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QUANTITATIVE ASSESSMENT OF FINANCIAL RISKS IN INVESTMENT DECISION-MAKING AND IMPROVEMENT OF RISK MANAGEMENT MECHANISMS

Rafiyeva Zarina Xusanovna
Senior Lecturer, Department of 'Investment and Innovation',
Samarkand Institute of Economics and Service
Kadirova Nigora Nurmamatovna
Student of Samarkand institute of economics and service
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Abstract: This article examines quantitative methods for assessing financial risks in investment decision-making and improving risk management mechanisms. It explores the application of NPV, VaR, sensitivity analysis, scenario analysis, and Monte Carlo simulation. Recommendations are developed to mitigate financial risks and enhance investment decision-making in Uzbekistan's economic environment.
Keywords: investment decision-making, financial risk, quantitative assessment, risk management, investment project, NPV, VaR, Monte Carlo simulation.

Annotatsiya: Maqolada investitsion qarorlarni qabul qilishda moliyaviy risklarni miqdoriy baholash usullari va ularni boshqarish mexanizmlarini takomillashtirish masalalari tahlil qilingan. Investitsion loyihalar samaradorligini baholashda NPV, VaR, sezgirlik tahlili, ssenariyli tahlil va Monte-Karlo simulyatsiyasidan foydalanish imkoniyatlari yoritilgan. O'zbekiston iqtisodiyoti sharoitida risklarni kamaytirish va investitsion qarorlar samaradorligini oshirish bo'yicha takliflar ishlab chiqilgan.
Kalit so'zlar: investitsion qarorlar, moliyaviy risk, miqdoriy baholash, risklarni boshqarish, investitsion loyiha, NPV, VaR, Monte-Karlo simulyatsiyasi.

Аннотация: В статье анализируются методы количественной оценки финансовых рисков при принятии инвестиционных решений и направления совершенствования механизмов управления ими. Рассматриваются возможности применения NPV, VaR, анализа чувствительности, сценарного анализа и моделирования Монте-Карло. Разработаны рекомендации по снижению финансовых рисков и повышению эффективности инвестиционных решений в условиях экономики Узбекистана.
Ключевые слова: инвестиционные решения, финансовый риск, количественная оценка, управление рисками, инвестиционный проект, NPV, VaR, моделирование Монте-Карло.

INTRODUCTION

Investment is a fundamental mechanism through which financial resources are transformed into productive assets, technological capabilities, infrastructure, and long-term economic growth. However, the expected return on an investment is rarely certain. Future cash flows depend on a combination of macroeconomic conditions, market demand, financing costs, exchange rates, regulatory developments, and the managerial capacity of the investing organisation. Consequently, investment decisions based

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exclusively on expected profitability may produce misleading results if the probability and potential magnitude of financial losses are not assessed systematically.

The central problem of investment risk management is therefore not the complete elimination of uncertainty, which is generally impossible, but the identification of risks that may materially affect investment value and the design of mechanisms that keep potential losses within acceptable limits. Quantitative risk assessment provides a methodological basis for this process by translating uncertainty into measurable indicators, probability distributions, stress scenarios, and decision thresholds.

In Uzbekistan, the relevance of this issue is reinforced by the expansion of investment activity. According to the National Statistics Committee's statistical database, investment in fixed assets amounted to UZS 356,071.4 billion in 2023 and UZS 507,490.2 billion in 2024. These figures demonstrate a substantial increase in the volume of resources allocated to fixed assets. The expansion creates opportunities for economic development while increasing the importance of evaluating project feasibility, financing structures, foreign-exchange exposure, and the capacity of future cash flows to service debt.

The theoretical foundations of this research draw on the relationship between risk and return, the time value of money, portfolio diversification, and corporate financial management. Traditional investment appraisal evaluates a project using indicators such as net present value, internal rate of return, and payback period. Although these indicators remain essential, they do not independently explain how uncertain cash flows may alter the probability of project failure. For example, two projects may have identical expected NPVs but substantially different downside exposure because one relies on stable domestic demand while the other depends on imported equipment, foreign-currency borrowing, and volatile export prices.

Uzbekistan-based research contributes to this discussion. Abdullayeva's study of international standards for financial risk assessment highlights the importance of structured risk identification and management in financial decision-making. Sattarov examines modern investment risk management mechanisms, including risk matrices, VaR, Monte Carlo simulation, and continuous monitoring. Ismailova's research addresses investment activity and investment security in Uzbekistan, emphasising the relationship between investment conditions and macroeconomic stability.

