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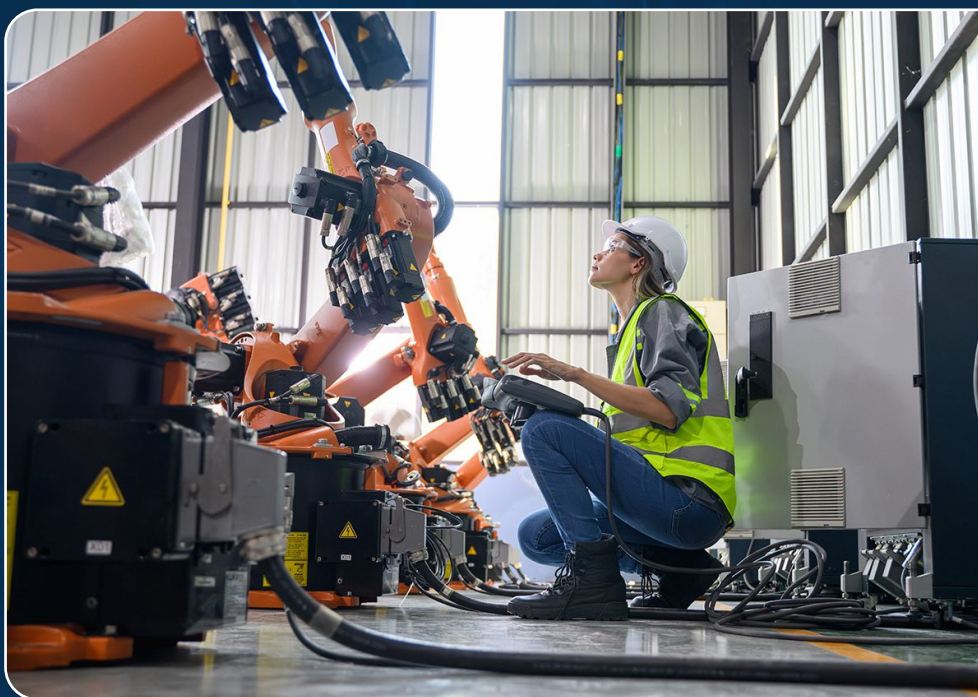
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Bosh muharrir:

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Bosh muharrir o'rinbosari:

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- 05.01.03 – Informatikaning nazariy asoslari
- 05.01.04 – Hisoblash mashinalari, majmualari va kompyuter tarmoqlarining matematik va dasturiy ta'minoti
- 05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
- 05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
- 05.01.07 – Matematik modellashtirish
- 05.01.11 – Raqamli texnologiyalar va sun'iy intellekt
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- 08.00.16 – Raqamli iqtisodiyot va xalqaro raqamli integratsiya
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PROSPECTS FOR APPLYING THE Z-SCORE MODEL IN ASSESSING FINANCIAL STABILITY IN THE UZBEKISTAN BANKING SYSTEM

S. Gaybulloev

Independent Researcher

Tashkent International University of Kimyo

Abstract. This paper investigates the prospects for applying the Z-Score model to the assessment of financial stability in the Uzbek banking sector. The study is based on monthly financial data spanning 2020 to 2024 for three institutions - Aloqabank, Asia Alliance Bank, and Mikrokreditbank which represent distinct ownership models and strategic orientations within the national banking system. The bank-adapted Z-Score formula, $Z = (\mu\text{ROA} + E/A) / \sigma\text{ROA}$, is employed to quantify each institution's distance from insolvency, where μROA denotes mean annual return on assets, E/A is the year-end equity-to-assets ratio, and σROA captures the standard deviation of monthly ROA observations within each year. The results demonstrate that Asia Alliance Bank posted a sustained upward trajectory in financial stability, with Z-Scores rising from 20.93 in 2021 to 53.36 in 2024, driven by robust profitability gains (ROA increasing from 0.54% to 4.91%) and steadily improving cost efficiency (CIR declining from 49.43% to 35.45%). Aloqabank exhibited moderate but variable stability, peaking at 34.42 in 2021, declining to a trough of 14.82 in 2023 amid earnings volatility and a temporary breach of the regulatory capital adequacy minimum, before partially recovering to 22.19 in 2024. Mikrokreditbank recorded exceptionally high Z-Scores of 100.85, 133.83, and 351.63 in 2021–2023 respectively, reflecting an extremely low standard deviation of ROA characteristic of government-directed specialized lending, but experienced a sharp deterioration to 7.86 in 2024 when the institution posted negative mean ROA of -0.57% . The findings contribute to the empirical literature on banking stability in transition economies and yield actionable implications for bank supervisors and management teams.

Keywords: Z-Score, financial stability, bank risk, return on assets (ROA), return on equity (ROE), capital adequacy ratio (CAR), cost-to-income ratio (CIR).

