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IMPROVING THE METHODOLOGY FOR APPLYING MODERN FINANCIAL MODELS IN EVALUATING THE ECONOMIC EFFICIENCY OF INVESTMENT PROJECTS

Rafiyeva Zarina Xusanovna
Senior Lecturer, Department of 'Investment and Innovation',
Samarkand Institute of Economics and Service
Safarov Sardor Sattorovich
Student of Samarkand institute of economics and service
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Abstract. The article examines the improvement of the methodology for evaluating the economic efficiency of investment projects based on modern financial models. An approach is proposed that integrates discounted cash flows, the weighted average cost of capital, scenario analysis, Monte Carlo simulation, real options, and multi-criteria evaluation. The necessity of accounting for inflation, exchange rates, the cost of financing, and investment risks within the context of Uzbekistan's economy is substantiated.

Keywords: investment project, economic efficiency, net present value, internal rate of return, weighted average cost of capital, Monte Carlo simulation, real options, investment risk, Uzbekistan.

Аннотация. В статье рассматриваются вопросы совершенствования методологии оценки экономической эффективности инвестиционных проектов на основе современных финансовых моделей. Предлагается подход, сочетающий дисконтированные денежные потоки, средневзвешенную стоимость капитала, сценарный анализ, моделирование методом Монте-Карло, реальные опционы и многокритериальную оценку. Обосновывается необходимость учета инфляции, обменного курса, стоимости финансирования и инвестиционных рисков в условиях экономики Узбекистана.

Ключевые слова: инвестиционный проект, экономическая эффективность, чистая приведённая стоимость, внутренняя норма доходности, стоимость капитала, инвестиционный риск, моделирование Монте-Карло.

Annotatsiya. Maqolada investitsiya loyihalarining iqtisodiy samaradorligini baholash metodologiyasini zamonaviy moliyaviy modellar asosida takomillashtirish masalalari o'rganilgan. Diskontlangan pul oqimlari, kapitalning o'rtacha tortilgan qiymati, ssenariy tahlili, Monte-Karlo modellashtirish, real opsionlar va ko'p mezonli baholashni birlashtiruvchi yondashuv taklif etilgan. O'zbekiston iqtisodiyoti sharoitida inflyatsiya, valyuta kursi, moliyalashtirish qiymati va investitsion risklarni hisobga olish zarurati asoslangan.

Kalit so'zlar: investitsiya loyihasi, iqtisodiy samaradorlik, sof joriy qiymat, ichki daromadlilik normasi, kapital qiymati, moliyaviy risk, Monte-Karlo modellashtirish.

Introduction

Investment projects are among the principal mechanisms through which financial resources are transformed into productive capacity, technological modernization, employment opportunities

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and long-term economic growth. However, the allocation of capital does not automatically generate economic value. A project may demonstrate high projected revenue while remaining financially unattractive because of excessive capital expenditure, weak operating margins, delayed implementation, exchange-rate exposure or an inappropriate discount rate. Consequently, the methodological quality of investment appraisal has direct implications for corporate competitiveness, public expenditure efficiency and the sustainability of economic development. Conventional investment evaluation relies predominantly on net present value (NPV), internal rate of return (IRR), profitability index (PI) and payback period. These indicators provide an analytical foundation for comparing expected benefits with the resources committed to a project. Nevertheless, their reliability depends on the quality of projected cash flows, the appropriateness of the discount rate and the consistency of the assumptions used. When uncertainty is represented by a single forecast, the resulting assessment may conceal substantial differences between expected and adverse outcomes.

The issue is particularly relevant to Uzbekistan, where investment activity has expanded alongside economic diversification, infrastructure development, industrial modernization and the digital transformation of business processes. According to the National Statistics Committee, investment in fixed capital amounted to UZS 443.6 trillion during January–September 2025, increasing by 15.2% compared with the corresponding period of 2024. The official release also indicates that investment volumes over the preceding five years had increased by approximately 2.8 times. These figures demonstrate the scale of capital formation and the importance of selecting projects according to their actual capacity to generate sustainable economic benefits.

Investment growth alone, however, does not establish the effectiveness of capital allocation. The volume of investment represents an input indicator, whereas economic efficiency depends on the relationship between resources used and results achieved. Projects with similar initial investment requirements may generate substantially different cash flows, productivity gains, employment effects and fiscal contributions. A rigorous evaluation system must therefore distinguish between the amount invested, the financial return received by investors and the wider economic value generated for society.

