows that Uzbekistan's banking system is resilient against various shocks in both the baseline and adverse scenarios from 2023 to 2025. Despite a decline in CAR due to increased RWA, losses on loans and securities, and tax and dividend payments, it is offset by the expected growth in banks' net interest income and other net operating income. CAR of the banking system is significantly higher than the minimum regulatory capital requirement in both scenarios. The baseline scenario shows that CAR may reach 21.5 percent by the end of 2025 with low losses in securities, no concentration risk in the banking system, and no losses in the real estate market. Payment of taxes and dividends will reduce CAR by 4 and 1.6 percentage points, respectively.

Figure 41. Banking Sector Capital Resilience in Baseline and Adverse Scenarios, %

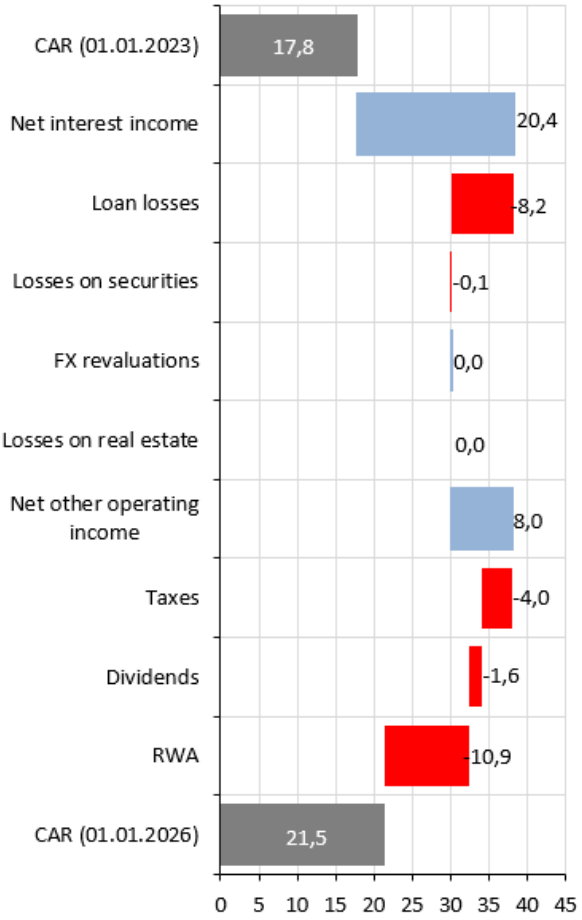


Source: CBU staff calculations.

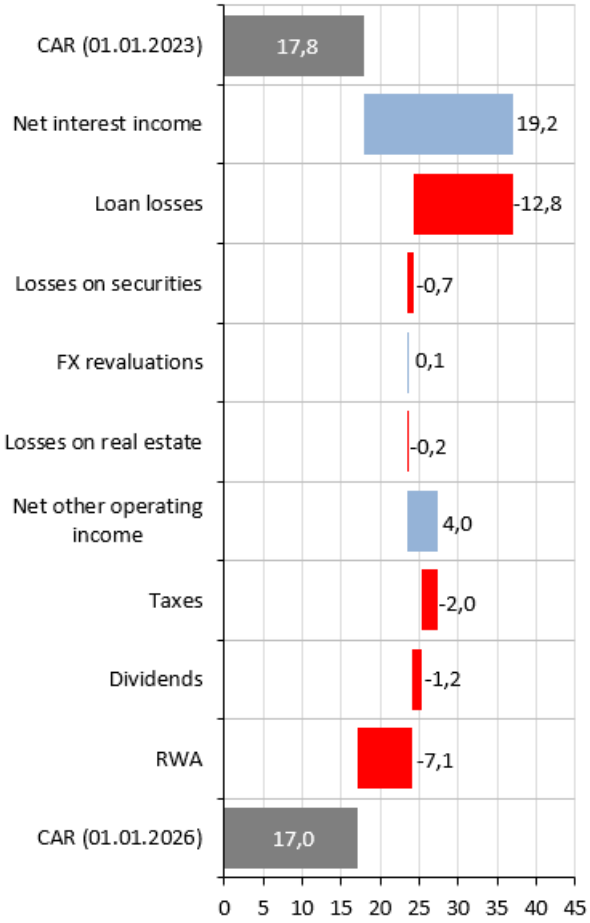
The depreciation of the soum does not cause direct losses as banks have an open foreign currency position that is almost balanced between foreign currency assets and liabilities. However, there is a rise in RWA due to the soum's depreciation, leading to an increase in the volume of foreign currency loans' UZS equivalent. The higher debt servicing cost for borrowers with foreign currency loans increases the amount of NPLs and potential loan losses. The expected significant increase in net loans, determined by deducting reserves against possible losses from the total gross loans, and the amount of funds to be received from other banks and financial institutions may cause the total RWA amount to be high.

Figure 42. Macro Stress Test Results, %

Baseline Scenario



Adverse Scenario

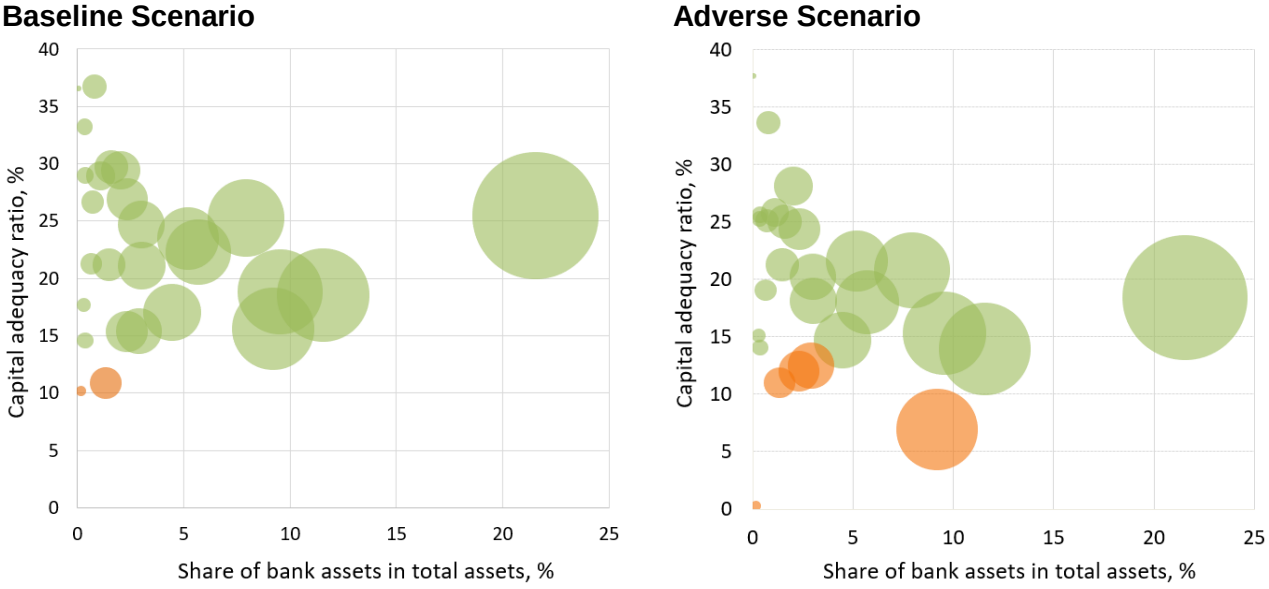


Source: CBU staff calculations.

In the adverse scenario, CAR may be 17 percent by the end of 2025 with high loan losses, some losses on securities and real estate, and an increase in RWA. Despite this, CAR would still be significantly above the minimum requirement due to the rise in net interest income and net other operating income. The increase in net interest income is due to the rise in interest-bearing assets. As of the end of 2022, these assets comprised 91 percent of the total assets. Under this scenario, the volume of interest-bearing assets is expected to increase 1.5 times compared to 2022 due to a projected 60 percent rise in the total outstanding loans over the next 3 years. As a result, banks will have significant growth in their interest income.

The concentration level in the banks and the risk of a particular bank's instability spreading to the banking system help express the scale of risk and determine the probability of systemic risk materialization more accurately. The default of banks with a small share of the banking system's assets is unlikely to cause major structural systemic risks. For instance, in Q1 2023, the banking system was not significantly affected by suspending banking activities and bankruptcy declarations of Hi-tech and Turkiston banks.

Figure 43. Macro Stress Test Results by Banks



Source: CBU staff calculations.

Note: The graph displays banks with CAR of less than 40 percent. The size of each bank's bubble corresponds to the share of its assets in the banking system's total assets. A green bubble indicates that a bank meets the minimum capital adequacy requirement of 13 percent, while a brown bubble demonstrates that a bank does not meet this requirement.

When banks have a significant portion of the banking system's assets and a high level of interdependence, their instability, such as falling below the minimum regulatory requirement of CAR, can result in structural systemic risks.

The probability of materialization of structural systemic risks is very low under the baseline scenario. However, there is a possibility of some small banks experiencing instability by the end of 2025. In the adverse scenario, both small and large banks may face instability. Illustratively, in the adverse scenario conditions, a bank's very low CAR suggests that it may experience greater losses than its regulatory capital. This risk is especially concerning for banks with a large share of the banking system's assets, as their significant losses could lead to systemic risks.

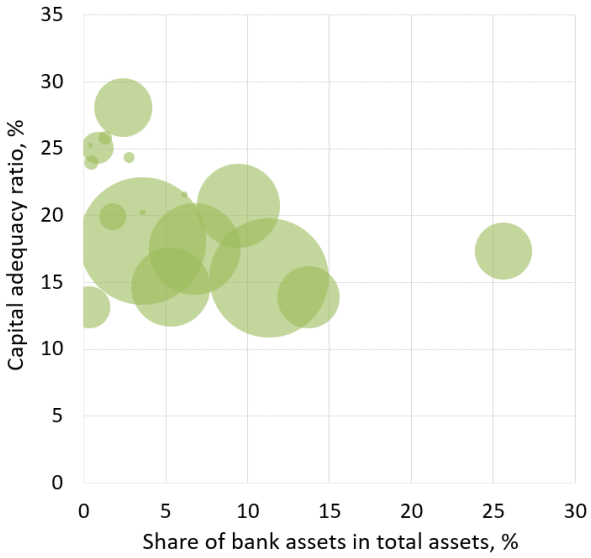
In case of breaching the capital adequacy requirement, banks should have an action plan to raise their capital to the regulatory minimum[74].