Annotatsiya. Ushbu maqolada O'zbekiston bank tizimida moliyaviy barqarorlikni baholashda Z-Score modelini qo'llash istiqbollari tahlil qilinadi. Tadqiqot 2020–2024-yillar davomida uchta bank — Aloqabank, Asia Alliance Bank va Mikrokreditbank bo'yicha oylik moliyaviy ma'lumotlarga asoslangan bo'lib, ular milliy bank tizimidagi turli mulkchilik shakllari va strategik yo'nalishlarni ifodalaydi. Banklarga moslashtirilgan Z-Score formulasi, ya'ni $Z = (\mu\text{ROA} + E/A) / \sigma\text{ROA}$ qo'llanilib, har bir bankning to'lovga qodir emaslik holatidan masofasi baholandi. Bu yerda μROA — aktivlar rentabelligining o'rtacha yillik ko'rsatkichi, E/A — yil oxiridagi kapitalning aktivlarga nisbati, σROA esa har bir yil bo'yicha oylik ROA ko'rsatkichlarining standart og'ishidir. Natijalar shuni ko'rsatdiki, Asia Alliance Bank moliyaviy barqarorlik bo'yicha barqaror o'sish dinamikasini namoyon etib, Z-Score ko'rsatkichi 2021-yildagi 20.93 dan 2024-yilda 53.36 ga yetgan. Bu o'sish yuqori rentabellik (ROA 0.54% dan 4.91% gacha oshgan) va xarajatlar samaradorligining yaxshilanishi (CIR 49.43% dan 35.45% gacha kamaygan) bilan izohlanadi. Aloqabankda esa nisbatan o'rtacha, ammo o'zgaruvchan barqarorlik kuzatilib, 2021-yilda 34.42 ga yetgan bo'lsa, 2023-yilda 14.82 gacha pasaygan, bu daromadlarning beqarorligi va kapital yetarliligi me'yorining vaqtinchalik buzilishi bilan bog'liq. 2024-yilda esa ko'rsatkich 22.19 gacha tiklangan. Mikrokreditbank 2021–2023-yillarda juda yuqori Z-Score ko'rsatkichlarini (100.85, 133.83 va 351.63) qayd etgan bo'lib, bu davlat tomonidan yo'naltirilgan ixtisoslashgan kreditlashga xos bo'lgan ROA dispersiyasining juda pastligi bilan izohlanadi. Biroq 2024-yilda bankda ROA o'rtacha qiymatining -0.57% ga tushib ketishi natijasida Z-Score keskin ravishda 7.86 gacha pasaygan. Tadqiqot natijalari o'tish iqtisodiyotiga ega mamlakatlarda bank barqarorligi bo'yicha empirik adabiyotlarni boyitadi hamda bank nazoratchilari va boshqaruv organlari uchun amaliy tavsiyalarni shakllantiradi.

Kalit so'zlar: Z-Score, moliyaviy barqarorlik, bank riski, aktivlar rentabelligi (ROA), kapital rentabelligi (ROE), kapital yetarliligi koeffitsiyenti (CAR), xarajatlar va daromadlar nisbati (CIR).



Аннотация. В данной статье исследуются перспективы применения модели Z-Score для оценки финансовой устойчивости банковского сектора Узбекистана. Исследование основано на ежемесячных финансовых данных за 2020–2024 годы по трём банкам — Aloqabank, Asia Alliance Bank и Mikroreditbank, которые представляют различные формы собственности и стратегические направления в национальной банковской системе. Для оценки дистанции до неплатёжеспособности используется адаптированная для банков формула Z-Score: $Z = (\mu ROA + E/A) / \sigma ROA$, где μROA — средняя годовая рентабельность активов, E/A — отношение собственного капитала к активам на конец года, а σROA — стандартное отклонение ежемесячных значений ROA в течение года. Результаты показали, что Asia Alliance Bank продемонстрировал устойчивую положительную динамику финансовой устойчивости: значение Z-Score увеличилось с 20.93 в 2021 году до 53.36 в 2024 году, что обусловлено ростом прибыльности (ROA увеличился с 0.54% до 4.91%) и повышением операционной эффективности (CIR снизился с 49.43% до 35.45%). Aloqabank характеризовался умеренной, но нестабильной динамикой: показатель достиг 34.42 в 2021 году, снизился до 14.82 в 2023 году вследствие волатильности доходов и временного нарушения нормативов достаточности капитала, после чего частично восстановился до 22.19 в 2024 году. Mikroreditbank зафиксировал чрезвычайно высокие значения Z-Score в 2021–2023 годах (100.85, 133.83 и 351.63 соответственно), что связано с крайне низкой вариацией ROA, характерной для специализированного кредитования с государственным участием. Однако в 2024 году наблюдалось резкое ухудшение показателя до 7.86 вследствие отрицательной средней доходности активов (–0.57%). Полученные результаты вносят вклад в эмпирические исследования финансовой устойчивости банков в странах с переходной экономикой и формируют практические рекомендации для органов банковского надзора и менеджмента.

Ключевые слова: Z-Score, финансовая устойчивость, банковский риск, рентабельность активов (ROA), рентабельность капитала (ROE), достаточность капитала (CAR), коэффициент затрат и доходов (CIR).

INTRODUCTION

The financial stability of the banking sector is a precondition for sustainable macroeconomic development, particularly in transition economies undergoing structural reform. Banks serve as the principal intermediaries between savers and investors, transmit monetary policy impulses, and provide critical payments infrastructure. A financially fragile banking system amplifies economic shocks, restricts credit supply, and erodes public confidence - consequences that carry severe social and economic costs. The global financial crisis of 2007–2009, along with subsequent episodes of banking distress in various emerging markets, underscored the urgent need for robust early warning frameworks capable of identifying vulnerability before it escalates into systemic failure.

Among the quantitative approaches developed for this purpose, the Z-Score model has gained considerable traction in both academic research and supervisory practice. Originally formulated in the corporate finance literature by Altman (1968) and subsequently adapted to the banking context by Boyd and Runkle (1993) and Laeven and Levine (2009), the banking Z-Score measures the number of standard deviations by which a bank's returns must fall before equity capital is fully depleted - that is, the institution's statistical distance to insolvency. Compared with complex structural models requiring market data, the Z-Score can be computed directly from standard accounting statements, making it especially suited to emerging and transition markets where market-based risk indicators are limited or unreliable.

Uzbekistan's banking sector has undergone significant structural transformation since the 2017 reform programme initiated by Presidential Decree No. PD-3270, which opened state-owned banks to private capital participation, strengthened prudential regulation, and accelerated financial inclusion. These reforms have produced a heterogeneous banking landscape encompassing state-directed commercial banks such as Aloqabank, dynamically expanding private institutions such as Asia Alliance Bank, and specialized microfinance-oriented lenders such as Mikroreditbank. Each institution pursues a distinct risk-return strategy and operates under different ownership incentives - circumstances that make a comparative Z-Score analysis both analytically informative and policy-relevant.

