

MULTI-OBJECTIVE OPTIMISATION OF BANK SECURITIES PORTFOLIOS

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Abstract: The article substantiates the need to diversify the securities portfolios of commercial banks in Uzbekistan between government and highly reliable corporate securities using a multi-objective portfolio optimisation model (MOPO: risk – return – liquidity – correlation). More than 96% of banks' portfolios are concentrated in government and central bank instruments, and the portfolio yield (9.0%) is well below the overall return on assets (15.1%). Using illustrative data, the study shows that with a correlation of 0.3, shifting about one third of the portfolio into investment-grade corporate bonds lowers portfolio risk by 9.3% while raising its return by 1.5 percentage points.

Keywords: commercial bank, securities portfolio, diversification, multi-objective optimisation, risk, liquidity, correlation.

1. Introduction

A securities portfolio serves two purposes for a bank: it generates income and it acts as a liquidity buffer that can be turned into cash quickly when needed. To serve both purposes well, the portfolio should be spread across different assets rather than concentrated in one type, that is, it should be diversified*.

In Uzbekistan, banks' securities portfolios have grown rapidly in recent years: between 2020 and 2025 their share in total assets rose from 2.58% to 11.14%. Yet the composition of the portfolio has hardly changed. According to the author's calculations, more than 96% of the portfolio is held in national-currency government and central bank instruments. The interest yield of the portfolio is only 9.0%, well below the overall return on bank assets (15.1%). In other words, the portfolio depends too heavily on a single type of asset and its potential is not fully used.

The aim of this study is to substantiate a model for allocating commercial banks' portfolios between government and highly reliable corporate securities that takes risk, return, liquidity and correlation into account at the same time, and to assess its effect on portfolio risk.

* Diversification means spreading funds across different types of assets rather than holding one type, so that a fall in the value of one asset does not strongly affect the whole portfolio.

2. Literature Review

Modern portfolio theory was founded by H. Markowitz, who showed that portfolio risk depends not only on the risk of individual assets but also on how they move together (their correlation). Combining assets that are weakly related can therefore reduce overall risk without lowering return [1]. Later, $\text{VaR}^\dagger$ became a standard measure of portfolio risk [4], and E. Altman's Z-score[‡] became one of the main tools for assessing the credit risk of issuers [2].

In practice, investors care about more than risk and return. M. Ehrgott and co-authors and R. Steuer and co-authors showed that optimising a portfolio against several objectives at once (return, risk, liquidity and others) meets investors' needs better than the traditional two-criteria approach [5; 6]. Such models for banks have been developed by V. Tovkach [9], R. Chaudhury and S. Islam [10] and R. Yang and co-authors [11], who combine risk, return and liquidity criteria.

Heavy concentration of banks in government securities is itself a source of risk. V. Acharya and S. Steffen showed that banks with large holdings of sovereign bonds suffered heavy losses in the European debt crisis [7], while E. Farhi and J. Tirole showed that the financial positions of governments and banks can form a self-reinforcing «doom loop» [8]. The Basel Committee also requires the stock of high-quality liquid assets (HQLA[§]) to be diversified across issuers [3]. However, no model combining all four criteria (risk, return, liquidity and correlation) has yet been proposed for Uzbek banking practice.

3. Methodology

The study uses data on the composition and yield of Uzbek commercial banks' securities portfolios in 2020–2025 (author's calculations), data from the Central Bank and the Tashkent Stock Exchange [12–15] and international regulatory documents [3]. Structural and comparative analysis, Markowitz portfolio theory and multi-objective optimisation methods are applied.

In the proposed MOPO model, minimising portfolio risk is the main objective, while the other criteria enter as constraints:

$$\min \sigma_p^2 = w^T \Sigma w \quad (1)$$

[†] VaR (Value at Risk) is the largest loss a portfolio may suffer over a given period with a given probability (for example, 99 per cent).

[‡] The Altman Z-score estimates a company's probability of bankruptcy from its financial statements. $Z < 1.81$ indicates the distress zone, $1.81\text{--}2.99$ the grey zone and $Z > 2.99$ the safe zone.

[§] HQLA (High-Quality Liquid Assets) are assets that can be sold quickly with little or no loss of value even in a crisis: cash, central bank reserves, government securities and similar instruments.

subject to: $E(R_p) = w^T \mu \geq R_{min}$ – the return constraint; $\sum w_i \cdot L_i \geq L_{min}$ – the liquidity constraint; $w_i = 0$ if the issuer's Altman score is $Z_i < 1.81$ – the credit quality constraint; $\sum w_i = 1$, $w_i \geq 0$ – the budget and no-short-selling constraint. Here w is the vector of asset weights; μ is the vector of expected returns; Σ is the covariance matrix, which contains asset risks and the correlations** between them; L_i is the liquidity coefficient of an asset (from 0 to 1). The model thus accounts for all four criteria at once.