4.3. Contagion Risk

Shocks can cause contagion risks among banks due to their financial interdependence. If banks with CAR below the required minimum were to default in the adverse scenario, they might be unable to pay their debts to other banks. This could cause creditor banks to lose their capital. Therefore, the adverse consequences for the banking system caused by the default of banks with high liabilities to other banks were analyzed.

[74] O'zbekiston Respublikasi Markaziy banki boshqaruvining "Tijorat banklari kapitalining monandligiga qo'yiladigan talablar to'g'risidagi nizomni tasdiqlash haqida"gi 14/3-sonli qarori, 2015 yil 13 iyun.

Figure 44. Impact of Contagion Risk on Macro Stress Test Results under Adverse Scenario



Source: CBU staff calculations.

Note: The graph illustrates banks that have CAR below 35 percent and banks that have liabilities to other banks. The size of each bank's bubble reflects the share of its interbank liabilities in the total interbank liabilities. The green bubble represents banks that meet the minimum capital adequacy requirement of 13 percent.

In the adverse scenario, the default of banks that fail to meet the minimum CAR requirement has a weak negative impact on other banks. Other banks should be able to meet the minimum capital requirements, even if these banks default. Banks' financial interdependence level is low, with interbank liabilities only accounting for around 2.5 percent of total assets.

The contagion risk among banks that are not likely to default was also analyzed in different combinations. In this analysis, the simulation continued until the losses associated with a certain bank's default did not lead to the default of other banks. It was found that the financial losses resulting from the default of individual banks would not lead to the default of other banks. However, if the three banks with the highest liabilities to other banks default at once, one bank may also default. Nevertheless, the default of this bank would not lead to any other bank defaulting. Finally, if the five banks with the most liabilities to other banks default, only the bank mentioned above may not be able to meet the minimum capital requirements.

4.4. Additional Shocks under Adverse Scenario

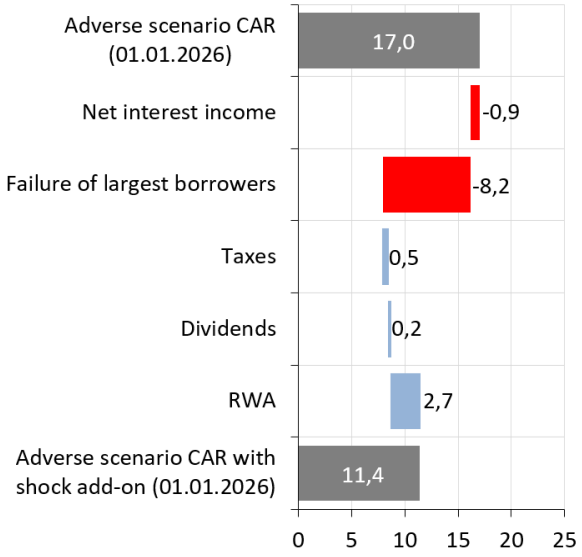
An analysis was conducted on the banking system's ability to withstand the materialization of potential systemic risks through a macro stress test. It explored the effects of additional shocks, including high concentration risk, a sharp depreciation of the soum, climate change-induced damage to the agricultural sector, and a significant drop in housing prices.

Concentration Risk

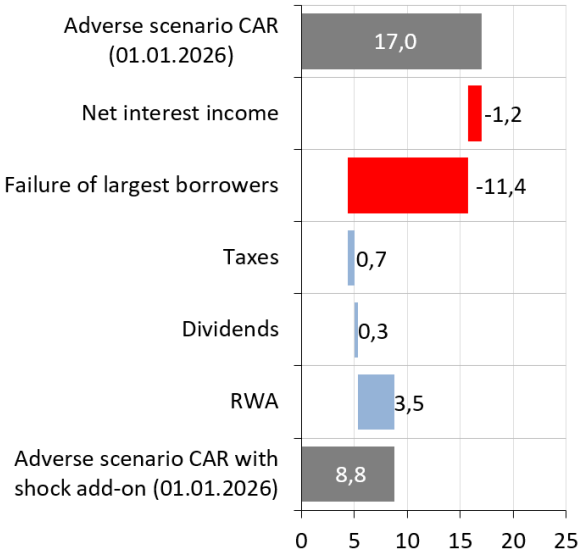
If a small group of borrowers makes up a significant portion of the total banks' loan portfolios, their default during economic stress could lead to significant credit losses in the banking system. To assess the impact of this scenario, the default of the 5 or 10 largest borrowers for each bank was analyzed in the adverse scenario. Loss given default is assumed at 50 percent, i.e., half of the outstanding loans are considered lost due to the default of these borrowers. Based on this scenario, by the end of 2025, CAR for the banking system could fall to 11.4 or 8.8 percent, depending on whether 5 or 10 of the largest borrowers defaulted. Due to the high concentration risk in the banking system, potential losses from defaulting large borrowers could drive the system's CAR below the minimum regulatory requirement.

Figure 45. Macro Stress Test Results with Concentration Risk, %

Default of 5 Largest Borrowers



Default of 10 Largest Borrowers



Source: CBU staff calculations.

Sharp Depreciation of Soum

The banking system currently has an almost balanced open foreign currency position; the amount of foreign currency assets and liabilities is roughly the same. Therefore, the soum depreciation should not cause direct losses in the banking system.

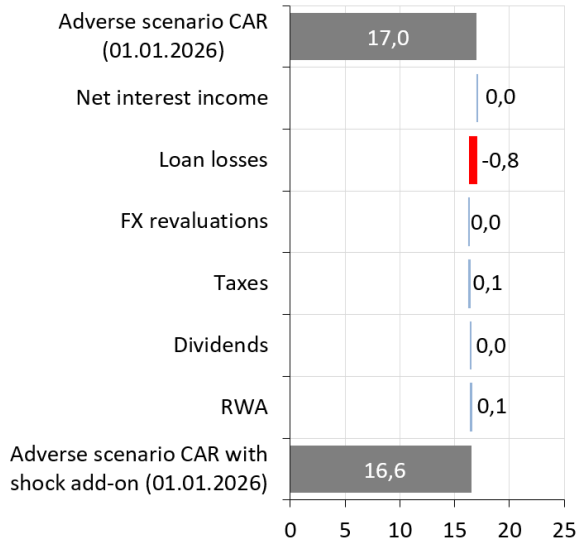
Since loans are highly dollarized at 48 percent as of January 1, 2023, the soum depreciation leads to a rise in the national currency equivalent of RWA. This, in turn, increases the insolvency risk for foreign currency borrowers who do not have income in foreign currency, leading to a rise in banks' NPLs and higher credit risk.

To assess the impact of the sharp depreciation of the soum on the banking system's financial stability, a stress test of 20 and 30 percent annual depreciation under the adverse scenario was conducted. The results showed that by the end of 2025, the banking system's CAR could fall to 16.6 and 15.3 percent due to the additional shock of the soum depreciation. The share of NPLs in total loans could also rise to 12 and 13.5 percent, respectively.

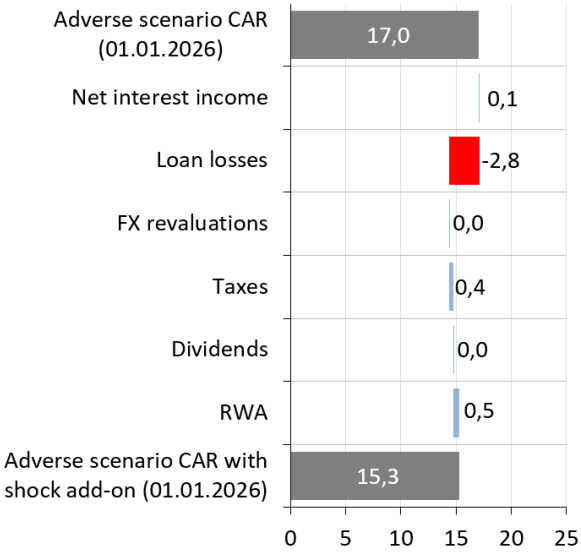
Despite the possibility of banks incurring loan losses due to the soum depreciation, they will have sufficient capital to cover these losses. Hence, CAR will remain above the minimum regulatory requirement.

Figure 46. Macro Stress Test Results with Exchange Rate Depreciation, %

20 Percent Annual Depreciation



30 Percent Annual Depreciation



Source: CBU staff calculations.

Impact of Climate Change on Agricultural Sector

In 2022, agriculture, forestry, and fishing made up 25 percent of Uzbekistan's GDP [75], making it a crucial economic sector. However, climate change could pose significant challenges for this industry, including rising temperatures, water shortages, droughts, desertification, and soil salinization, resulting in a decline in agricultural production[76]. Additionally, unexpected natural disasters could cause financial difficulties for agricultural businesses, ultimately threatening the banking system's stability.

To better understand the potential impact of these physical risks, a stress test was conducted where the 5 or 10 largest borrowers in the agricultural sector defaulted on their loans under the adverse scenario. In this case, loss given default was assumed at 50 percent (i.e., half of the outstanding loans are considered a loss due to the default of these borrowers). The stress test showed that the banking system's CAR would decrease slightly to 16.5 or 16.2 percent by the end of 2025.

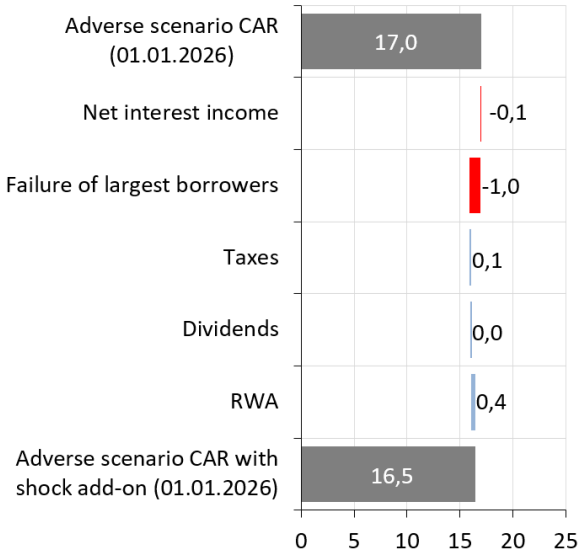
While the share of outstanding loans to the agricultural sector was only 11 percent as of January 1, 2023, some banks have a higher concentration of agricultural loans, which could result in significant loan losses if borrowers default due to climate change-related issues. To better assess the impact of climate change on the banking system, a climate stress test is being developed by the CBU to evaluate not just the agricultural sector but other industries as well (Appendix 8).