This study pursues three primary objectives: (i) to compute and compare annual Z-Scores for Aloqabank, Asia Alliance Bank, and Mikroreditbank over the period 2020–2024, based on actual monthly financial reporting data; (ii) to identify the key financial determinants - including profitability, capitalization, and cost efficiency - that drive cross-institutional differences in financial stability; and (iii) to derive evidence-based implications for bank management and regulatory oversight in Uzbekistan.

REVIEW OF LITERATURE ON THE SUBJECT

The assessment of financial stability in banking systems has long been a central topic in Financial Economics, particularly in the context of risk measurement and early warning systems. One of the most influential approaches in this field is the Z-score model, originally developed by Edward I. Altman in 1968. Altman demonstrated that a combination of financial ratios, when analyzed through discriminant analysis, can effectively predict corporate bankruptcy. This model laid the foundation for subsequent adaptations in banking, where Z-score is widely used as a proxy for insolvency risk and overall financial stability.

The theoretical roots of the Z-score concept can be traced back to the “safety-first” principle proposed by A. D. Roy, which emphasizes minimizing the probability of ruin in portfolio selection. This concept aligns closely with the logic of banking stability assessment, where institutions aim to maintain sufficient capital buffers to absorb potential losses. Building on this theoretical framework, modern studies have extended the Z-score approach to banking systems by incorporating profitability, capitalization, and volatility indicators.

Empirical research has significantly contributed to understanding the determinants of bank stability. For instance, Thorsten Beck and Asli Demirgüç-Kunt developed a comprehensive database on financial institutions, highlighting cross-country differences in financial development and stability. Their work provides an essential macro-level context for applying models such as Z-score in different institutional environments. Similarly, Allen N. Berger and co-authors examined the relationship between corporate governance and bank performance, demonstrating that ownership structures and governance mechanisms significantly influence risk-taking behavior.

Further studies emphasize the role of bank-specific characteristics in determining financial stability. John H. Boyd and David E. Runkle analyzed the relationship between bank size and performance, suggesting that larger banks may benefit from diversification but also face increased complexity and risk exposure. In a similar vein, Giovanni Iannotta and colleagues showed that ownership structure affects both risk and profitability in the European banking sector, while Luc Laeven and Ross Levine highlighted the importance of regulation and governance in shaping banks' risk-taking incentives.

The relationship between bank activities, funding strategies, and financial stability has also been widely explored. Asli Demirgüç-Kunt and Harry Huizinga found that diversification into non-traditional activities may increase returns but also introduces additional risks. Moreover, Laetitia Lepetit and Frank Strobel advanced the Z-score methodology by proposing time-varying measures, which better capture dynamic changes in bank insolvency risk over time. These developments are particularly relevant for emerging economies, where financial systems are subject to structural transformations and external shocks.

Another important dimension in the literature concerns differences in banking models and their implications for stability. Martin Cihák and Heiko Hesse conducted an empirical analysis comparing Islamic and conventional banks, concluding that institutional characteristics can influence resilience to financial crises. Additionally, Ying Tan and Chris Floros examined the relationship between bank profitability and macroeconomic growth, demonstrating that stable banking systems are closely linked to overall economic performance.

In the context of Uzbekistan, the application of the Z-score model gains particular importance due to ongoing financial sector reforms and increasing integration into global markets. According to the Central Bank of Uzbekistan, recent years have witnessed improvements in capital adequacy, asset quality, and risk management practices. However, challenges such as credit concentration, external vulnerabilities, and evolving regulatory requirements necessitate the use of reliable analytical tools for assessing financial stability.

Overall, the literature indicates that the Z-score model remains a robust and widely accepted instrument for evaluating bank stability. Its adaptability to different institutional settings, combined with its ability to integrate key financial indicators, makes it particularly suitable for analyzing the prospects of the Uzbekistan banking system. At the same time, recent advancements suggest that incorporating dynamic and country-specific factors can further enhance its predictive accuracy and policy relevance.

RESEARCH METHODOLOGY

The study employs the bank-adapted Z-Score methodology established by Boyd and Runkle (1993) and widely applied in cross-country banking stability research by Laeven and Levine (2009). The Z-Score is defined as follows:

$$Z = (\mu\text{ROA} + E/A) / \sigma\text{ROA}$$

where μROA is the annual mean return on assets (net profit divided by total assets) computed from 12 monthly observations, E/A is the year-end equity-to-assets ratio representing the institution's capital buffer, and σROA is the standard deviation of monthly ROA observations within the same calendar year. A higher Z-Score indicates a larger buffer against insolvency - a more severe adverse shock to earnings would be required to



deplete equity capital. The measure jointly captures profitability, capitalization, and earnings stability, making it a comprehensive proxy for financial soundness.

Data were sourced from monthly balance sheet and income statement filings submitted to the Central Bank of Uzbekistan, covering January 2020 through December 2024. The dataset encompasses 172 financial indicators per institution per month, including balance sheet items, income statement components, profitability ratios, regulatory capital ratios, and liquidity metrics. Z-Scores are reported from 2021 onwards, as the standard deviation of ROA requires a minimum of two monthly observations; the year 2020 serves as a descriptive baseline. All monetary figures are expressed in millions of Uzbek sums (UZS mln).

In addition to the Z-Score, the following complementary indicators are analyzed: Return on Equity (ROE = Net Profit / Total Equity), Capital Adequacy Ratio (CAR = Regulatory Capital / Risk-Weighted Assets), Cost-to-Income Ratio (CIR = Total Operating Expenses / Total Operating Income), and the equity-to-assets ratio (E/A). Together, these metrics provide a multidimensional portrait of each institution's profitability, capitalization, and operational efficiency (Table 1).