Despite these contributions, an important practical challenge remains: quantitative methods are not always integrated into a single decision-making process that links project cash flows, probabilities of adverse outcomes, financing risks, management responsibilities, and post-investment monitoring. The purpose of this study is to develop an integrated framework for quantitatively assessing financial risks in investment decision-making and improving the mechanisms used to manage those risks in the economic conditions of Uzbekistan. The study addresses three interconnected research questions. How can quantitative risk indicators complement conventional investment appraisal? How can stress testing and probability-based models improve the identification of financially vulnerable projects? Which organisational and financial mechanisms can strengthen the practical application of risk assessment in Uzbekistan?

The study's contribution lies in connecting investment appraisal with a structured risk governance mechanism. Rather than treating risk measurement as a separate analytical exercise, the proposed approach incorporates quantitative results into financing decisions, investment approval thresholds, mitigation measures, and continuous monitoring.

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METHODOLOGY

The research applies a quantitative and analytical design combining official investment statistics, comparative analysis of risk assessment techniques, financial modelling, and scenario-based evaluation. The empirical context is Uzbekistan, while the methodological framework draws on established principles of corporate finance and risk management. Official investment data are obtained from the National Statistics Committee's SIAT statistical database. Local academic publications on financial risk assessment, investment security, and investment risk management are used to contextualise the research within Uzbekistan's scholarly environment. The quantitative project example is illustrative and is not presented as an observed company-level dataset.

The distinction between observed statistics and simulated project results is essential. National investment figures describe reported economic activity, whereas the numerical project model demonstrates how quantitative risk techniques can be applied. No company-specific loss probabilities or historical project failure rates are inferred from national investment growth.

The annual growth rate of investment in fixed assets is calculated as:

$$g_t = \frac{I_t - I_{t-1}}{I_{t-1}} \times 100\% \quad (1)$$

where I_t represents investment in fixed assets during the current year and I_{t-1} represents investment during the preceding year. This indicator provides contextual information about the expansion of investment activity. However, investment growth is not interpreted as direct evidence of increasing or decreasing financial risk. Such a conclusion would require additional data on project performance, debt exposure, cash-flow volatility, defaults, and realised investment returns.

Net present value is calculated as:

$$NPV = -I_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} \quad (2)$$

where I_0 is the initial investment, CF_t is the net cash flow in period t, r is the discount rate, and n is the investment horizon. A positive NPV indicates that the projected cash flows exceed the initial investment after discounting at the selected rate. Nevertheless, a positive expected NPV does not guarantee a positive realised return. The discount rate must also be consistent with the cash-flow currency, inflation assumptions, financing structure, and risk characteristics of the project.

RESULTS AND DISCUSSION

The development of investment activity in Uzbekistan provides an important empirical context for examining financial risk management. The official statistical data presented in Table 1 show that investment in fixed assets increased substantially between 2020 and 2024.

Table 1

DYNAMICS OF INVESTMENT IN FIXED ASSETS IN UZBEKISTAN[1]

[1] Author's calculations based on the National Statistics Committee of Uzbekistan, SIAT database.

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T/r	Year	Investment volume, UZS billion	Annual growth, %
1	2020	210,195.10	—
2	2021	239,552.60	14
3	2022	266,240.00	11.1
4	2023	356,071.40	33.7
5	2024	507,490.20	42.5

The statistical evidence reveals that investment in fixed assets increased from UZS 210.20 trillion in 2020 to UZS 507.49 trillion in 2024. This represents an increase of approximately 141.4% over the four-year period. The annual growth rate accelerated considerably in 2023 and 2024, reaching approximately 33.7% and 42.5%, respectively.

These results indicate a rapidly expanding investment environment, but they do not establish whether individual projects are becoming more or less risky. A larger investment volume can coexist with sound project selection, excessive borrowing, weak cash-flow planning, or uneven risk distribution. The critical issue is whether investment appraisal and risk governance develop alongside the scale of capital allocation. The structure of investment financing also matters. The National Statistics Committee reported that during January–June 2024, enterprises' and organisations' own funds financed UZS 42 trillion, equivalent to 18.3% of total investment in fixed assets. Direct foreign investment accounted for UZS 66.8 trillion, or 29.1% of the total.