The legal environment also shapes investment appraisal. The Law of the Republic of Uzbekistan No. ZRU-598 of 25 December 2019, On Investments and Investment Activities, establishes a legal framework for investment relations and the protection of investment activity. Its provisions should be considered alongside applicable tax, corporate, currency and environmental regulations when preparing project cash-flow forecasts and assessing implementation risks. The Development Strategy of New Uzbekistan for 2022–2026, approved by Presidential Decree No. PF-60 of 28 January 2022, provides an additional strategic context for economic modernization and investment-led development. Legal compliance and consistency with national priorities should complement, rather than replace, financial feasibility analysis.

Recent Uzbek research has addressed the improvement of investment project financial analysis, the integration of risk into discount rates and the development of comprehensive project assessment systems. Aliqulov (2025) discusses conventional indicators alongside Monte Carlo simulation, real options and artificial-intelligence-based forecasting. Other domestic studies examine integrated evaluation, multicriteria selection and the relationship between financing costs and investment performance. These contributions provide a foundation for further methodological development.

The central research problem is that individual financial indicators frequently produce incomplete or conflicting signals. A project can have a positive NPV but a relatively low IRR, or a high IRR but limited absolute value creation. Furthermore, conventional models do not

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automatically reflect managerial flexibility, the possibility of project expansion, the value of postponing investment or the interaction among uncertain variables. The purpose of this study is to develop an integrated methodology for evaluating investment project efficiency that combines traditional discounted cash-flow indicators with risk modelling, scenario analysis, real options and broader economic criteria. The research addresses three interrelated questions: how modern financial models can be combined without double-counting risk; how uncertainty can be incorporated into investment decisions; and how the proposed approach can be adapted to the institutional and macroeconomic conditions of Uzbekistan.

The principal contribution is a structured framework in which financial viability serves as the initial decision criterion, risk analysis tests the robustness of projected returns, and strategic, social and environmental factors inform the final investment decision.

LITERATURE REVIEW

The theoretical foundations of investment appraisal are closely associated with the time value of money, opportunity cost and the relationship between risk and expected return. Fisher's analysis of interest and capital provides an early theoretical basis for comparing present resources with future benefits. Modern corporate finance further develops this logic by treating investment decisions as a process of allocating scarce capital among competing opportunities. The discounted cash-flow approach is widely recognized as a fundamental method for evaluating long-term investments. Its central principle is that cash flows expected in different periods cannot be compared directly without accounting for the time value of money. NPV measures the present value of expected project cash flows after deducting the initial investment. A positive NPV indicates that the project is expected to create value relative to the selected discount rate and the assumptions underlying the forecast.

The IRR complements NPV by identifying the discount rate at which the project's NPV equals zero. It is intuitively attractive because it expresses the expected return as a percentage. Nevertheless, IRR can produce misleading rankings when projects differ in scale, timing or cash-flow structure. Non-conventional cash flows may generate multiple IRRs, while the implicit reinvestment assumptions associated with IRR may be unrealistic. For mutually exclusive projects, NPV should therefore normally take priority when the objective is to maximize value creation.

The profitability index expresses the present value of future inflows relative to the initial investment. It can be useful when capital is constrained and projects must be ranked according to value generated per unit of investment. However, a high profitability index does not necessarily imply the largest absolute contribution to enterprise value. The discounted payback period adds information about the time required to recover investment in present-value terms, but it ignores cash flows occurring after the recovery point. These limitations explain why contemporary investment appraisal increasingly emphasizes methodological integration. The weighted average cost of capital (WACC) provides a benchmark for discounting operating cash flows when the financing structure and risk characteristics support its use. However, a single company-wide WACC may be inappropriate for projects with materially different business, country, technological or financing risks. Project-specific risk adjustments are therefore necessary, provided that risk is not counted twice through both cash-flow adjustments and an excessive discount-rate premium.