Table 1. Annual Z-Score Values by Institution (2021–2024)

Year	Asia Alliance Bank	Aloqabank	Mikrokreditbank
2021	20.93	34.42	100.85
2022	16.72	25.79	133.83
2023	32.63	14.82	351.63
2024	53.36	22.19	7.86

Table 1 presents the annual Z-Score estimates for all three institutions over the study period. Values above zero indicate a positive distance from insolvency; higher values denote greater resilience. Asia Alliance Bank records a clear upward trend, peaking at 53.36 in 2024. Aloqabank demonstrates the greatest interannual variability, declining from 34.42 in 2021 to a low of 14.82 in 2023 before partial recovery. Mikrokreditbank exhibits the most extreme pattern - Z-Scores exceeding 100 in 2021–2023 followed by a collapse to 7.86 in 2024 - a dynamic examined in detail in the Results and Discussion sections.

ANALYSIS AND RESULTS

Figure 1. Z-Score Dynamics of Three Banks (2021–2024)

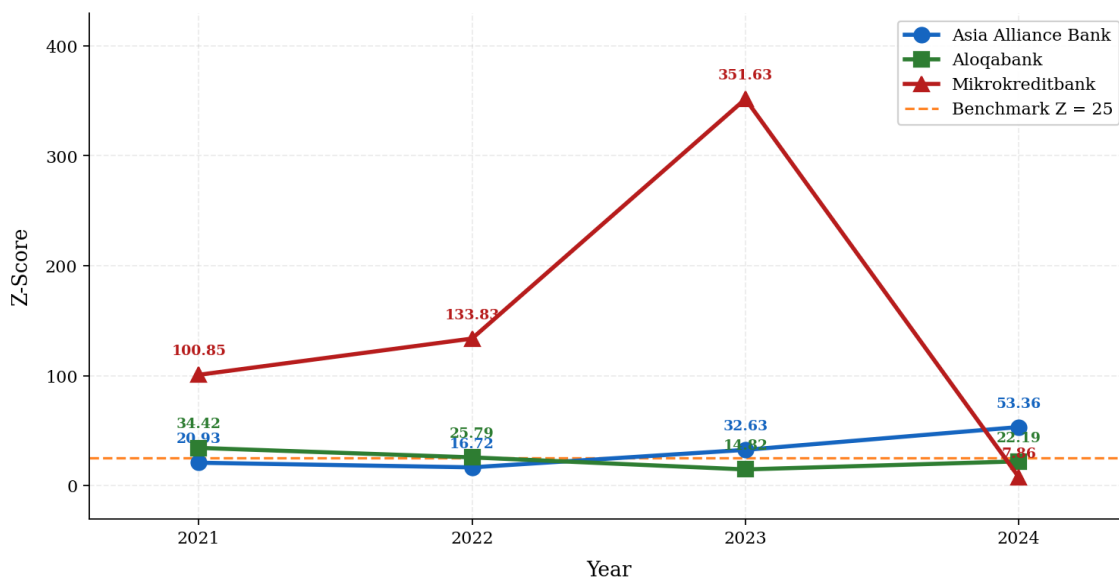


Figure 1. Z-Score Dynamics of Three Banks, 2021–2024

Figure 1 depicts the temporal evolution of Z-Scores across the three institutions. Asia Alliance Bank traces a broadly ascending trajectory: starting at 20.93 in 2021, dipping modestly to 16.72 in 2022 amid a temporary increase in earnings volatility ($\sigma_{ROA} = 0.69\%$), then recovering strongly to 32.63 in 2023 and reaching a peak of 53.36 in 2024. This trajectory reflects the compounding effect of rapidly rising mean ROA - which grew

from 0.54% in 2021 to 4.91% in 2024 - alongside declining earnings variability, which widened the statistical distance to insolvency substantially.

Aloqabank’s Z-Score follows a more volatile course: beginning at 34.42 in 2021, declining through 25.79 in 2022 and further to 14.82 in 2023, before a partial recovery to 22.19 in 2024. The 2023 trough coincided with the highest earnings volatility in the sample ($\sigma\text{ROA} = 1.22\%$), alongside only moderate mean ROA of 1.67%, consistent with margin pressure and increased provisioning requirements during that period. Mikrokreditbank’s Z-Score profile is analytically exceptional: values of 100.85, 133.83, and 351.63 in 2021–2023 reflect an extremely low standard deviation of ROA (0.17%, 0.16%, and 0.06% respectively), a structural feature arising from the institution’s narrow, government-directed lending mandate. The dramatic collapse to 7.86 in 2024 was driven by a reversal to negative mean ROA of -0.57% combined with a sharp spike in earnings volatility ($\sigma\text{ROA} = 1.85\%$), which simultaneously reduced the numerator and inflated the denominator of the Z-Score formula (Figure 2).