[75] O‘zbekiston Respublikasi Prezidenti huzuridagi Statistika agentligi. (2023). Iqtisodiy faoliyat turlari bo‘yicha yalpi ichki mahsulot hajmi.

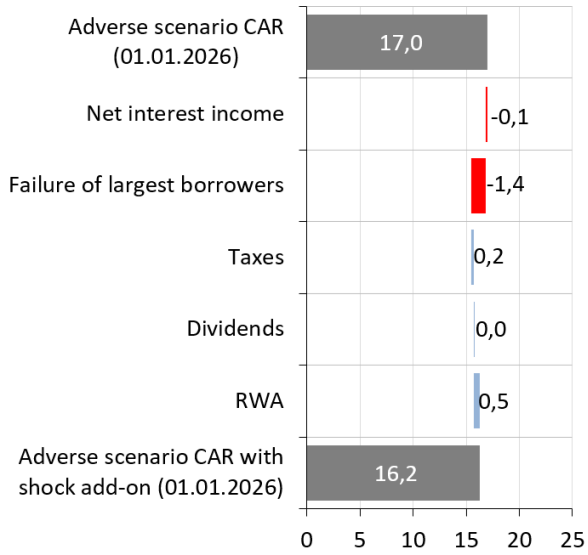
[76] World Bank Group and Asian Development Bank. (2021). Climate Risk country profile: Uzbekistan.

Figure 47. Macro Stress Test Results with Impact of Climate Change on Agricultural Sector, %

Default of 5 Largest Borrowers



Default of 10 Largest Borrowers



Source: CBU staff calculations.

Decline in House Prices

The banking system may be significantly affected by an increase in mortgage loans as house prices fluctuate. If house prices rise, the collateral value for mortgage loans also increases, making banks less likely to experience credit losses. However, if house prices continue to grow above their fundamental price, it could result in systemic risks building up in the real estate market. Factors like a decline in economic activity, a decrease in population income, and an increase in taxes can lead to a reduction in housing demand, ultimately causing a fall in house prices.

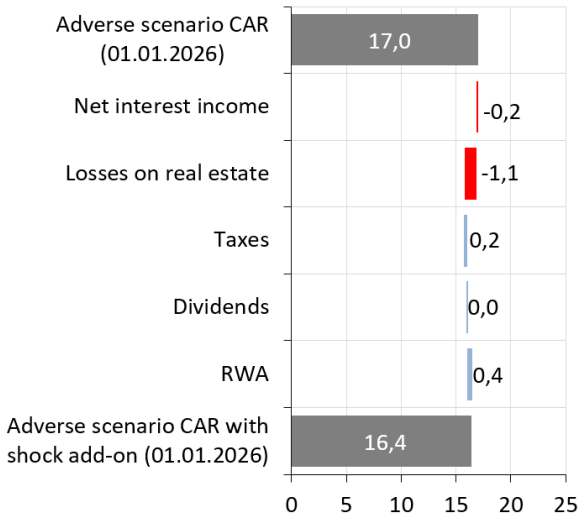
If house prices decline sharply, then mortgage loans with a high LTV ratio may exceed the collateral value, possibly causing borrowers to abandon their loans without repayment. This can lead to banks being unable to cover loan losses from mortgages by selling foreclosed houses due to falling prices in the real estate market.

An additional shock was conditionally added to the adverse scenario to determine the impact of a sharp fall in housing prices on the banking system's stability. It was assumed that if the LTV ratio exceeds 120 percent due to a sharp decline in house prices, it increases the probability of borrowers defaulting on their mortgage loans.

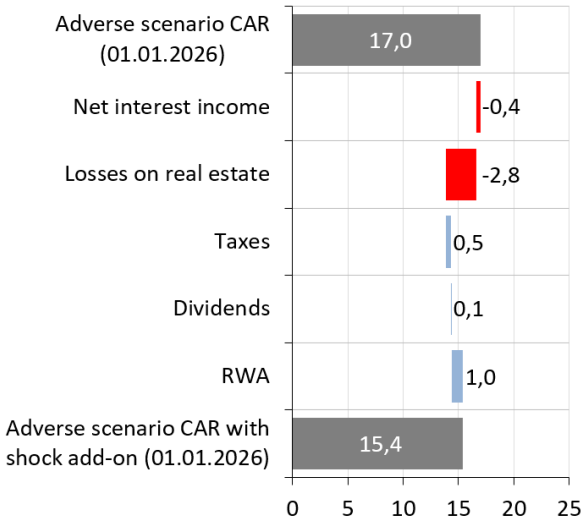
The macro stress test results show that a 20 percent fall in house prices did not significantly affect the increase in NPLs, indicating that mortgage loans issued by banks are secured with sufficient collateral. If house prices decline by 30 or 40 percent, CAR will decrease to 16.4 and 15.4 percent by the end of 2025. The share of NPLs in total loans may increase to 12.7 and 14.5 percent, respectively.

Figure 48. Macro Stress Test Results with Decline in House Prices, %

30 Percent Reduction in House Prices



40 Percent Reduction in House Prices



Source: CBU staff calculations.

A 30 or 40 percent drop in house prices may increase mortgage loan losses due to a sharp decline in collateral value relative to the loan amount. The sale of foreclosed collateral by banks to cover loan losses from mortgages when house prices are falling may also increase the supply in the real estate market and exacerbate the situation.

V. Prospects of Introducing Countercyclical Capital Buffer

International experience with using CCyB

The Basel Committee on Banking Supervision (BCBS) developed Basel III in 2010 as a package of measures to strengthen the capital and liquidity positions of banks following the global financial crisis[77].

These measures included the introduction of CCoB and CCyB, which were designed to improve the quality and quantity of banks' capital base, along with tighter regulatory minimum capital requirements.

CCyB is a macroprudential instrument in the form of CET1 capital. It can range from 0 to 2.5 percent of RWA. The objective of CCyB is to help maintain the supply of credit to the real economy during the materialization of financial vulnerabilities. It also aims to enhance the resilience of the overall banking system to cyclical systemic risks that accumulate during periods of excessive credit growth.

In international practice, central banks, financial sector supervisory authorities, inter-agency committees, and governments are designated authorities responsible for activating and calibrating the CCyB rate. In Uzbekistan, the CBU is responsible for setting capital requirements and buffers.

According to Basel recommendations, the designated authority's decision to increase the level of CCyB takes effect within 12 months of the official announcement. Banks are given reasonable time to adapt to additional capital requirements and adjust their capital plans. However, the decision to relax or fully release this buffer requirement takes effect immediately to maintain the credit supply during the bust phase[78].

Table 2. Basel II and Basel III Capital Requirements, % of RWA

Basel standards	CET1 capital	Tier 1 capital	Total capital	CCoB[79]	CCyB
Basel II	2	4	8	–	–
Basel III	4,5	6	8	2,5	0–2,5

Source: Basel Committee.

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

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

[79] The capital conservation buffer is an additional requirement on top of the minimum capital requirements.

Table 3. Designated Authorities for Setting and Calibrating CCyB Rate in Selected Countries

Central bank	Financial sector supervisory authority	Inter-agency committee	Government
Armenia, Belgium, Brazil, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Georgia, Greece, Hong Kong, Hungary, Iceland, Ireland, Italy, Lithuania, Malta, Netherlands, Portugal, Romania, Saudi Arabia, Singapore, Slovakia, Slovenia, Spain, United Kingdom, United States	Australia, Austria, Canada, Germany, Japan, Kazakhstan, Latvia, Luxembourg, Mexico, South Korea, Sweden	Finland, France	Denmark, Norway, Poland, Switzerland

Source: IMF, Basel Committee and national authorities.

Based on the IMF macroprudential policy survey database[80], 89 countries have implemented the CCyB framework (Appendix 12). Out of those, 15 countries had introduced or announced a positive CCyB rate before the Covid-19 pandemic (Appendix 9). Although the pandemic's economic impact was unrelated to the financial cycle, some countries maintained a zero percent CCyB rate.

The European Central Bank reported that CCyB accounted for only 0.2 percent of RWA in the euro area banking system at the end of 2019, while structural buffer requirements (CCoB, systemic risk buffer, and capital buffer for SIBs) stood at 3.4 percent[81]. Unlike CCyB, the structural buffers are not designed to provide loans to the economy. It is important to balance cyclical and structural buffer requirements to make macroprudential policy more effective. This can be achieved by using CCyB more actively or implementing a positive cycle-neutral CCyB rate.

The Covid-19 crisis has led to strong macroprudential measures, including easing macroprudential requirements and releasing additional capital[82] (Appendix 10). Most countries with a positive CCyB rate, which was set before the pandemic, released this additional buffer either partially or fully. BCBS supports setting a positive cycle-neutral CCyB rate when risks are not subdued or elevated[83].

Core and additional indicators for determining CCyB rate in Uzbekistan

The core and additional indicators that determine a CCyB rate assess the build-up of vulnerabilities in the financial

[80] International Monetary Fund. Macroprudential Policy Survey Database.

[81] Guindos, L. (2021). Is macroprudential policy resilient to the pandemic? ECB speech.

[82] Adrian, T. (2021). Macroprudential Responses to the COVID-19 Pandemic and Outlook. 5th European Systemic Risk Board Annual Conference.

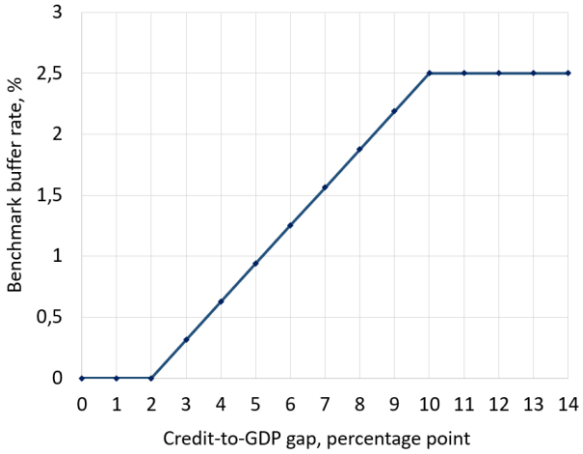
[83] Basel Committee on Banking Supervision. (2022, October). Newsletter on positive cycle-neutral countercyclical capital buffer rates.

system and unsustainable volatility in selected variables. The private sector credit-to-GDP gap is a core indicator used to activate and calibrate the CCyB rate. It helps identify the accumulation of cyclical systemic risks. In general, to determine the benchmark buffer rate[84] under the credit-to-GDP gap method, three steps are followed[85]:

1. The aggregate private sector credit-to-GDP ratio is calculated.
2. The credit-to-GDP gap is calculated by finding the difference between the credit-to-GDP ratio and its long-term trend[86].
3. The credit-to-GDP gap is transformed into the benchmark buffer rate.