Risk analysis introduces an additional dimension. Sensitivity analysis examines how changes in individual assumptions affect project outcomes. Scenario analysis evaluates internally consistent combinations of changes, such as weaker demand occurring simultaneously with currency depreciation and higher financing costs. Monte Carlo simulation extends this approach

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by assigning probability distributions to uncertain variables and repeatedly recalculating outcomes. The result is a distribution of possible NPV values rather than a single deterministic estimate. Real options theory further challenges the assumption that investment decisions are irreversible commitments made once at the beginning of a project. In practice, management may delay implementation, expand capacity, abandon an unsuccessful operation or switch production technologies. These choices can have economic value when uncertainty is substantial and management retains the flexibility to respond. The real-options approach is particularly relevant to infrastructure, renewable energy, technology-intensive manufacturing and projects whose returns depend on market development.

Domestic scholarship reflects the increasing relevance of these approaches in Uzbekistan. Aliqulov considers modern risk-sensitive methods in investment financial analysis. Research by Aytmuratova examines integrated evaluation of investment projects in joint-stock companies, while more recent studies consider scenario-based and multicriteria assessment. This literature indicates that the next methodological step is not simply to add more indicators, but to establish a coherent hierarchy in which each model addresses a distinct analytical question. A further theoretical distinction concerns financial and economic efficiency. Financial efficiency measures the returns accruing to investors or the enterprise. Economic efficiency considers the wider opportunity cost of resources and benefits to society, including externalities not fully reflected in market prices. A project may be financially attractive while generating environmental costs, or financially weak while producing significant public benefits. Separate financial and socioeconomic analyses are therefore necessary, particularly for public infrastructure and socially oriented investments.

Methodology

The study uses a conceptual and analytical research design based on comparative evaluation of financial models, examination of Uzbekistan's investment context and development of an integrated assessment framework. It combines theoretical synthesis, formula-based analysis, risk classification and a hypothetical numerical illustration. The illustration is designed to demonstrate the proposed methodology rather than to report empirical results from a specific Uzbek company.

Results

The analysis supports the proposition that a single financial indicator cannot adequately represent the full economic efficiency of an investment project. NPV provides the strongest primary measure of value creation under conventional discounted cash-flow assumptions, while IRR, PI and discounted payback provide complementary information about relative returns, capital productivity and liquidity exposure.

The principal methodological result is the proposed integration of five analytical dimensions: discounted cash-flow valuation, project-specific cost of capital, uncertainty analysis, managerial flexibility and socioeconomic assessment. Each dimension addresses a different source of decision error. Cash-flow valuation establishes financial value; cost-of-capital analysis establishes the required return; uncertainty analysis tests the robustness of the forecast; real options capture the value of flexibility; and multicriteria analysis incorporates outcomes that are not fully represented by private cash flows.

The following table summarizes the role and limitations of the principal models within the proposed framework.

Table 1

Comparative characteristics of modern models for investment project evaluation

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Model	Main evaluation purpose	Key strength	Principal limitation	Recommended application
NPV	Absolute value creation	Directly measures discounted net value	Sensitive to cash-flow and discount-rate assumptions	Primary financial decision criterion
IRR	Percentage return	Intuitive communication of profitability	Multiple values or misleading rankings may occur	Complementary return indicator
WACC	Required return on invested capital	Integrates equity and debt financing costs	May not reflect project-specific risk	Discounting suitable operating cash flows
Sensitivity and scenario analysis	Exposure to changing assumptions	Identifies critical risk drivers	Does not automatically assign reliable probabilities	Early-stage risk assessment and stress testing
Monte Carlo simulation	Distribution of possible outcomes	Estimates downside probability and uncertainty	Dependent on distribution and correlation assumptions	Projects with several material uncertainties
Real options	Value of managerial flexibility	Captures the value of delay, expansion or abandonment	Requires credible flexibility and additional modelling	Irreversible, uncertain and staged investments
Multicriteria assessment	Broader economic and strategic contribution	Integrates financial and nonfinancial objectives	Weights may be subjective	Public, infrastructure and strategic projects

The table indicates that the models are complementary rather than interchangeable. NPV and IRR assess financial performance, whereas WACC establishes the required return used in valuation. Scenario analysis and Monte Carlo simulation address uncertainty at different levels, and real options account for decisions that can be changed over time. Multicriteria assessment broadens the decision framework without replacing the financial analysis.

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The importance of this integration is reinforced by Uzbekistan's investment statistics. The National Statistics Committee reported UZS 443.6 trillion in fixed-capital investment during January–September 2025, 15.2% above the corresponding period of 2024. <Cite refs={["turn401996search36"]}/> The scale and growth of investment increase the importance of appraisal methods that distinguish between capital expenditure and actual value creation. These aggregate figures do not, by themselves, demonstrate the profitability or productivity of individual projects; project-level data would be required to establish such relationships.