Figure 2. Return on Assets (ROA) Comparison, 2021-2024

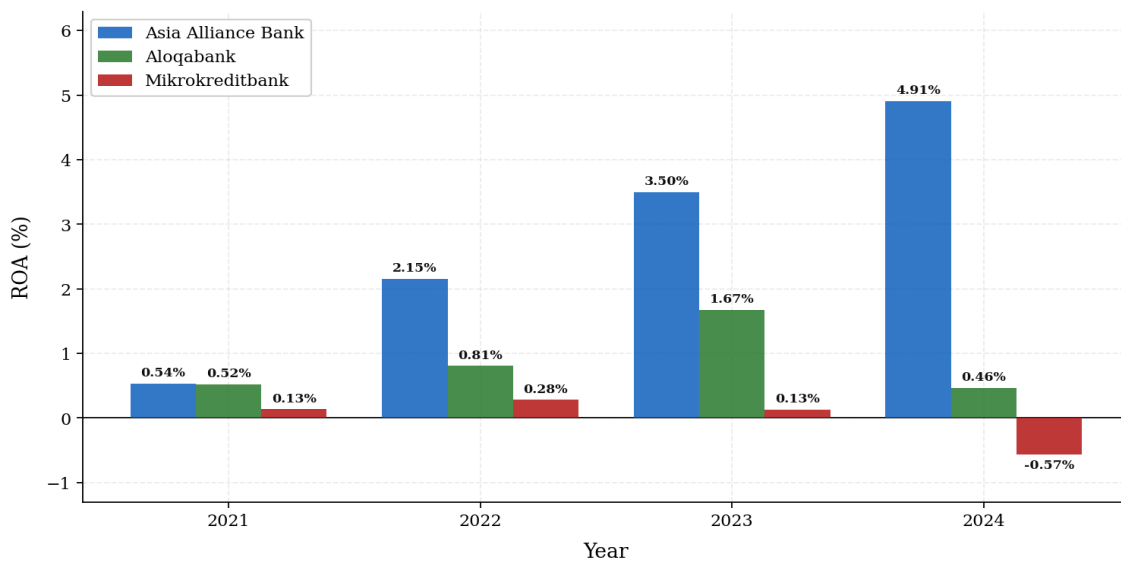


Figure 2. Return on Assets (ROA) Comparison, 2021–2024 (%)

Figure 2 illustrates annual mean ROA values for the three institutions. Asia Alliance Bank recorded the most pronounced and sustained profitability growth, with mean ROA rising from 0.54% in 2021 to 4.91% in 2024 - a level substantially exceeding the international CAMELS benchmarks of 1% (satisfactory) and 2% (strong). This trajectory reflects successful loan portfolio expansion, improved asset quality management, and diversification into non-interest income streams. Aloqabank’s ROA remained structurally constrained throughout the period, ranging between 0.46% and 1.67%, reflecting the bank’s public-interest lending obligations that compress net interest margins. Mikrokreditbank recorded negative mean ROA of -0.57% in 2024 - its first loss-making year over the study period - attributable to a combination of rising impairment charges on its microenterprise lending portfolio and mounting operational cost pressures. Mean ROA remained below 0.3% in all other years, reflecting the structural profitability constraints of its specialized mandate (Table 2).

Table 2. Key Financial Ratios - Asia Alliance Bank (2020–2024)

Indicator	2020	2021	2022	2023	2024
μROA (%)	0.67	0.54	2.15	3.50	4.91
σROA (%)	—	0.62	0.69	0.43	0.38
μROE (%)	6.65	4.02	15.81	28.67	38.64
CAR (%)	14.92	14.41	13.74	14.81	15.95
E/A (yr-end, %)	11.50	12.39	9.35	10.53	15.46
CIR (%)	57.61	49.43	38.87	34.20	35.45
Z-Score	—	20.93	16.72	32.63	53.36



Table 2 summarizes the complete financial profile of Asia Alliance Bank. The most striking feature is the simultaneous improvement across all dimensions: ROA rising fivefold, ROE approaching 39%, CAR remaining above the regulatory floor of 13% throughout, and CIR declining by more than 22 percentage points from 2020 to 2024. The declining σ ROA (from 0.62% in 2021 to 0.38% in 2024) indicates not only higher but also more stable earnings - both components of the Z-Score numerator and denominator moving in the favorable direction, which accounts for the near-trebling of the Z-Score between 2021 and 2024 (Table 3).

Table 3. Key Financial Ratios - Aloqabank (2020–2024)

Indicator	2020	2021	2022	2023	2024
μ ROA (%)	1.06	0.52	0.81	1.67	0.46
σ ROA (%)	—	0.40	0.46	1.22	0.62
μ ROE (%)	7.66	4.02	6.33	12.65	3.10
CAR (%)	19.39	15.79	12.93	12.36	14.15
E/A (yr-end, %)	19.35	13.35	11.16	16.47	13.26
CIR (%)	53.87	50.29	43.49	44.26	62.27
Z-Score	-	34.42	25.79	14.82	22.19

Table 3 reveals Aloqabank's more constrained performance profile. The CAR deteriorated to 12.93% in 2022 and 12.36% in 2023 - both below the 13% regulatory minimum - indicating a period of capital stress that necessitated supervisory engagement and subsequent equity strengthening. The CIR surpassed the 60% efficiency benchmark in 2024 (62.27%), reflecting elevated operating costs not offset by commensurate income growth. The interaction between high earnings volatility (σ ROA = 1.22%) and only moderate mean ROA in 2023 produced the lowest Z-Score of the bank's study-period record, at 14.82. The year-end E/A ratio fluctuated considerably (11.16%–19.35%), reflecting the interplay of asset growth cycles and episodic equity injections (Table 4).

Table 4. Key Financial Ratios - Mikrokreditbank (2020–2024)

Indicator	2020	2021	2022	2023	2024
μ ROA (%)	0.56	0.13	0.28	0.13	-0.57
σ ROA (%)	—	0.17	0.16	0.06	1.85
μ ROE (%)	2.64	0.73	1.60	0.67	-3.36
CAR (%)	14.58	15.45	19.58	18.78	17.84
E/A (yr-end, %)	16.90	17.28	21.71	20.64	15.08
CIR (%)	54.13	34.61	41.83	48.99	62.26
Z-Score	—	100.85	133.83	351.63	7.86

Table 4 highlights the distinctive and analytically complex characteristics of Mikrokreditbank. The institution maintained comparatively high capital buffers (CAR averaging 17.9% over 2021–2024) and a strong equity-to-assets position, consistent with its government-owned mandate and periodic state recapitalization. However, profitability metrics are structurally low throughout: mean ROA remained at or below 0.28% in all profitable years, reflecting concessional lending to micro-enterprises at below-market rates. The defining feature of the Z-Score computation for this institution is the extraordinarily low σ ROA in 2021–2023 (0.17%, 0.16%, and 0.06% respectively) a consequence of the bank's homogeneous, policy-directed portfolio generating highly predictable monthly returns. In 2024, the σ ROA surged to 1.85% as losses materialized, simultaneously reversing the sign of the numerator and producing the dramatic Z-Score collapse to 7.86. The CIR deteriorated markedly from 34.61% in 2021 to 62.26% in 2024, indicating rapid expense growth unmatched by income (Figure 3).