The Basel Committee established lower and upper thresholds for the credit-to-GDP gap to determine the optimal benchmark buffer rate. If the credit-to-GDP gap is 2 percentage points or less, the benchmark buffer rate will be 0 percent. If the credit-to-GDP gap is 10 percentage points or more, the maximum benchmark buffer rate should be 2.5 percent. The benchmark buffer rate will vary linearly[87] between 0 and 2.5 percent when the credit-to-GDP gap is between the lower and upper thresholds.

Figure 49. Benchmark CCyB Rate



Source: Basel Committee.

Before the Covid-19 pandemic, Uzbekistan experienced an expansion of the credit-to-GDP gap[88], calculated according to BCBS guidelines. Although this increase was due to an exchange rate effect, it also indicated an escalation of systemic risk[89]. In 2022, the credit-to-GDP gap remained below the lower threshold that would trigger CCyB's activation, resulting in a benchmark buffer rate of 0 percent.

Several countries have activated CCyB at a rate greater than zero despite having a negative credit-to-GDP gap. This suggests that the credit-to-GDP gap may not be a reliable indicator for signaling the buildup of the buffer[90].

[84] This is a buffer guide indicating a specific CCyB rate and can serve as a common starting point for the activation of this tool.

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

[86] According to the BCBS approach, a one-sided HP filter calculates the long-term trend of the credit-to-GDP ratio using a smoothing parameter of 400,000 for quarterly data.

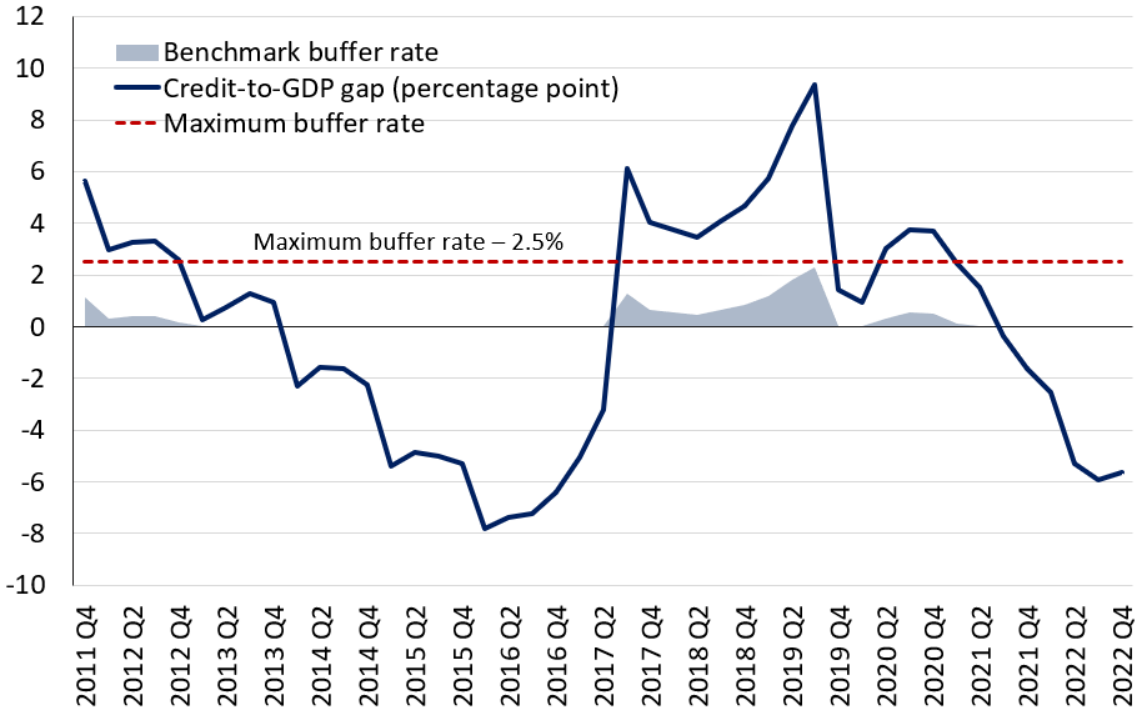
[87] The benchmark CCyB rates between 0 and 2.5 percent are determined using the formula: 0,3125*credit-to-GDP gap – 0,625.

[88] Under this approach, it is recommended to have at least 10 years of reliable credit-to-GDP ratio data.

[89] International Monetary Fund. (2022, March). Macroprudential Policies to Enhance Financial Stability in the Caucasus and Central Asia.

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

Figure 50. Credit-to-GDP Gap and Benchmark Buffer Rate, %



Source: CBU staff calculations.

To set the CCyB rate, core indicators can be used to draw preliminary conclusions. However, the final decision depends on expert judgment based on the analysis of additional indicators that indicate financial vulnerabilities.

The CBU has developed a financial vulnerability heatmap to identify risks in the financial system, which covers the most frequently used indicators in international practice regarding the decision on CCyB. According to the heatmap, credit growth slowed in 2021 and 2022, resulting in a slight decline in financial system vulnerabilities. Additionally, the leverage ratio shows that banking system capitalization is improving.

The macro stress test can also be used to calibrate the level of CCyB. It helps estimate the banking system's credit losses and capital shortfalls under an adverse scenario[91].

The core and additional indicators analysis suggest that credit growth in Uzbekistan has slowed in recent years. However, individuals' credit outstanding has increased significantly due to greater financial inclusion, increased competition in the credit market, and the emergence of digital credit products.

Here are some of the key benefits of implementing CCyB:

- The CBU will be able to express its macroprudential policy stance by calibrating the CCyB level.

- It will facilitate the steady provision of credit to the economy and decrease the impact of financial cycles downturns

[91] See Macro stress test section.

(which is impossible with minimum capital requirements alone).

- CCyB helps moderate excessive credit growth.

Furthermore, due to the challenges in assessing cyclical systemic risk, delays in obtaining data, and other structural disruptions, implementing a positive cycle-neutral CCyB rate provides an opportunity to absorb losses in the banking system due to financial cycle downturns or economic shocks.

Table 4. Additional Indicators for CCyB Activation

Indicators	2018				2019				2020				2021				2022			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Growth in credit-to-GDP ratio																				
Total credit growth (YoY)																				
GDP growth (YoY)																				
Real house prices (Tashkent city)																				
Leverage ratio																				
Current account balance (percent of GDP)																				
Tier 1 capital-to-RWA ratio																				
Household debt service ratio																				

Source: CBU staff calculations.

Note: When the color changes from green to red, it signifies a rise in financial risks.

Box 5. Positive Cycle-Neutral Countercyclical Capital Buffer Rate

Capital buffers play an important role in increasing the resilience of banks to external and internal shocks. In this regard, in addition to the minimum capital adequacy requirements, the Basel Committee recommends that banks maintain high-quality, loss-absorbing capital reserves[92]. Some countries have implemented a positive cycle-neutral CCyB rate under normal risk conditions. This is due to the complexity of assessing cyclical systemic risks and lags in data availability. If created untimely, buffers can make banks more vulnerable to aggregate shocks. A new approach has emerged where banks keep additional high-quality capital when faced with non-cyclical shocks, such as the Covid-19 pandemic or geopolitical tensions.

The United Kingdom was the first country to implement a positive cycle-neutral CCyB rate. In 2016, this rate was set at 1 percent of RWA, based on considerations about the difficulty of assessing systemic risk and limits to the speed of buffer accumulation when risks increase. In 2019, it was revised to 2 percent of RWA. Other countries like Australia (1 percent)[93], Netherlands (2 percent)[94], Sweden (2 percent)[95], Estonia (1 percent)[96], and Georgia (1 percent)[97] have followed suit by maintaining a positive cycle-neutral CCyB rate in good times. This buffer can be partially or fully released when cyclical systemic risks materialize and shocks occur, thus increasing the banking system's resilience.

This approach determines the total CCyB rate using the following formula:

$$CCyB_{total} = CCyB_{base} + CCyB_{cyclical}$$

Where:

$CCyB_{base}$ is a constant positive CCyB rate that is set in normal systemic risk conditions.

$CCyB_{cyclical}$ is a buffer rate that is set by looking at the boom–bust phases of the financial cycle.

[92] Basel Committee on Banking Supervision. (2022, October). Buffer usability and cyclicality in the Basel framework.

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

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

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

[96] Eesti Pank. Financial Stability Review 2/2021.

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

Appendices

Appendix 1

Methodology for Developing Financial Vulnerabilities Heatmap

The financial system's vulnerabilities are made clear through a heatmap[98] that uses colors to represent large amounts of data. When colors change from green to red, it indicates an intensification of vulnerabilities. The heatmap's simplicity and ease of understanding make it convenient for analyzing financial system vulnerabilities regularly and assisting in the timely implementation of macroprudential policy measures.

It's important to note that the colors indicating vulnerability levels should not be interpreted in an absolute sense. Instead, they should be compared to historical benchmarks of the selected indicator to signal the build-up of systemic vulnerabilities.

This monitoring tool for financial system risks was developed using the methodology of Arbatli and Johansen (2017). First, to construct a financial vulnerabilities heatmap, a specific period for indicators is selected. Then, the set of indicators is standardized using the following empirical cumulative distribution function:

$$z_t = F_N(x_t) = \begin{cases} \frac{r}{N}\ , for\ x^r \leq x_t < x^{r+1}, r = 1,2, \dots, N-1 \\ 1\ , for\ x_t \geq x^N \end{cases}$$

Where:

x^N is the highest level of the indicator in a given sample.

x^1 is the lowest level of the indicator.

z_t is a standardized indicator.

r is a ranking number assigned to a particular realization of x_t.

N is the total number of observations.

Each indicator's minimum and maximum limits are in the range of (0,1]. Standardized indicators are then displayed as colors, with the gradation from green to red representing an increase in financial vulnerabilities.

[98] Arbatli, E., & Johansen, R. (2017). A Heat Map for Monitoring Systemic Risk in Norway. Norges Bank staff memo 10.

Emergency Liquidity Assistance

If a bank experiences temporary liquidity shortages, it can turn to central banks for emergency liquidity assistance (ELA). Central banks act as a lender of last resort by offering ELA to solvent banks facing temporary liquidity problems. The primary purpose of ELA is to ensure financial stability, not to regulate short-term liquidity[99].