A hypothetical project illustrates how the methodology operates. Assume that an enterprise plans to invest UZS 100 billion in a production facility and expects annual free cash flows of UZS 30 billion for five years, with no terminal value. At a discount rate of 15%, the present value of the expected inflows is approximately UZS 100.6 billion. The resulting NPV is approximately UZS 0.6 billion, and the profitability index is approximately 1.006. The project is marginally acceptable under the base-case assumptions, but its small positive NPV indicates limited protection against adverse developments.

If operating cash flows were 10% lower in every year, their present value would fall to approximately UZS 90.5 billion, producing an NPV of about negative UZS 9.5 billion. This illustration demonstrates that a project that appears viable under a single forecast may become unattractive after a relatively modest deterioration in operating performance. The figures are hypothetical and are not estimates of an actual Uzbek investment project.

The result also demonstrates why risk should not be addressed solely by increasing the discount rate. A higher rate reduces the present value of all future cash flows but does not explain which operational variable creates the greatest exposure. Sensitivity analysis identifies the relevant driver, scenario analysis shows how adverse variables may interact, and Monte Carlo simulation estimates the likelihood and magnitude of negative outcomes. These methods provide decision-makers with more actionable information than an unexplained risk premium.

A further result concerns the distinction between financing and operating cash flows. When free cash flow to the firm is discounted at WACC, interest payments should not also be deducted from the operating cash flows being valued. Conversely, cash flows available to equity holders should be discounted at the required return on equity. Inconsistent combinations can lead to double-counting financing costs and materially distort the estimated project value. The analysis also indicates that project appraisal should continue after approval. Construction delays, cost overruns, weaker-than-expected demand and changes in financing conditions can invalidate the assumptions used in the original business case. Periodic reforecasting allows management to compare actual performance with the approved model and decide whether to continue, redesign, expand or discontinue the project. Thus, methodological improvement involves both the initial valuation and the establishment of a continuous monitoring system.

Discussion

The findings are consistent with the broader movement in investment analysis from deterministic appraisal toward risk-adjusted and decision-oriented valuation. Traditional indicators remain indispensable because they provide a common quantitative foundation. Their limitations arise not from their mathematical structure alone but from the assumptions under which they are applied. NPV should remain the principal indicator for projects whose objective is to maximize financial value. Unlike IRR, NPV measures the absolute monetary contribution of an investment and avoids several ranking problems associated with projects of different scale. Nevertheless, NPV is only as reliable as the cash-flow forecasts and discount rate used to calculate it. A precise formula cannot eliminate uncertainty in demand, costs, regulation or implementation.

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The appropriate use of WACC is especially important in emerging-market conditions. Financing costs may vary across firms, industries and projects, while the availability of long-term debt may be limited. Currency mismatches can also create material exposure when a project earns revenue in domestic currency but imports equipment or services in foreign currency. Consequently, a uniform discount rate for all projects can produce systematically misleading comparisons. A stronger methodology should separate identifiable operating risks from risks appropriately reflected in the cost of capital. Where an adverse event is explicitly incorporated into probability-weighted cash flows, the analyst must avoid adding the same risk again through an arbitrary discount-rate premium. Conversely, using optimistic expected cash flows with an inadequately adjusted discount rate can overstate value. Transparent documentation of the risk-adjustment mechanism is therefore essential.

The Uzbek legal framework reinforces the need to connect financial modelling with regulatory and institutional analysis. The Law on Investments and Investment Activities establishes the broader legal basis for investment relations, but the financial implications of an individual project also depend on applicable tax rules, contractual obligations, currency arrangements, licensing requirements and environmental standards. These factors should be incorporated into the project model where they affect cash flows, implementation schedules or contingent liabilities.

Strategic consistency is another relevant consideration. The Development Strategy of New Uzbekistan for 2022–2026 provides a policy context for modernization and economic development. However, alignment with national priorities should not be interpreted as proof of financial efficiency. Publicly supported projects may pursue wider social benefits that are not fully captured by investor cash flows, but these benefits should be assessed explicitly and compared with the fiscal resources committed. The integrated methodology therefore requires two complementary evaluations. The financial assessment determines whether the project can generate sufficient cash flows to compensate investors for the capital and risk involved. The economic assessment examines wider effects, including employment, productivity, environmental consequences and external benefits. The distinction helps prevent social objectives from being used to conceal weak financial performance and prevents narrow financial metrics from excluding projects with legitimate public value.