To show the practical effect of the model, a simplified two-asset case is considered: government and central bank securities (G) and investment-grade corporate bonds (C). The risk of such a portfolio is:

$$\sigma_p = \sqrt{(w_G^2 \sigma_G^2 + w_C^2 \sigma_C^2 + 2w_G w_C \rho \sigma_G \sigma_C)} \quad (2)$$

4. Results

The main indicators of commercial banks' securities portfolios are given in Table 1.

Table 1. Structural and quality indicators of Uzbek commercial banks' securities portfolios

Indicator	2020	2025	Conclusion
Investments and securities / total assets, %	2.58	11.14	Portfolio grew fast, but its structure was not diversified
Share of national-currency government and CB instruments, %	> 90	> 96	High concentration in one type of asset
Interest income on securities / total interest income, %	2.0	5.7	Share is rising, but small compared with loans
Portfolio yield / overall return on assets, %	–	9.0 / 15.1	Portfolio lowers the average return on assets
Share of foreign-currency securities, %	2.7	3.7	Low diversification by currency as well

Source: Author's calculations.

** The correlation coefficient (ρ) shows how closely the returns of two assets move together: $\rho = 1$ means they always move together, $\rho = 0$ means they are unrelated. The lower the correlation, the more diversification reduces risk.

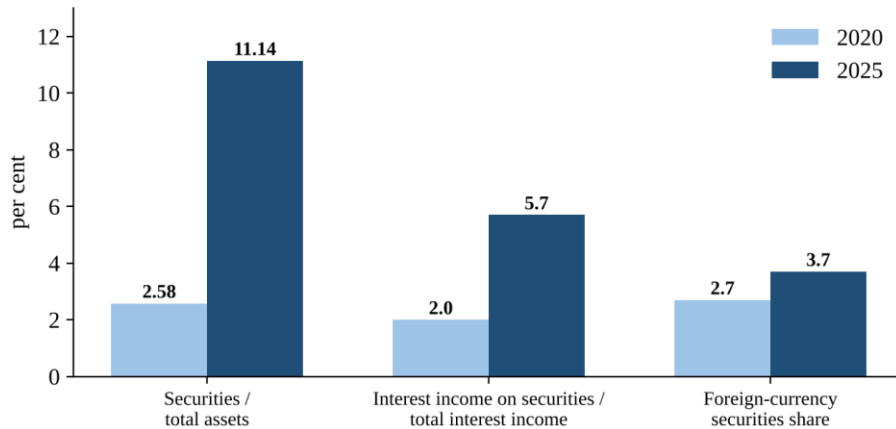


Figure 1. Indicators of commercial banks' securities portfolios, %

Source: Author's calculations.

The table and Figure 1 show that the portfolio grew almost fourfold in five years while its composition barely changed. With total banking assets of about UZS 877 trillion [15], the portfolio amounts to roughly UZS 98 trillion. Concentrating such a large amount almost entirely in one type of asset makes the banking system highly dependent on government debt and on changes in interest rates.

At the same time, opportunities for diversification are emerging in the domestic market. In 2025 the number of bond trades on the Tashkent Stock Exchange rose by 347% and turnover reached UZS 1.7 trillion, with 26 bond issues listed [14]. The average yield on corporate bonds in 2025 was about 25% [13], compared with about 15% on central bank bonds [12]. Reliable corporate bonds can therefore raise portfolio returns.

The four criteria of the proposed model rest on international regulatory and academic foundations (Table 2).

Table 2. Regulatory and academic foundations of the four MOPO criteria

Criterion	Foundation	Source
Risk	Requirement to diversify the HQLA stock by issuer and counterparty (Basel III)	BCBS, 2013 [3]
Return	Multi-criteria models optimising a bank's securities portfolio by expected return, risk and liquidity	Tovkach, 2012 [9]
Liquidity	Multi-objective model reducing liquidity and interest rate risk at the same time in bank asset-liability management	Chaudhury and Islam, 2021 [10]
Correlation	Multistage stochastic model accounting for links between risk factors; Markowitz portfolio theory	Yang et al., 2022 [11]; Markowitz, 1952 [1]

Source: Compiled by the author from the cited sources.