Figure 3. Return on Equity (ROE) Comparison, 2021–2024

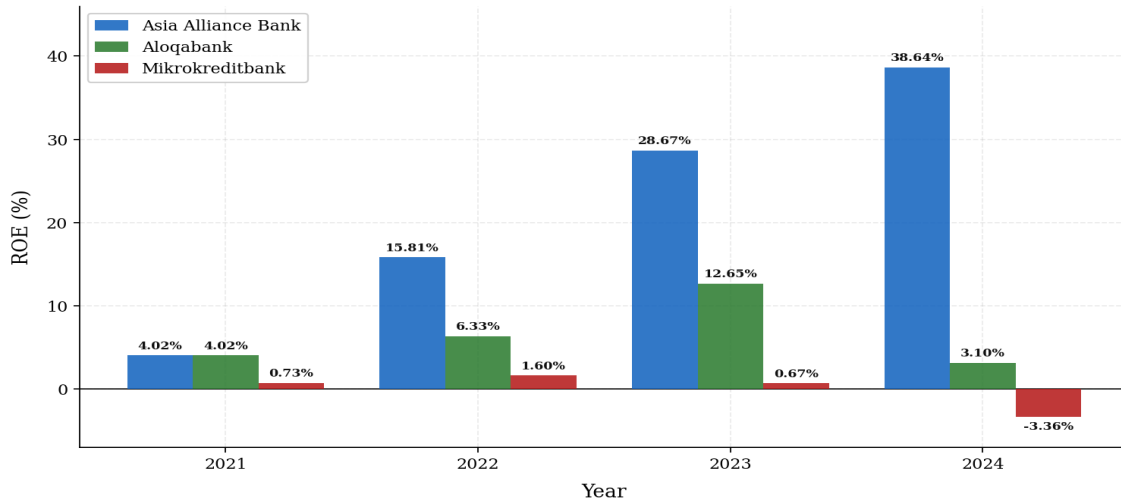


Figure 3. Return on Equity (ROE) Comparison, 2021–2024 (%)

Figure 3 presents mean annual ROE dynamics. Asia Alliance Bank’s ROE increased from 4.02% in 2021 to 38.64% in 2024, positioning the bank among the most profitable commercial institutions in the Uzbek banking system by the close of the study period. This strong return on equity reflects both high net earnings and efficient capital deployment relative to the equity base. Aloqabank’s ROE peaked at 12.65% in 2023, when absolute net profits were highest, before contracting sharply to 3.10% in 2024 as earnings compressed. Mikrokreditbank’s ROE remained structurally low - below 2% in all profitable years - and fell to –3.36% in 2024, reflecting the significant profitability gap between its policy-driven mandate and commercially oriented peers (Figure 4).

Figure 4. Capital Adequacy Ratio (CAR) Dynamics, 2021–2024

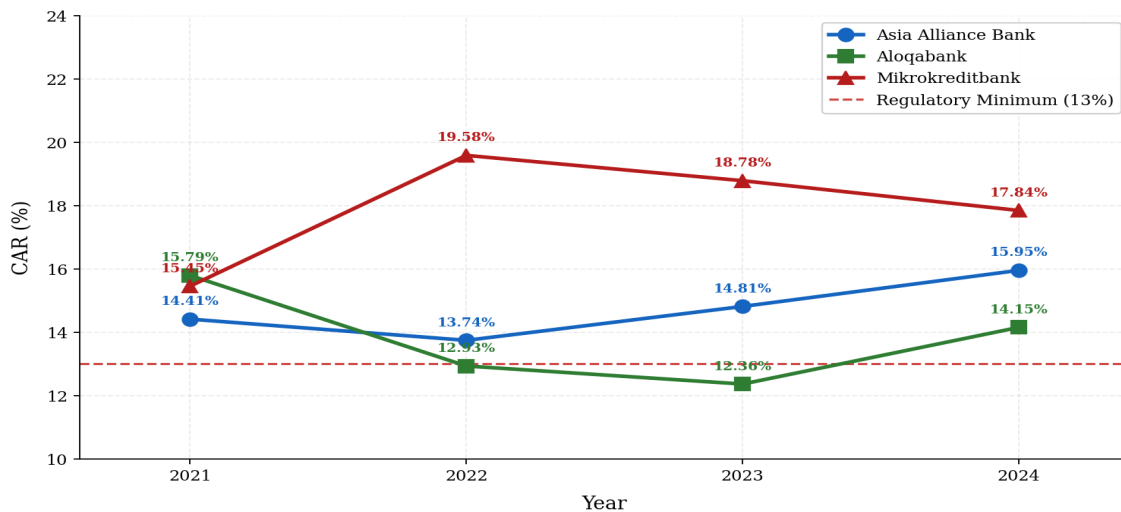


Figure 4. Capital Adequacy Ratio (CAR) Dynamics, 2021–2024 (%)

Figure 4 depicts CAR dynamics relative to the 13% regulatory minimum prescribed by the Central Bank of Uzbekistan. Asia Alliance Bank maintained its CAR within the 13.74%–15.95% range, remaining consistently above the regulatory floor and trending upward in 2023–2024 as retained earnings strengthened the capital base. Aloqabank experienced a notable capital deterioration in 2022–2023, with CAR falling to 12.93% and 12.36% respectively - breaching the regulatory minimum on both occasions - before recovering to 14.15% in 2024 through capital-strengthening measures. Mikrokreditbank maintained the highest average CAR (approximately 17.9% over the study period), reflecting a combination of low risk-weighted assets from its government-guaranteed lending portfolio and periodic injections of state capital. The decline from 19.58% in 2022 to 17.84% in 2024 corresponds to the bank’s asset expansion phase and the emergence of losses in the final year (Figure 5).