These figures illustrate why financial risk management must consider funding sources rather than evaluating projects solely by their projected returns. Foreign investment may introduce exchange-rate and cross-border contractual exposures, while debt-financed projects face repayment and interest-rate risks. Projects financed from internal funds may have lower direct debt-service obligations but can still create liquidity pressure and opportunity costs.

Table 2

QUANTITATIVE ASSESSMENT OF FINANCIAL RISKS IN INVESTMENT PROJECTS[2]

T/r	Risk category	Quantitative indicators	Potential financial effect	Management mechanism
1	Market risk	Volatility, beta, VaR	Decline in asset value or sales revenue	Diversification and exposure limits
2	Credit risk	Probability of default, loss given default, expected credit loss	Non-payment and financing losses	Credit analysis, collateral, covenants
3	Liquidity risk	Cash-flow gap, current ratio, liquidity buffer	Inability to meet short-term obligations	Cash reserves and maturity matching

[2] Author's synthesis based on financial risk assessment principles

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4	Interest-rate risk	Duration, interest coverage, rate sensitivity	Higher borrowing costs	Fixed-rate financing and repricing limits
5	Foreign-exchange risk	Net currency exposure, exchange-rate sensitivity	Increased import costs or foreign-currency debt burden	Currency matching and eligible hedging instruments
6	Inflation risk	Real cash-flow growth, inflation sensitivity	Reduction in purchasing power and project margin	Price adjustment mechanisms and real-term forecasts
7	Operational and implementation risk	Cost overrun, schedule variance	Delays, additional expenditure, reduced returns	Contingency reserves and milestone controls

The table demonstrates that a single universal risk indicator is insufficient. Market risk can be expressed through return volatility and VaR, whereas liquidity risk requires cash-flow forecasts, maturity analysis, and liquidity buffers. Credit risk depends on the likelihood of default and the amount that could be lost if default occurs. Combining these measures provides a more complete view of financial vulnerability.

This distinction is important for investment committees. A positive expected NPV indicates that the probability-weighted outcome is favourable under the model assumptions; it does not imply that the project is safe or that losses are unlikely. The appropriate decision depends on the investor's risk tolerance, available capital, liquidity position, and ability to withstand the adverse scenario. The standard deviation of the scenario-based NPV distribution is approximately UZS 25.77 billion. The coefficient of variation, calculated as the standard deviation divided by the expected NPV, is approximately 2.24. Although this coefficient illustrates the scale of dispersion relative to expected value, its interpretation is limited because the expected NPV is relatively small compared with the standard deviation.

The results support the use of scenario analysis alongside conventional investment appraisal. They also demonstrate why decision-makers should consider both the expected outcome and the magnitude of potential losses.

Sensitivity analysis identifies the variables that have the greatest effect on investment value. In practice, the variables most relevant to a project depend on its industry, financing structure, and operating model. For an industrial project in Uzbekistan that relies on imported machinery, foreign-currency debt, and domestic sales, exchange rates, interest rates, equipment costs, and demand may all materially affect the NPV.

The sensitivity results show that an investment project can remain profitable under individual adverse changes but become financially unattractive when several negative conditions occur simultaneously. In this example, the initial investment cost overrun has a greater effect on NPV than the isolated operating-cost increase. The combined adverse scenario turns the project's NPV negative. These values should not be interpreted as universal elasticities. They are model outputs that depend on

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the hypothetical project's cash flows, discount rate, cost structure, and forecast horizon. A real assessment requires the underlying financial model and verified input data.

Stress testing extends sensitivity analysis by considering severe but plausible conditions, including simultaneous exchange-rate depreciation, declining demand, higher refinancing costs, and delayed commissioning. It is particularly important when the variables are correlated. For example, currency depreciation may increase imported equipment costs while also increasing the domestic-currency value of foreign-currency debt. The management implication is that risk assessment should include both isolated shocks and combined scenarios. A project that survives a moderate movement in each individual variable may still be vulnerable to a simultaneous deterioration in several variables.

Value at Risk is useful when an investment portfolio or a project's financial exposure can be expressed through a suitable distribution of losses. For example, a one-month 95% VaR of UZS 5 billion would indicate that the model estimates a 5% probability of losses exceeding UZS 5 billion over that specified horizon, under the assumptions used. This interpretation requires three qualifications. First, the confidence level and time horizon must be explicitly stated. Second, the estimate depends on the quality and relevance of the underlying data. Third, VaR does not describe how severe losses may become once the threshold is exceeded. Expected shortfall addresses the third limitation by estimating the average loss in the tail of the loss distribution. For investment projects with concentrated exposures, heavy-tailed outcomes, or significant downside asymmetry, expected shortfall can provide additional information for capital allocation and risk limits.