Banks facing temporary liquidity problems can apply to the central bank for liquidity support. The central bank considers the financial performance of these banks and decides whether to provide liquidity under the ELA[100]. Banks that are insolvent or have a low probability of recovering their solvency in the future are not eligible for ELA.

Based on international experience, ELA is provided to banks based on three principles: banks must be solvent, ELA should be secured by collateral, and ELA should be given at an interest rate higher than the market rate.

Bank of Canada can provide liquidity to eligible financial institutions and financial market infrastructures facing liquidity issues. ELA's interest rate is no lower than the rate of interest that the Bank of Canada charges on one-day loans to major financial institutions. ELA can be provided for up to six months, with an option to extend loans if necessary[101]. Collateral in the form of a Canadian-dollar loan portfolio (excluding mortgage loans) or less liquid securities, and in some cases Canadian-dollar mortgage loans, is required for ELA loans.

Monetary Authority of Singapore provides ELA to banks through two modes: market-wide and bespoke[102]. Market-wide ELA is available to all banks to absorb large-scale liquidity shocks caused by sudden and system-wide disruptions in funding markets. Bespoke ELA is extended to D-SIBs, given their crucial role in the financial system and broader economy. Collateral and loan terms for bespoke ELA are broader and more flexible than those for market-wide ELA.

Sweden's central bank, Riksbank, offers credits to solvent financial institutions in Swedish krona or foreign currency to prevent severe disruptions in the financial system[103]. The importance of an institution in need of liquidity is assessed by its level of contagion risk or activity in the financial system[104]. Interest rates for ELA are higher than that for loans received by other organizations from the market, cover credit risks, and reflect reasons for the need for ELA[105].

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[99] International Monetary Fund. (2002). Building Strong Banks Through Surveillance and Resolution.

[100] Dobler, M., Moretti, M., & Piris, A. (2020). Managing Systemic Banking Crises – New Lessons and Lessons Relearned. International Monetary Fund.

[101] Bank of Canada. Emergency Lending Assistance.

[102] Monetary Authority of Singapore. (2019). Emergency liquidity assistance in Singapore.

[103] Sveriges Riksbank. (2022). The Sveriges Riksbank Act.

[104] Sveriges Riksbank. Emergency liquidity assistance.

[105] Sveriges Riksbank. (2022). Policy for pricing of Emergency Liquidity Assistance.

Norway's Norges Bank can provide ELA to the entire banking system or individual banks when liquidity is unavailable from alternative sources[106]. ELA is allocated only to solvent banks with adequate collateral, and interest rates are set higher than market rates to encourage banks to use market-financing sources. Moreover, banks deemed to have a high probability of failing by the Financial Supervisory Authority of Norway will not be eligible to receive ELA[107].

The Swiss National Bank (SNB) acts as a lender of last resort and can provide ELA to domestic banks unable to refinance operations on the market[108]. ELA is provided to banks important for financial system stability, solvent, and with sufficient collateral, as determined by the SNB. The Financial Market Supervisory Authority (FINMA) assesses the solvency of banks or a group of banks.

[106] Norges Bank. Lender of last resort.

[107] Norges Bank. (2020). Principles for emergency liquidity assistance (ELA).

[108] Swiss National Bank. (2004, March). Guidelines of the Swiss National Bank on monetary policy instruments.

Appendix 3

Table 5. Models for FSI Calculation: Applicability in Uzbekistan

Step for FSI calculation	Model	Is sufficient time series data available?	Is crisis dummy needed?
Indicators selection	AUROC	Yes	No
	Logistic regression	Yes	No
Indicators standardization	Z-score	Yes	Yes
	Logit transformation	Yes	Yes
	Min-max	Yes	Yes
	Cumulative distribution function	Yes	Yes
Indicators aggregation to subindex	Principal component analysis	Yes	Yes
	Equal variance	Yes	Yes
Subindices' weights estimation	AUROC	Yes	No
	Logistic regression	Yes	No
	Evaluating relative impact on the economic growth	Yes	Yes
Subindices aggregation to final index	Principal component analysis	Yes	Yes
	Portfolio theory	No	Yes

FSI Calculation Methods

To calculate the FSI, first, effective indicators that represent changes in the financial system are selected. These indicators are then standardized and combined into subindices that show the condition of the financial sectors. Based on their significance, the weights of the subindices are determined. Finally, the values and weights of the subindices are used to calculate the FSI.

Selection of effective indicators. Selecting effective indicators when calculating the FSI is crucial to ensure the reliability of the index results. Indicators can be chosen based on the country's characteristics and experiences of other countries or evaluated using econometric models to determine their significance level.

When selecting indicators, choosing those readily available with a high-frequency publication, representing market-wide developments, and having sufficient time series is essential[109]. The Area under the Receiver Operating Characteristic Curve, AUROC, (United Kingdom[110], Ukraine[111]) and logistic regression (Ukraine) models are commonly used to identify important indicators for FSI calculation.

When evaluating indicators' effectiveness using the AUROC model, Type I[112] and Type II[113] errors are considered to determine how accurately they represent crisis periods[114]. High AUROC values indicate that indicators accurately represent crisis periods, with a value of 0.7 indicating a 70 percent chance that the model correctly distinguishes between crisis and non-crisis events.

Logistic regression models determine the probability of a particular event by identifying significant indicators that accurately represent the crisis period[115].

Standardization of indicators. To compare and combine indicators into subindices, they are first standardized using various methods. Standardization of indicators is done by Z-score (Turkey[116], Ukraine, Albania[117]), logit transformation (Albania), min-max

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

[110] Chatterjee, S., Chiu, C-W. J., Duprey, T., & Hoke, S. H. (2017). A financial stress index for the United Kingdom. Bank of England.

[111] Filatov, V. (2021). A New Financial Stress Index for Ukraine. National Bank of Ukraine.

[112] In a Type I error, financial stress is not expected to occur, but it does.

[113] In a Type II error, financial stress is expected to occur, but it does not.

[114] Chatterjee, S., Chiu, C-W. J., Duprey, T., & Hoke, S. H. (2017). A financial stress index for the United Kingdom. Bank of England.

[115] Gujarati, D.N. (2009). Basic Econometrics Fifth Edition. McGraw-Hill.

[116] Chadwick, M., & Ozturk, H. (2018). Measuring Financial Systemic Stress for Turkey: A Search for the Best Composite Indicator. Central Bank of the Republic of Turkey.

[117] Kota, V., & Saqe, A. (2013). A Financial Systemic Stress Index for Albania. Bank of Albania.

(Macedonia[118], Ukraine), and cumulative distribution function (United Kingdom, Turkey, India[119]) methods.

The Z-score method is based on how much the difference between the indicator's current value and its arithmetic mean is above or below its standard deviation. Indicator standardization through the min-max method is carried out by determining the ratio of the difference between the actual value and the lowest value of the indicator during the observation period to the difference between the highest and lowest values of the same indicator during that same period. The cumulative distribution function method involves placing the values of each indicator in ascending order and assigning them ordinal numbers based on their location. The indicators are then standardized by dividing the given order number by the total number of indicator time series[120].

Aggregation of indicators into a subindex. Standardized indicators are combined into subindices based on their representation of different sectors within the financial system. To calculate the subindex value, either the PCA (Albania) or equal variance (Czech Republic[121]) models are used.

In the equal variance model, the indicators are aggregated into subindices by calculating their arithmetic mean with equal weights. This common method reduces the probability of any single indicator dominating the subindex.

For PCA, a linear transformation is used to reduce the dimension of multiple indicators with mutual correlation while retaining the maximum variance[122]. This process combines several indicators into a single indicator.

Estimating the weights of subindices. To calculate the final FSI, subindices representing various segments of the financial system are first weighted. The weight of subindices can be calculated using models such as AUROC (United Kingdom, Ukraine) and logistic regression (Ukraine[123]). Subindices with high values in these models are assigned higher weights in the final FSI. Additionally, the weights of subindices in the final index can be determined by evaluating their relative impact on economic growth and considering factors such as the number of indicators in the subindex or assigning equal weights.

Aggregation of subindices into a final index. In the last stage of calculating the FSI, subindices are aggregated into the final index. The aggregation of subindices into the

[118] Petroska, M., & Mihajlovska, E.M. (2013). Measures of Financial Stability in Macedonia. Journal of Central Banking Theory and Practice.

[119] Senapati, M., & Kavediya, R. (2020). Measuring Financial Stress in India. Reserve Bank of India.

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

[121] Malega, J., & Horvath, R. (2017). Financial Stress in the Czechia: Measurement and Effects on the Real Economy.

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

[123] Filatov, V. (2021). A New Financial Stress Index for Ukraine. National Bank of Ukraine.

final index is carried out through the PCA (Belarus[124], India[125]) and portfolio theory (Albania, United Kingdom, Ukraine) models, as well as by calculating the sum or weighted average value of subindices (Czech Republic, Turkey).

The portfolio theory model expresses the FSI as a vector multiplication of the subindices' values, weights, and dynamic correlation matrix. The correlation matrix's elements represent the time-varying cross-correlations among indicators, which are determined using the exponentially weighted moving average (EWMA) and dynamic conditional correlation multivariate generalized auto-regressive conditional heteroskedasticity (DCC-MGARCH) models.

[124] Mazol, A. (2017). The influence of financial stress on economic activity and monetary policy in Belarus. Belarusian Economic Research and Outreach Center.

[125] Senapati, M., & Kavediya, R. (2020). Measuring Financial Stress in India. Reserve Bank of India.

GARCH Model

Autoregressive Conditional Heteroskedasticity (ARCH) model has been extended to the GARCH model[126]. The model determines the conditional variances of heteroskedastic[127] and autoregressive[128] indicators. Furthermore, the model is based on conditional variances, which are expressed as a linear function of the squared values of past time series.

According to the GARCH (*p, q*) model, the following is done:

(1) $E(\epsilon_t \mid \epsilon_u, u < t) = 0, \quad t \in Z.$

(2) $\sigma_t^2 = Var(\epsilon_t \mid \epsilon_u, u < t) = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_i \sigma_{t-j}^2, \quad t \in Z.$

(3) $\epsilon_t = \sigma_t n_t.$

Where, ϵ is the residual, σ^2 is a conditional variance, α and β are non-negative constants, ω is a strictly positive constant, p and q are lags representing the previous values of ARCH and GARCH, n is an independent and identically distributed random variable with mean zero and unit variance.

GARCH (1, 1) model is considered a special case of GARCH *(p, q)* and has the following form (p=q=1):

$$\begin{cases} \sigma_t^2 = \omega + \alpha \epsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \\ \epsilon_t = \sigma_t n_t \end{cases}$$

Where, σ^2 is a conditional variance, α and β are non-negative constants, ω is a strictly positive constant, ϵ is the residual, n is an independent and identically distributed random variable with mean zero and unit variance.