The risk, return and liquidity criteria have each been tested separately in the literature, while adding correlation is a natural extension of Markowitz theory. Returns on government and corporate bonds depend on different factors: the former mainly on fiscal and monetary policy, the latter on the credit quality of companies. Their co-movement is therefore incomplete, which makes it possible to reduce overall risk further.

An illustrative calculation was carried out to show the effect of the model (Table 3, Figure 2). The yield on government securities was set at the level of central bank bonds (15%). For investment-grade corporate bonds a conservative 20% was used, below the market average of 25%, because the model selects only highly reliable issuers ($Z > 2.99$).

Table 3. Comparison of the current portfolio and portfolios formed with MOPO ($\rho = 0.3$)^{††}

Indicator	Current portfolio	A: minimum risk	B: same risk as current
Government / corporate securities, %	96 / 4	65.5 / 34.5	35.1 / 64.9
Expected return, %	15.2	16.7	18.2
Portfolio risk (standard deviation), %	3.91	3.54	3.90
Change in risk, %	—	−9.3	0
Liquidity coefficient ($\Sigma w \cdot L$)	0.98	0.86	0.74
Concentration (HHI)	0.92	0.55	0.54

Source: Author's calculations. Illustrative parameters: return $G = 15\%$, $C = 20\%$; standard deviation $G = 4\%$, $C = 5\%$; liquidity $G = 1.0$, $C = 0.6$.

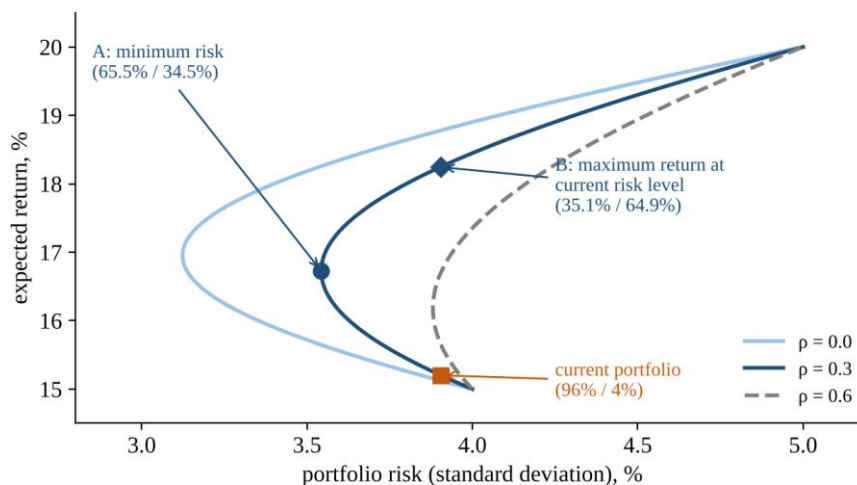


Figure 2. Portfolio risk and return depending on the shares of government and corporate securities

Source: Author's calculations based on equation (2).

^{††} Standard deviations and the correlation coefficient are illustrative values chosen by the author. In practice they should be estimated from each bank's own portfolio and historical market prices.

Figure 2 shows that the current portfolio lies below the efficient frontier. If 34.5% of the portfolio is moved into corporate bonds (point A), risk falls from 3.91% to 3.54%, that is by 9.3%, while return rises from 15.2% to 16.7%. This is the core effect of diversification: although corporate bonds are riskier on their own than government securities, adding them to the portfolio lowers overall risk. If the bank keeps its current level of risk (point B), it can raise the return to 18.2%. In both cases the liquidity coefficient stays at an adequate level and portfolio concentration (HHI^{**}) falls from 0.92 to 0.55.

5. Discussion

The results are consistent with Markowitz theory [1] and with multi-objective portfolio models [5; 6]: when assets are not perfectly correlated, diversification reduces risk. At the same time, the size of the effect depends directly on correlation. With a correlation of 0, risk falls by 18.8%, while with 0.6 it falls by only 2.1%. If correlation exceeds 0.8, adding corporate securities no longer reduces risk. This is why the model treats correlation as a separate criterion that each bank should estimate regularly from its own data. If the 1.5 percentage-point gain in return were applied to the whole banking system's portfolio (about UZS 98 trillion), additional income could reach roughly UZS 1.5 trillion per year.