Monte Carlo simulation is particularly useful when several uncertain inputs influence project cash flows. Rather than relying on a single estimate of sales, costs, and financing expenses, the model assigns plausible distributions to these variables and generates many possible combinations. For example, a manufacturing project may be affected by demand volatility, exchange-rate movements, energy costs, and construction delays. A simulation model can represent these factors jointly and calculate the resulting NPV for each simulated outcome.

The principal decision indicators include the expected NPV, the probability that NPV is negative, lower-percentile NPV, expected shortfall, and the sensitivity of results to different assumptions. If the estimated probability of a negative NPV exceeds the investment committee's approved tolerance, the project may require redesign, additional capital buffers, a different financing structure, or rejection. However, the credibility of simulation results depends on the assumptions. Treating correlated risks as independent can materially understate potential losses. Using arbitrary probability distributions without historical or technical justification may create an appearance of precision without corresponding reliability.

For projects with limited historical data, expert elicitation and engineering estimates can be used, but their assumptions should be documented, tested, and updated as new information becomes available. The model should also be recalibrated when the economic environment changes materially.

The first improvement is to introduce a standardised risk assessment requirement before major investment commitments are approved. Project documentation should include the baseline financial model, key assumptions, risk register, scenario results, financing plan, and contingency measures. This reduces the likelihood that investment decisions will depend excessively on optimistic forecasts.

The second improvement is to establish a clear relationship between risk exposure and financing structure. Projects that generate revenues in Uzbek soums but carry substantial foreign-currency liabilities may face a mismatch between operating cash flows and debt-service obligations. Where

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appropriate and economically justified, management can consider currency matching, fixed-rate financing, contractual price adjustments, or permitted hedging instruments. Such measures should be evaluated for their cost, availability, legal requirements, and residual risk.

The third improvement is to develop risk limits that are operational rather than merely descriptive. A risk register that lists possible problems but does not specify thresholds, responsible personnel, escalation procedures, and corrective actions has limited practical value. An effective system defines the conditions under which management must reassess, postpone, restructure, or discontinue a project.

The fourth improvement concerns liquidity management. Investment projects frequently require large initial outlays while generating cash flows only after commissioning. Consequently, a project may be profitable in present-value terms but unable to meet short-term obligations. Rolling cash-flow forecasts, debt-service coverage analysis, and contingency funding arrangements should therefore accompany NPV calculations.

CONCLUSION

The research demonstrates that quantitative financial risk assessment is an essential complement to conventional investment appraisal. Although NPV, internal rate of return, and payback period provide useful information about investment feasibility, they do not fully describe the uncertainty surrounding future cash flows or the severity of potential financial losses. Official statistics show that investment in fixed assets in Uzbekistan increased from UZS 356.07 trillion in 2023 to UZS 507.49 trillion in 2024, an annual increase of approximately 42.5%. This expansion reinforces the importance of sound investment selection and financial risk governance. However, aggregate investment growth alone cannot establish the risk level of individual projects.

The illustrative financial model demonstrates that a project may have a positive expected NPV while retaining a substantial probability of a negative outcome. This finding supports the combined use of probability-weighted cash flows, sensitivity analysis, scenario analysis, stress testing, and Monte Carlo simulation. VaR and expected shortfall can provide additional information about downside exposure when appropriate data and modelling assumptions are available. The proposed risk management framework integrates financial modelling with financing decisions, liquidity controls, exposure limits, independent review, and continuous monitoring. Its practical value lies in connecting the measurement of risk with specific management actions rather than treating risk analysis as a separate reporting exercise.

For Uzbekistan, the most important direction for further improvement is the systematic integration of quantitative risk indicators into the investment project lifecycle. This requires consistent financial data, transparent modelling assumptions, competent risk personnel, clear approval thresholds, and regular reassessment of forecasts. The adoption of these mechanisms can improve the quality of capital allocation and strengthen the resilience of investment projects under uncertain economic conditions. The study's main conclusion is that investment decisions should be evaluated not only by the amount of expected return but also by the probability, magnitude, and manageability of potential losses. A risk-adjusted decision-making framework can therefore provide a stronger analytical foundation for sustainable investment and long-term financial stability.

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