Real options analysis adds a further dimension where uncertainty and flexibility interact. A project that can be implemented in stages may have an advantage over an otherwise similar project requiring an irreversible commitment of all capital at the outset. Management may initially invest in a pilot phase, obtain new information and expand only if demand develops favourably. This flexibility can reduce downside exposure and preserve future opportunities. However, real options should not be treated as an automatic adjustment that makes an unattractive project acceptable. The option must be supported by actual decision rights, feasible alternatives and a credible source of uncertainty resolution. Where management cannot delay construction, abandon the project or change its scale, the claimed option value may be negligible.

The practical implementation of Monte Carlo simulation also requires discipline. Assigning arbitrary probability distributions to uncertain variables can produce an appearance of scientific precision without improving decision quality. Project analysts should use historical observations, supplier quotations, market studies, expert elicitation and documented assumptions to determine plausible ranges. Correlations among demand, prices, exchange rates and financing costs should be considered where evidence suggests that these variables move together. The methodological contribution of this study is therefore the allocation of a specific function to each model. NPV establishes financial value; IRR communicates the implied rate of return; WACC establishes a

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suitable opportunity-cost benchmark; scenario and probabilistic models examine uncertainty; real options quantify feasible managerial flexibility; and multicriteria assessment considers broader strategic and socioeconomic effects. The combination reduces the likelihood that a single favourable indicator will dominate the decision.

Implementation in Uzbekistan would benefit from standardized project templates, documented assumptions, transparent discount-rate policies and periodic post-investment reviews. Public institutions and enterprises could improve comparability by requiring consistent treatment of inflation, taxes, exchange rates, residual values and financing costs. For major projects, independent validation of demand forecasts and sensitivity assumptions could further strengthen accountability. Data quality remains a fundamental constraint. Financial models cannot produce reliable estimates when project cash flows, capital expenditure schedules or operating assumptions are incomplete. The development of centralized investment databases, standardized reporting practices and digital monitoring systems could support more consistent evaluation over time. Artificial intelligence may assist with forecasting and anomaly detection, but its use should be accompanied by explainable assumptions, validation and human review. Algorithmic forecasts should complement, not replace, economic reasoning and legal accountability.

Finally, the proposed framework should be applied proportionately. A small enterprise with a short investment horizon may require a transparent discounted cash-flow model and a limited sensitivity analysis. A major infrastructure or energy project may warrant probabilistic modelling, explicit country-risk assessment, real options and socioeconomic cost-benefit analysis. The sophistication of the model should correspond to the project's scale, irreversibility, uncertainty and potential consequences.

CONCLUSION

Improving the methodology for evaluating investment project efficiency requires a transition from isolated financial indicators to an integrated, risk-sensitive decision framework. NPV remains the principal measure of financial value creation, while IRR, profitability index and discounted payback provide complementary information about returns, capital productivity and liquidity. Their interpretation should be supported by an appropriate cost-of-capital estimate and consistent treatment of inflation, currency denomination, taxes and financing flows. The study proposes a framework that integrates discounted cash-flow valuation, WACC, sensitivity analysis, scenario modelling, Monte Carlo simulation, real options and multicriteria assessment. The framework distinguishes financial feasibility from wider economic and social outcomes and emphasizes that no model should be used without considering its assumptions and limitations.

The hypothetical illustration shows that a project with a slightly positive base-case NPV can become financially unattractive after a modest reduction in cash flows. This supports the use of systematic stress testing and probabilistic analysis, particularly when project returns are exposed to demand uncertainty, cost escalation or currency fluctuations. The example is illustrative rather than empirical, and further research should validate the framework using actual project-level data. For Uzbekistan, the reported expansion of fixed-capital investment strengthens the practical importance of transparent and consistent investment appraisal. The recommended priorities include standardizing financial models, improving project-specific risk estimation, integrating socioeconomic analysis where appropriate, introducing continuous performance monitoring and strengthening the quality of underlying data. These measures can improve capital allocation, support more accountable investment decisions and increase the likelihood that investment growth translates into sustainable economic value.

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