The liquidity coefficient chosen for corporate bonds ($L = 0.6$) is also in line with Basel III. In the LCR, highly rated corporate bonds count as Level 2A assets with a 15% haircut, and lower investment-grade bonds as Level 2B assets with a 50% haircut, while Level 2 assets may not exceed 40% of total HQLA [3]. Corporate securities are thus recognised as liquid assets, but valued below government securities. For this reason the model does not raise the corporate share without limit: the liquidity constraint ($\sum w_i \cdot L_i \geq L_{\min}$) keeps a sufficient part of the portfolio in government securities.

In practice the model is applied through a three-tier portfolio structure (Figure 3). Tier 1, the liquidity core (30–40%), consists of government securities and highly rated Eurobonds that secure compliance with the LCR and NSFR. Tier 2, the stable income core (35–45%), consists of investment-grade corporate bonds, green bonds and sukuk. Tier 3, the growth core (15–25%), consists of liquid listed equities spread across at least 10–15 issuers from different sectors.

^{**} The Herfindahl–Hirschman Index (HHI) is the sum of the squared shares of assets in a portfolio. The closer it is to 1, the more the portfolio is concentrated in a single asset.

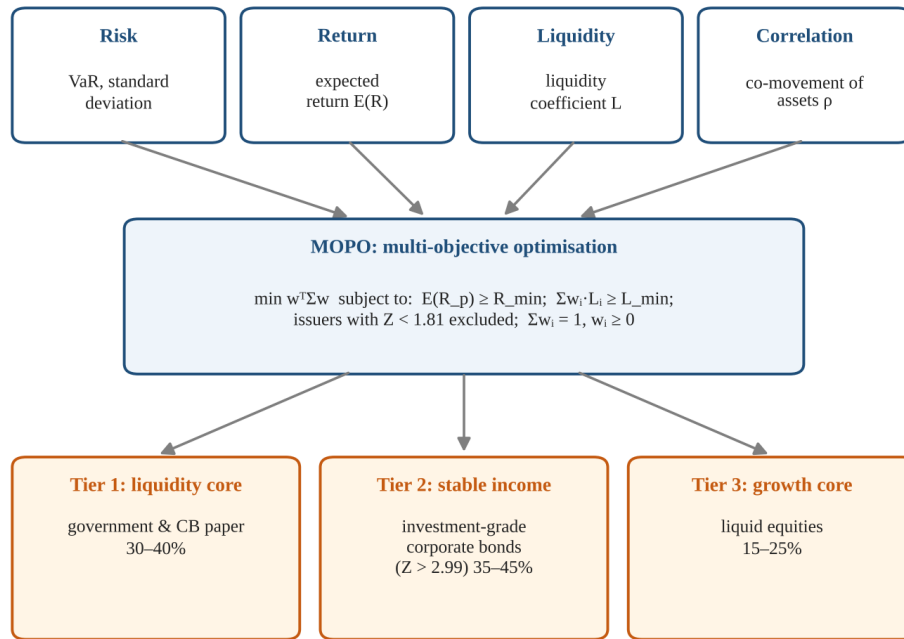


Figure 3. Structure of a bank portfolio built on the MOPO model

Source: Developed by the author.

Limitations of the domestic market should also be kept in mind: the number of reliable corporate issuers is still small, some bonds are illiquid and short selling is not practised. The corporate share should therefore be raised gradually, in step with market development.

6. Conclusion and Recommendations

The results show that more than 96% of Uzbek commercial banks' securities portfolios are concentrated in government and central bank instruments, and that the portfolio yield (9.0%) is well below the overall return on assets (15.1%). This points to excessive dependence on one type of asset and a lack of diversification.

Basel III requirements and international research on multi-objective portfolio optimisation confirm the need to consider risk, return, liquidity and correlation together. According to illustrative calculations, moving about one third of the portfolio into investment-grade corporate bonds reduces risk by 9.3%, raises return by 1.5 percentage points and almost halves portfolio concentration. As a result of the study, the following scientific proposal has been developed:

A proposal to minimise the overall level of risk by diversifying commercial banks' assets between government and highly reliable corporate securities on the basis of a multi-objective portfolio optimisation model (MOPO – multi-objective risk-return-liquidity-correlation).

To implement the proposal, the following steps are recommended: first, to build banks' investment portfolios on three tiers (liquidity core, stable income core and growth core); second, to screen corporate issuers with the Altman Z-score and include only investment-grade issuers; third, to re-estimate correlations between assets every quarter on the bank's own data and adjust the portfolio accordingly; fourth, to raise the share of corporate securities gradually, in line with the growth of domestic market liquidity.

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