GARCH parameters are estimated using the maximum likelihood function.

Maximum likelihood function

If the observations of the log return series $\{r_1, r_2 \ldots, r_T\}$ are fixed, their joint probability density function with the parameter vector $\theta(\omega, \alpha, \beta)$ can be represented as follows:

$$f(r_t, r_{t-1}, \ldots, r_1; \theta) = f(r_t \mid r_{t-1}, \ldots, r_1; \theta) \times \ldots \times f(r_2 \mid r_1; \theta) \times f(r_1; \theta)$$

[126] Francq, C., & Zakoian, J.-M. (2010). GARCH models: structure, statistical inference, and financial applications.

[127] Heteroskedasticity is the condition where the variance of random variables is not constant across observations.

[128] The autoregressive indicator's residual of the current period correlates with its past values.

The general likelihood function $L(\theta; r_t)$ can be derived based on the above equation:

$$L(\theta; r_t) = \prod_{t=1}^{T} f(r_t|\, r_{t-1}, \dots, r_1; \theta).$$

The log-likelihood function is more common to use in practice than the general likelihood function:

$$l(\theta; r_t) = \prod_{t=1}^{T} f(r_t|\, r_{t-1}, \dots, r_1; \theta) = \sum_{t=1}^{T} \log f(r_t|\, r_{t-1}, \dots, r_1; \theta).$$

Since the residual (ϵ_t) is important in estimating the GARCH parameters, it is appropriate to use the residual in the above equation. Under the distributional assumption of standard normal n_t in the conditional log-likelihood functions for GARCH (*p, q*) model with normal innovations, $\epsilon_t = \sigma_t n_t \sim N(0; \sigma_t^2)$ can be approached. Using the data up to time $t-1$ and based on $n_t \sim N(0; 1)$ the density function of n_t is expressed as follows:

$$f(n_t|\, n_{t-1}, \dots, n_0; \theta) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{n_t^2}{2}\right).$$

Also, the density function of ϵ_t is expressed as:

$$f(\epsilon_t|\, \epsilon_{t-1}, \dots, \epsilon_0; \theta) = \frac{1}{\sqrt{2\pi\sigma_t^2}} \exp\left(-\frac{\epsilon_t^2}{2\sigma_t^2}\right).$$

The conditional log-likelihood function for the GARCH (*p, q*) model is calculated as follows:

$$l(\theta; \epsilon_{t-1}, \dots, \epsilon_0) = \sum_{t=1}^{T} \log f(\epsilon_t|\, \epsilon_{t-1}, \dots, \epsilon_0) = \sum_{t=1}^{T} \frac{1}{\sqrt{2\pi\sigma_t^2}} \exp\left(-\frac{\epsilon_t^2}{2\sigma_t^2}\right) =$$

$$\sum_{t=1}^{T} \left[-\frac{1}{2}\ln(2\pi) - \frac{1}{2}\ln(\sigma_t^2) - \frac{\epsilon_t^2}{2\sigma_t^2}\right] =$$

$$-\frac{T}{2}\ln(2\pi) - \frac{1}{2}\sum_{t=1}^{T}\left[\ln(\omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2) + \frac{\epsilon_t^2}{\omega + \alpha\epsilon_{t-1}^2 + \beta\sigma_{t-1}^2}\right].$$

The values of the parameters that maximize the logarithmic probability are determined by taking special derivatives with respect to the unknown parameters (ω, α, β) and setting them equal to zero.

Appendix 6

Principal Component Analysis

Principal component analysis (PCA) involves reducing the dimension of multiple indicators with mutual correlation by linear transformation while retaining the maximum possible variance[129].

Several common components may cause changes in a large number of indicators. Also, the relationship between components and indicators is expressed as follows[130]:

$$x_{it} = \lambda_i F_t + e_{it}$$
$$x_{it} = C_{it} + e_{it}$$

Where, x_{it} are indicators, λ_i is the eigenvalue between component and indicator, F is the principal component, e_{it} is the variance attributed to each indicator, C_{it} is the common component of the model, i is the number of indicators, t is time period.

For instance, principal component analysis is performed as follows for three conditional indicators (x_1, x_2, x_3). These indicators are first standardized[131] and then converted to matrix form:

$$A = \begin{vmatrix} X_{11} & X_{21} & X_{31} \\ X_{12} & X_{22} & X_{32} \\ X_{13} & X_{23} & X_{33} \\ X_{14} & X_{24} & X_{34} \\ X_{15} & X_{25} & X_{35} \end{vmatrix}$$

Where, X_{it} is a standardized value of indicator i in period t.

For these standardized indicators, the covariance matrix with square[132] and symmetric matrix[133] properties is calculated as follows:

$$\text{Covariance matrix} = \begin{vmatrix} cov(X_1, X_1) & cov(X_1, X_2) & cov(X_1, X_3) \\ cov(X_2, X_1) & cov(X_2, X_2) & cov(X_2, X_3) \\ cov(X_3, X_1) & cov(X_3, X_2) & cov(X_3, X_3) \end{vmatrix}$$

[129] James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An Introduction to Statistical Learning.

[130] Petrovska, M., & Mihajlovska, E. M. (2013). Measures of Financial Stability in Macedonia. Journal of Central Banking Theory and Practice.

[131] The historical mean is subtracted from the indicator value, and then the result is divided by the standard deviation.

[132] A matrix with an equal number of columns and rows.

[133] A matrix with symmetric arrangement of matrix elements relative to the main diagonal.

$$cov(X_i, X_j) = \frac{\sum_{t=1}^{T}((X_{it} - \overline{X_{it}}) \times (X_{jt} - \overline{X_{jt}}))}{T-1};$$

Where, X_{it} is the standardized value of indicator i in period t, X_{jt} is the standardized value of indicator j in period t, $\overline{X_{it}}$ and $\overline{X_{jt}}$ are the corresponding average values of the standardized indicators X_i and X_j during the observation period, T is the number of observations.

In the subsequent step, the eigenvalue and eigenvectors for the covariance matrix are calculated. The eigenvalues and eigenvectors of the covariance matrix have the following relationship:

$$B.v = \lambda.v$$

Where, B is the covariance matrix, v is an eigenvector, λ is an eigenvalue.

If it is possible to choose a number λ, such that any nonzero vector v satisfying the equality $B.v = \lambda.v$, then v is called an eigenvector of a linear transformation. And λ is referred to as the eigenvalue corresponding to the eigenvector of the linear transformation[134].

The indicators on the right-hand side of the equation are moved to the left-hand side, resulting in equation $(B - \lambda).v = 0$. Taking into consideration the fact that the eigenvector v is a nonzero, the values of λ are determined by calculating the following determinant equation. Additionally, λ is multiplied by the unit matrix:

$$det(B - \lambda.I) = 0$$

$$det\left(\begin{pmatrix} cov(X_1,X_1) & cov(X_1,X_2) & cov(X_1,X_3) \\ cov(X_2,X_1) & cov(X_2,X_2) & cov(X_2,X_3) \\ cov(X_3,X_1) & cov(X_3,X_2) & cov(X_3,X_3) \end{pmatrix} - \lambda \times \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}\right) = 0$$

$$det\begin{pmatrix} cov(X_1,X_1) - \lambda & cov(X_1,X_2) & cov(X_1,X_3) \\ cov(X_2,X_1) & cov(X_2,X_2) - \lambda & cov(X_2,X_3) \\ cov(X_3,X_1) & cov(X_3,X_2) & cov(X_3,X_3) - \lambda \end{pmatrix} = 0$$

The determinant above is used to calculate the eigenvalues[135], and the corresponding eigenvectors are then calculated. In this case, equality is used to express the relationship between the eigenvalues and eigenvectors of the covariance matrix:

[134] Kuttler, K. (2022). Linear Algebra, Theory and Applications.

[135] The value of λ is defined by setting the value of the determinant to zero. In this case, since the determinant is 3X3, a cubic equation with respect to λ is formed, and λ can have 3 values ($\lambda = \lambda_i;\ i = 1,2,3$).

$$B.v = \lambda.v$$

$$\begin{pmatrix} cov(X_1,X_1) & cov(X_1,X_2) & cov(X_1,X_3) \\ cov(X_2,X_1) & cov(X_2,X_2) & cov(X_2,X_3) \\ cov(X_3,X_1) & cov(X_3,X_2) & cov(X_3,X_3) \end{pmatrix} \times \begin{pmatrix} v_{1i} \\ v_{2i} \\ v_{3i} \end{pmatrix} = \lambda_i \times \begin{pmatrix} v_{1i} \\ v_{2i} \\ v_{3i} \end{pmatrix}$$

$$\begin{cases} cov(X_1,X_1) \times v_{1i} + cov(X_1,X_2) \times v_{2i} + cov(X_1,X_3) \times v_{3i} = \lambda_i \times v_{1i} \\ cov(X_2,X_1) \times v_{1i} + cov(X_2,X_2) \times v_{2i} + cov(X_2,X_3) \times v_{3i} = \lambda_i \times v_{2i} \\ cov(X_3,X_1) \times v_{1i} + cov(X_3,X_2) \times v_{2i} + cov(X_3,X_3) \times v_{3i} = \lambda_i \times v_{3i} \end{cases}$$

Through the system of equations given above, the values of eigenvectors corresponding to each eigenvalue are determined. The values of the determined eigenvectors are arranged in the matrix in descending order. Specifically, the eigenvector corresponding to the largest eigenvalue is positioned in the first column of the matrix. This ordering signifies that the first column represents the largest variance in the initial indicator data.

The initial standardized indicators are linearly transformed by multiplying them with the defined eigenvectors:

$$\begin{pmatrix} X_{11} & X_{21} & X_{31} \\ X_{12} & X_{22} & X_{32} \\ X_{13} & X_{23} & X_{33} \\ X_{14} & X_{24} & X_{34} \\ X_{15} & X_{25} & X_{35} \end{pmatrix} \times \begin{pmatrix} v_{11} & v_{12} & v_{13} \\ v_{21} & v_{22} & v_{23} \\ v_{31} & v_{32} & v_{33} \end{pmatrix} = \begin{pmatrix} F_{11} & F_{12} & F_{13} \\ F_{21} & F_{22} & F_{23} \\ F_{31} & F_{32} & F_{33} \\ F_{41} & F_{42} & F_{43} \\ F_{51} & F_{52} & F_{53} \end{pmatrix}$$

$$\begin{cases} F_{11} = X_{11} \times v_{11} + X_{21} \times v_{21} + X_{31} \times v_{31} \\ F_{12} = X_{11} \times v_{12} + X_{21} \times v_{22} + X_{31} \times v_{32} \\ F_{13} = X_{11} \times v_{13} + X_{21} \times v_{23} + X_{31} \times v_{33} \\ \dots \\ F_{53} = X_{51} \times v_{13} + X_{52} \times v_{23} + X_{53} \times v_{33} \end{cases}$$

Where, X are the standardized indicators, v are the eigenvectors, F are the principal components.