Figure 5. Cost-to-Income Ratio (CIR) Comparison, 2021-2024

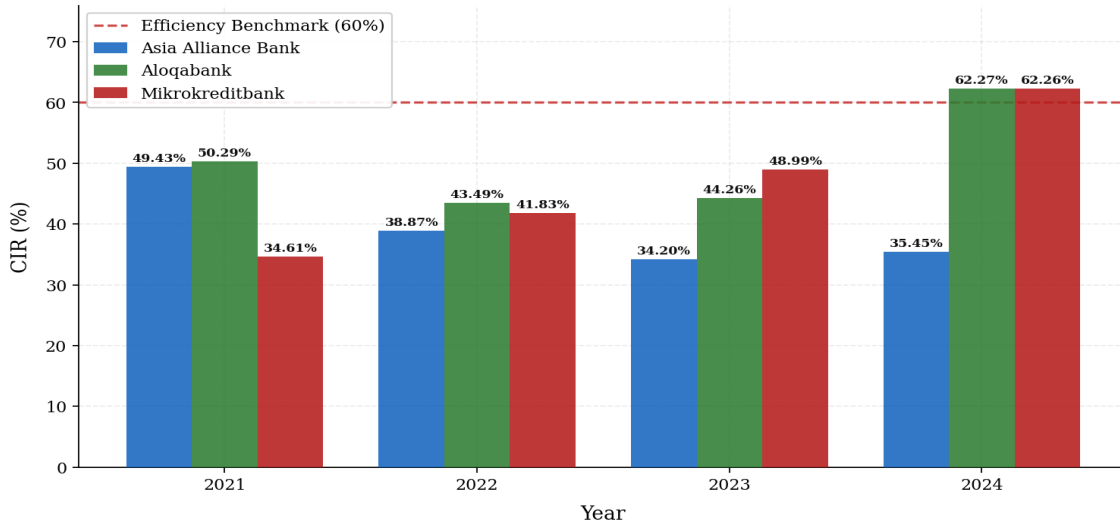


Figure 5. Cost-to-Income Ratio (CIR) Comparison, 2021-2024 (%)

Figure 5 illustrates the cost efficiency dynamics of the three institutions. Asia Alliance Bank achieved the most substantial efficiency improvement over the study period, with CIR declining from 49.43% in 2021 to 35.45% in 2024 - remaining well below the internationally recognized 60% efficiency threshold throughout. This improvement reflects a combination of strong income growth and disciplined expense management, consistent with the bank's profitability trajectory. Both Aloqabank and Mikrokreditbank breached the 60% benchmark in 2024 (62.27% and 62.26% respectively), signaling structural cost efficiency challenges. For Mikrokreditbank in particular, the sustained deterioration from 34.61% in 2021 to 62.26% in 2024 - an increase of nearly 28 percentage points over three years - represents a critical structural concern: rapidly rising personnel costs and branch network expansion were not matched by income growth, depressing earnings and contributing directly to the 2024 profitability deterioration (Figure 6).

Figure 6. Equity-to-Assets (E/A) Ratio Dynamics, 2021-2024

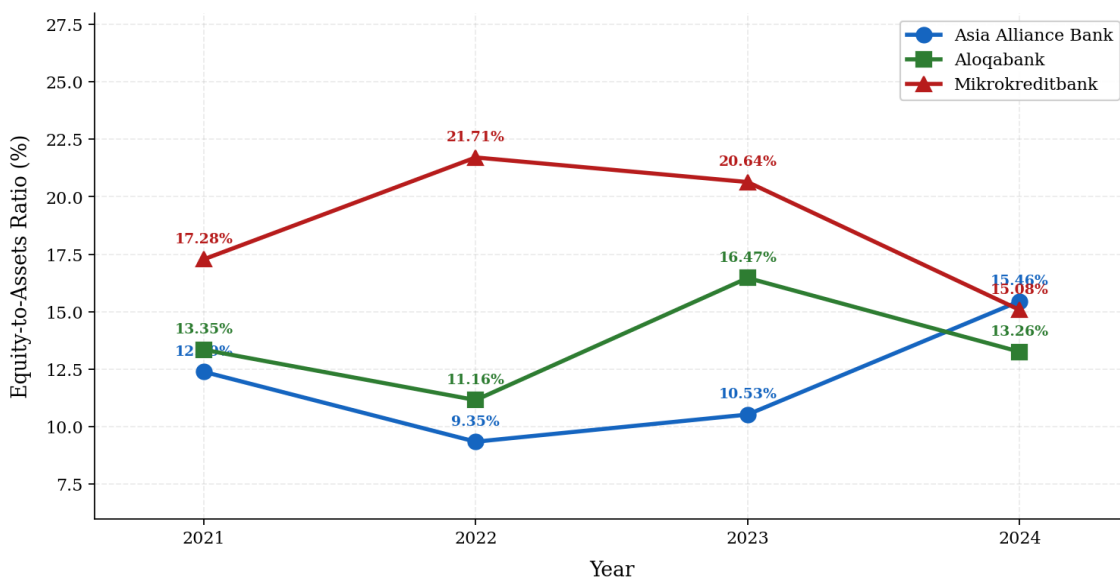


Figure 6. Equity-to-Assets (E/A) Ratio Dynamics, 2021-2024 (%)