The set of values obtained after performing the above linear transformation is referred to as the principal components. The principal component in the first column of the set represents the largest variance associated with the indicator data.

Methods for Identifying House Price Bubbles

The initial step in detecting a potential bubble in the real estate market is to estimate the fundamental house price. By comparing the estimated fundamental price to the market price, a gap is identified and, thus, a potential bubble in the real estate market. The SSM (China[136]), OLS (United Kingdom[137]), quantile regression (European Central Bank[138]), and price-income (Armenia[139], Czech Republic[140]) models are widely used to estimate the fundamental house price. The GSADF model (Iceland) is also widely used to determine periods when house market prices exceed their fundamental prices.

The SSM model is one of the most common methods for estimating the fundamental house price. To estimate the fundamental house price, it determines the linear function, which represents the effect of fundamental factors on dependent variable. The Kalman filter[141] estimates the unknown parameters representing the relationship between the variables by determining the maximum value of the log-likelihood function[142]. Moreover, the model can also evaluate the effect of fundamental factors on the demand and supply in the real estate market to estimate the fundamental house price, which is when demand and supply are in equilibrium[143].

It is possible to estimate the fundamental house price using **the OLS model.** According to the main property of the model, the regression parameters are estimated by minimizing the sum of squared errors, i.e. differences between the actual values of the dependent variable and its values estimated by the model[144]. However, when conducting regression analysis using OLS, the non-normality of the residuals and the presence of outliers throughout the observation period reduce the accuracy of the results. In such cases, quantile regression may be more appropriate for estimating the impact of different factors on the dependent variable[145].

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[136] Gabrieli, T., Pilbeam, K., & Wang, T. (2017). Estimation of bubble dynamics in the Chinese real estate market: a State space model.

[137] Chatterjee, S., Chiu, C–W. J., Duprey, T., & Hoke, S. H. (2017). A financial stress index for the United Kingdom. Bank of England.

[138] Gerdesmeier, D., Lenarcic, A., & Roffia, B. (2012). An alternative method for identifying booms and busts in the euro area housing market. European Central Bank.

[139] Central Bank of Armenia. (2022). Financial Stability Report (2021 annual report).

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

[141] Stata manuals, State-space models (SSM).

[142] The Kalman filter is a mathematical algorithm that estimates unobservable variables with observable ones. The Kalman filter consists of two stages. In the first stage, for each period t the Kalman filter estimates the values of the conditional expected unobservable variable vector $z_{t|t}$ and the conditional covariance matrix $\Omega_{t|t}$ conditional on the data up to this period through a recursive algorithm. In the second step, the predicted $z_{t|t}$ vector and conditional covariance matrix $\Omega_{t|t}$ are corrected from errors.

[143] Gabrieli, T., Pilbeam, K., & Wang, T. (2017). Estimation of bubble dynamics in the Chinese real estate market: a State space model.

[144] Gujarati, D. (2004). Basic Econometrics, fourth edition. McGraw-Hill Higher Education.

[145] Fabozzi, F., Focardi, S., Rachev, S., & Arshanapalli, B. (2014). The Basics of Financial Econometrics.

If the market house prices are higher than the fundamental prices of the 20th and 80th quantiles, estimated using the **quantile regression model** based on fundamental factors, it signals periods of boom, and if vice versa, it signals periods of bust. The average salary and weighted average interest rates for mortgage loans are usually used as independent variables to calculate the fundamental house price[146].

Unlike other methods, **the price-income model** does not require time series for determining the fundamental house price. The fundamental house price is calculated by evaluating the maximum borrowing capacity for obtaining mortgage loans based on household income[147].

The GSADF model is a tool used to detect when housing prices in the market exceed their fundamental prices. It works by dividing the entire observation period into subsamples and testing the indicator values within each subsample for stationarity[148]. The test statistics are compared to critical values from a limit distribution, estimated using Monte Carlo simulation. If the test statistic is above the critical value, it is considered that a price bubble occurred during that period[149]. The housing price-to-income ratio is analyzed using this model to identify periods of price bubbles in the real estate market.

[146] Gerdesmeier, D., Lenarcic, A., & Roffia, B. (2012). An alternative method for identifying booms and busts in the euro area housing market. European Central Bank.

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

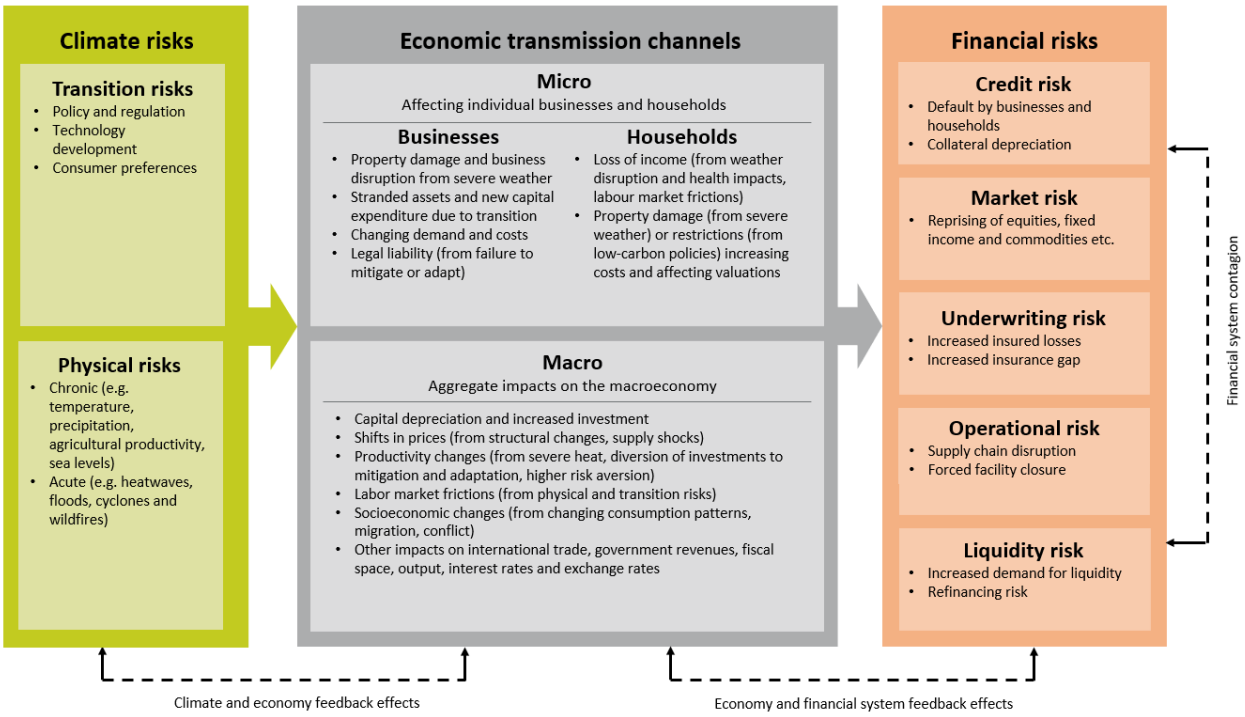
[148] A stationary variable is a variable whose statistical properties (mean and variance) remain constant for all periods.

[149] Phillips, P., Shi, S., & Yu, J. (2015). Testing for Multiple Bubbles: Historical Episodes of Exuberance and Collapse in the S&P 500. International Economic Review.

Climate Stress Test

Climate change poses a major global problem, as it brings a range of risks. The climate stress testing tool is used to analyze the impact of physical and transition risks due to climate change on banks' financial stability. Climate stress tests typically involve five stages based on a large database and sophisticated scenarios encompassing socioeconomic and geophysical variables. Firstly, the physical and transition risks associated with climate change and their impact on the real economy are identified. In the second stage, the extent to which the stress test can cover these risks is explored and data is collected. In the third stage, macro stress test scenarios that consider climate risks are developed. Next, based on these scenarios, a stress test is conducted to evaluate the resilience of banks to climate risks. Finally, the results of the climate stress test are analyzed.

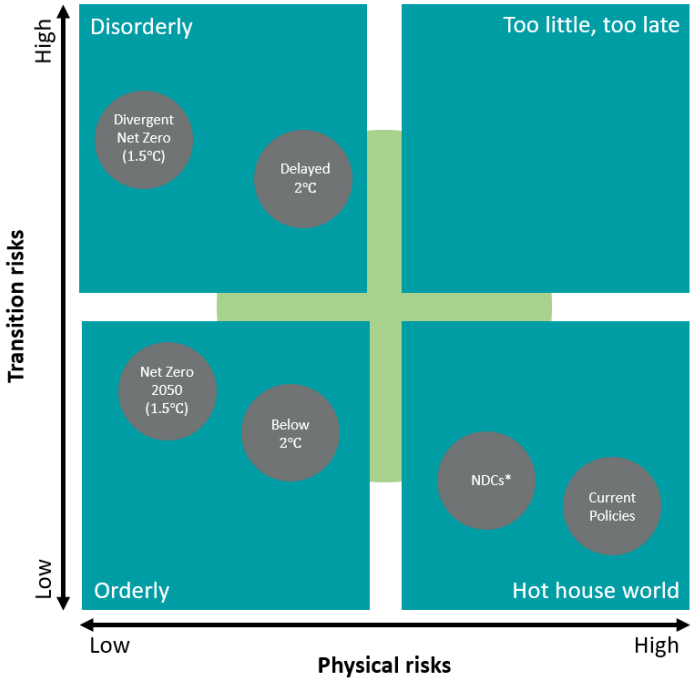
Figure 51. Impact of Climate Change Risks on the Financial System



Source: NGFS.

To properly evaluate the impact of climate change on the economy, an individual database by sector is required. Indicators such as carbon price, greenhouse gas emissions from businesses, energy consumption, energy resource prices, and other factors are used to assess transition risks. Physical risks can be expressed through indicators like economic losses from natural disasters, country temperature levels, and changes in labor productivity. Moreover, macro-financial effects are determined by analyzing GDP, unemployment, house prices, long-term interest rates, inflation, energy prices and consumption, and other relevant indicators.