Figure 6 presents the year-end equity-to-assets ratio, which constitutes the primary capitalization component of the Z-Score numerator. Mikrokreditbank maintained the highest E/A values in 2021-2023 (17.28%, 21.71%, and 20.64%), reflecting conservative leverage underpinned by state capital support, before declining to 15.08% in 2024. Aloqabank's E/A fluctuated substantially - from a high of 19.35% in 2020 to a low of 11.16% in 2022 - as rapid asset growth in certain periods outpaced equity accumulation. Asia Alliance

Bank's E/A declined from 12.39% in 2021 to 9.35% in 2022 as assets expanded rapidly, before recovering to 15.46% in 2024 as accumulated retained earnings strengthened the capital position. These capital buffer dynamics are central to understanding cross-institutional Z-Score differentials: all else equal, a higher E/A ratio directly increases the Z-Score by raising the numerator, reflecting the institution's greater capacity to absorb losses before insolvency.

CONCLUSIONS AND SUGGESTIONS

The empirical findings of this study yield several important insights into the financial stability dynamics of Uzbekistan's banking sector. First, the results confirm that the Z-Score model effectively differentiates between banks with structurally distinct business models, ownership structures, and risk appetites. The three institutions analyzed - a dynamically expanding private bank (Asia Alliance Bank), a state-affiliated commercial bank serving socially mandated credit segments (Aloqabank), and a government-owned microfinance institution (Mikrokreditbank) - display markedly different Z-Score profiles, underscoring the model's discriminatory power in a transition economy setting.

Asia Alliance Bank's consistently rising Z-Score (20.93 → 53.36 over 2021–2024) reflects the successful execution of a commercial transformation strategy. The bank's rapid loan portfolio expansion, deliberate diversification into fee-based income streams, and rigorous cost management (CIR declining from 49.43% to 35.45%) produced a compounding improvement in both profitability and earnings stability. Notably, σ ROA declined from 0.62% in 2021 to 0.38% in 2024 - indicating not only higher but also more predictable earnings - which further amplified the Z-Score improvement. These findings align with theoretical predictions that well-governed private banks operating in liberalizing environments can rapidly close performance gaps relative to state-owned incumbents (Berger et al., 2005). The CAR remained above 13% throughout, and the year-end E/A ratio improved to 15.46% by 2024, reflecting healthy equity accumulation.

Aloqabank's more volatile Z-Score path (34.42 → 14.82 → 22.19) warrants careful supervisory attention. The sharp deterioration in 2023 was driven by the convergence of elevated earnings volatility (σ ROA = 1.22%) and only moderate mean profitability (μ ROA = 1.67%), resulting from compressed net interest margins on concessional lending and increased provisioning requirements. The simultaneous breach of the 13% CAR minimum in 2022–2023 represents a material prudential signal that was addressed through subsequent capital-strengthening measures. The partial recovery to 22.19 in 2024, while encouraging, was undermined by a CIR surge to 62.27%, indicating that operating cost control remains a critical unresolved challenge. Aloqabank's experience exemplifies the tensions inherent in state-directed commercial banking: balancing developmental objectives against financial sustainability demands ongoing governance attention and a clear strategic framework.

Mikrokreditbank's Z-Score profile requires careful contextual interpretation. The extraordinarily high values in 2021–2023 (100.85, 133.83, and 351.63) are primarily a mechanical artefact of the model's structure: when σ ROA is extremely small - as observed at 0.17%, 0.16%, and 0.06% - the denominator of the Z-Score formula approaches zero, mechanically inflating the ratio irrespective of the institution's intrinsic resilience. This phenomenon, described in the banking stability literature as the low-sigma effect (Lepetit and Strobel, 2013), implies that Z-Score values for narrowly mandated policy banks must be interpreted with considerable caution and cannot be taken at face value as evidence of superior financial strength. The 2024 collapse to 7.86 - driven by a simultaneous sign reversal in μ ROA (to -0.57%) and a 31-fold increase in σ ROA (to 1.85%) - starkly illustrates the flip side of this dynamic. The institution's structurally low profitability (ROA below 0.30% in all profitable years), rapidly deteriorating cost efficiency (CIR: 34.61% → 62.26%), and dependence on state capital for capitalization adequacy constitute the primary risk vectors requiring substantive policy intervention.

Viewed comparatively, Asia Alliance Bank emerges as the most financially resilient institution over the study period, combining high and improving profitability, adequate capitalization, and superior cost efficiency. Aloqabank represents a moderate-stability profile with identifiable vulnerabilities in capital adequacy and operational efficiency that require sustained monitoring. Mikrokreditbank's apparent stability in 2021–2023 is an artefact of low earnings volatility rather than intrinsic financial strength; the institution's 2024 deterioration serves as a compelling case study of how rapidly Z-Score-based stability assessments can reverse when the structural conditions underpinning them change.

These findings carry practical implications for the ongoing reform of Uzbekistan's banking sector. Regulatory authorities should consider adopting institution-type-specific stability benchmarks rather than uniform Z-Score thresholds applied indiscriminately across banks with fundamentally different mandates and risk profiles. Management teams at Aloqabank and Mikrokreditbank should prioritize revenue diversification, disciplined cost reduction, and sustained loan portfolio quality improvement as the primary levers for durable stability enhancement. Asia Alliance Bank's demonstrated transformation trajectory - from a modest Z-Score of



20.93 in 2021 to 53.36 in 2024 - provides an evidence-based reference point for commercially driven banking sector development in Uzbekistan.

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