Figure 52. NGFS Climate Stress Test Scenarios



Source: NGFS

Note: Positioning of scenarios is approximate, based on an assessment of physical and transition risks out to 2100.
Net Zero 2050 (1.5℃) limits global warming to 1.5℃ through stringent climate policies and innovation, reaching global net zero CO_2 emissions around 2050.
Below 2℃ gradually increases the stringency of climate policies, giving a 67 percent chance of limiting global warming to below 2℃.
Divergent Net Zero (1.5℃) reaches net zero around 2050 but with higher costs due to divergent policies introduced across sectors leading to a quicker phase-out of oil use.
Delayed 2℃ assumes annual emissions do not decrease until 2030. Strong policies are needed to limit warming to below 2℃. Negative emissions are limited.
*NDCs (Nationally Determined Contributions) include all pledged targets even if not yet backed up by implemented effective policies.

The Network of Central Banks and Supervisors for Greening the Financial System (NGFS) develops indicators to express climate risks and stress test scenarios for the financial system. These scenarios prepare the financial system for possible future risks and shocks that may occur as a result of climate change. The NGFS has created six climate stress test scenarios categorized as orderly, disorderly, and hot house world scenarios. In orderly scenarios, countries introduce climate policies early that gradually become more stringent, resulting in lower physical and transition risks. In disorderly scenarios, there is a high transition risk due to delayed or divergent climate policies across countries. Hot house world scenarios assume that some countries implement climate policies to halt global warming, but not worldwide, leading to serious physical risks.

The impact of climate risks on banking system stability is analyzed by evaluating the negative effects on business entities and households using the stress test scenarios. Specifically, the credit losses incurred by banks due to the increased probability of

default and macroeconomic changes specific to each scenario are assessed. The results of the climate stress test enable decision-makers to incorporate climate risks into their decision-making process, allowing them to manage the impact of transitioning to a green economy and the climate-related risks on the banking system.

The availability of climate change impact indicators and scenarios for banks' financial stability enables the development of a country-specific climate stress test. In October 2022, the CBU became a member of the NGFS, which allows for sharing experience in managing the impact of climate risks on the financial system, learning from best international practices, and the potential development of a climate stress testing tool in the future.

Table 6. Countries with Positive CCyB Buffer Rate, % of RWA

Countries	Buffer rate set/announced prior to the Covid-19 pandemic	During the Covid-19 pandemic	CCyB buffer rate as of January 1, 2023, and announced rates
Australia	0	→ 0	↑ 1
Armenia	0	→ 0	→ 0 (01.05.2023: ↑ 1; 01.08.2023: ↑ 1.5)
Belgium	0.5	↓ 0	→ 0
Bulgaria	1.5	↓ 0.5	↑ 1.5 (01.10.2023: ↑ 2)
Croatia	0	→ 0	→ 0.0 (31.03.2023: ↑ 0.5; 31.12.2023: ↑ 1)
Cyprus	0	→ 0	→ 0 (30.11.2023: ↑ 0.5)
Czech Republic	2	↓ 0.5	↑ 2 (01.04.2023: ↑ 2.5)
Denmark	2	↓ 0	↑ 2 (31.03.2023: ↑ 2.5)
Estonia	0	→ 0	↑ 1 (01.12.2023: ↑ 1.5)
France	0.5	↓ 0	→ 0 (07.04.2023: ↑ 0.5; 02.01.2024: ↑ 1)
Georgia	0	→ 0	→ 0 (15.03.2024: ↑ 1)
Germany	0.25	↓ 0	→ 0 (01.02.2023: ↑ 0.75)
Hong Kong	2	↓ 1	→ 1
Hungary	0	→ 0	→ 0 (01.07.2023: ↑ 0.5)
Iceland	2	↓ 0	↑ 2 (15.03.2024: ↑ 2.5)
Ireland	1	↓ 0	→ 0 (15.06.2023: ↑ 0.5; 24.11.2023: ↑ 1)
Lithuania	1	↓ 0	→ 0 (01.10.2023: ↑ 1)
Luxembourg	0.5	→0.5	→ 0.5
Netherlands	0	→ 0	→ 0 (25.05.2023: ↑ 1)
Norway	2.5	↓ 1	↑ 2 (31.03.2023: ↑ 2.5)
Romania	0	→ 0	↑ 0.5 (23.10.2023: ↑ 1)
Slovakia	2	↓ 1	→ 1 (01.08.2023: ↑ 1.5)
Sweden	2.5	↓ 0	↑ 1 (22.06.2023: ↑ 2)
United Kingdom	2	↓ 0	↑ 1 (05.07.2023: ↑ 2)

Sources: Basel Committee, European Systemic Risk Board and national authorities.

Macroprudential Measures in Selected Countries During Covid-19 Pandemic[150]

Azerbaijan. The CAR ratio was reduced from 10 to 9 percent (from 12 to 11 percent for SIBs), and risk weights for mortgage loans were reduced from 100 to 50 percent.

Armenia. The Tier I capital requirement was reduced from 10 to 9 percent. The phase-in of the LCR and NSFR requirements, initially planned for Q2 2020, was postponed until January 2021. The LTV limit implementation was delayed until March 2021.

Brazil. In March 2020, the Central Bank of Brazil reduced the CCoB rate from 2.5 to 1.25 percent for one year and reestablished this requirement until March 2022[151].

Canada. The Office of the Superintendent of Financial Institutions lowered the buffer rate for D-SIBs from 2.25 to 1 percent in March 2020[152].

India. The planned phase-in of CCoB (from 1.875 to 2.5 percent) in March 2020 was delayed until April 2021[153].

Indonesia. Banks with Tier I capital exceeding 5 trillion Indonesian rupiah (340 million US dollars) were exempted from the 2.5 percent CCoB requirement until the end of March 2022[154].

Kazakhstan. In June 2020, the CCoB rate was reduced from 2 to 1 percent (from 3 to 2 percent for SIBs). The risk weights for foreign currency loans were reduced from 200 to 100 percent, for small and medium-sized enterprises from 75 to 50 percent, and for syndicated loans from 100 to 50 percent. The LCR requirement was reduced from 80 to 60 percent.

Kyrgyzstan. The minimum liquidity ratio was reduced from 45 to 30 percent, and the requirement for instant liquidity was suspended. The risk weights for foreign currency corporate loans and retail loans were reduced from 150 to 100 percent.

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[153] Basel Committee on Banking Supervision. (2021, July). Early lessons from the Covid-19 pandemic on the Basel reforms.

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Sectoral CCyB

The sectoral CCyB is a macroprudential tool used to address vulnerabilities in a specific sector. The Basel III standard determines the overall CCyB amount relative to the total RWA. The sectoral CCyB, however, is determined based on the relevant risk exposure in the targeted segment, such as a buffer aimed at reducing vulnerabilities in the real estate market. This makes the CCyB for specific sectors more targeted and flexible than broad-based macroprudential tools.

Switzerland has implemented a sectoral CCyB to mitigate vulnerabilities in the real estate market. In 2013, the country activated the sectoral CCyB to address accumulating vulnerabilities in the market and set it at 1 percent of the relevant RWA. The sectoral CCyB rate was raised to 2 percent in 2014[155]. However, due to the Covid-19 pandemic, the buffer was fully released to maintain the credit supply to the real economy. In response to heightened vulnerabilities in the real estate market, the Swiss Federal Council reactivated the sectoral CCyB and set it at 2.5 percent since September 30, 2022[156].

When activating and calibrating the sectoral CCyB rate, the SNB considers various indicators such as the mortgage loans-to-GDP ratio, the house price index, the credit-to-GDP gap, the house prices-to-rent ratio, and the annual growth of mortgage loans.

[155] Swiss National Bank. (2019, February). Basel III countercyclical capital buffer.

[156] Federal Council. (2022, January). Federal Council requires banks to hold additional capital for residential mortgages.

Table 7. Minimum Capital Adequacy Requirements and Capital Buffers in Selected Countries (as of January 1, 2023), % of RWA

Country	Minimum capital requirements			Buffer requirements			
	CET1[157]	Tier 1 [158]	CAR	CCoB	CCyB	SyRB	SIB buffer
Belgium	4,5	6	8	2,5	0	9	0,75–1,5
Canada	4,5	6	8	2,5	0	0	3
Croatia	4,5	6	8	2,5	0	0	0,25–1,5
Cyprus	4,5	6	8	2,5	0	0	0,25–1,5
Czech Republic	4,5	6	8	2,5	2	0	0,5–2,5
Estonia	4,5	6	8	2,5	1	2	2
Finland	4,5	6	8	2,5	0	0,5–1	0,25–1,25
France	4,5	6	8	2,5	0	0	0,5–2,5
Georgia	4,5	6	8	2,5	0	0	1,5–2,5
Germany	4,5	6	8	2,5	0	0	0,25–2
Greece	4,5	6	8	2,5	0	0	1
Hong Kong	4,5	6	8	2,5	1	0	1–3,5
Hungary	4,5	6	8	2,5	0	0	0,25–1
India	4,5	6	8	2,5	0	1,5	0,5–2
Ireland	4,5	6	8	2,5	0	0	0,5–1,5
Italy	4,5	6	8	2,5	0	0	0,25–1
Kazakhstan	5,5	7	9	2,5	0	0	0,2-0,6
Latvia	4,5	6	8	2,5	0	2	0,25–2
Liechtenstein	4,5	6	8	2,5	0	1	2
Malaysia	4,5	6	8	2,5	0	0	0,5–1
Malta	4,5	6	8	2,5	0	0	0,25–2
New Zealand	4,5	6	8	2,5–3,5	0	0	1
North Macedonia	4,5	6	8	2,5	0	0	1–2,5
Norway	4,5	6	8	2,5	2	4,5	1–2
Poland	4,5	6	8	2,5	0	3	0,25–2
Romania	4,5	6	8	2,5	0	0	0
Saudi Arabia	4,5	6	8	2,5	0,5	0–2	0,5–2
Slovenia	4,5	6	8	3	0	0	0,5–2,5
South Africa	4,5	6	8	2,5	0	2–3	0,5–2,5

Source: European Systemic Risk Board and national authorities.

[157] The minimum requirement for Tier 1 capital (6 percent) includes the minimum requirement for CET1 capital (4.5 percent).

[158] The minimum requirement for regulatory capital (8 percent) includes the minimum requirement for Tier 1 capital (6 percent).

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