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Evaluation of investment projects in Kyrgyzstan: Modern methods and errors in controlling practice

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Abstract. The study aimed to improve methodological approaches to assessing the effectiveness of investment projects in the Kyrgyz Republic. The study was based on the comparative economic, structural-dynamic, correlation-regression and scenario analysis, as well as methods of content analysis of regulatory acts and financial modelling, including calculations of discounted cash flows, net present value, internal rate of return and payback period. The results showed that in 2024, the total volume of investment in fixed capital increased by 14% compared to 2019, which indicated a gradual recovery of the investment cycle and a transition to a more active phase of capital investment. The highest growth rates were recorded in the energy (+5.8%) and infrastructure (+4.4%) sectors, where there is a steady expansion of the project portfolio and a strengthening of the role of long-term investments. Scenario analysis confirmed the high stability of energy projects amid fluctuations in key macroeconomic indicators, while agricultural and infrastructure initiatives are more sensitive to inflation and currency risks, requiring the use of risk-adjusted valuation methods. At the same time, the structure of funding sources is shifting towards private and mixed capital, reflecting the strengthening of public-private partnership mechanisms and the accelerated digitalisation of the investment process, including the use of online platforms for project registration and monitoring. The econometric model $E = f(I, r, \sigma)$ showed that a 1% increase in investment increases integral efficiency by 0.63 units, while a 1 p.p. increased in the cost of capital reduces it by 0.27 units, which highlighted the importance of the cost of capital and the structure of financing for the sustainability of investment decisions. The results obtained can be used by government agencies, financial and analytical departments, and consulting structures to improve the processes of evaluation, planning, and control of investment projects

Keywords: financial modelling; discounting; net present value; internal rate of return; integral efficiency; payback period

INTRODUCTION

Investment activity in the Kyrgyz Republic is considered one of the key factors for sustainable economic growth and structural transformation. The effectiveness of investment projects depends not only on the volume of resources attracted, but also on the quality of analytical procedures that determine the correctness of management decisions. The regulatory framework for investment policy is gradually being improved, but the methodological component of project evaluation remains underdeveloped. As a result, decisions are often made on an intuitive or formal basis, without the use of comprehensive controlling and financial modelling tools.

Several studies highlighted the institutional and methodological weaknesses of Kyrgyzstan's investment policy. As shown by R. Asizbaev & N. Djeenbekova (2022), without a methodological update of approaches to investment assessment, it is impossible to ensure the rational allocation of resources and the sustainability of the investment cycle. They emphasised that traditional practices based on administrative decisions and average indicators do not meet the requirements of a modern economy focused on capital returns and measurable performance. An analysis of the structure of foreign investment revealed that Kyrgyzstan remains dependent on short-term and poorly diversified

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flows, which limit the possibilities for long-term planning. As noted by O. Melkher & G. Ermekova (2023), capital inflows are highly volatile, and investment decisions are often made without considering macroeconomic and currency risks. The authors concluded that the main factor reducing efficiency is not a lack of capital, but a lack of an analytical basis for forecasting and controlling project profitability. The situation in the real sector of the economy reflects the same patterns. A study by I. Myrzaibraimova (2023) demonstrated that in the real estate and construction segment, investment decisions are often based on investors' subjective expectations, without analysing cash flows and calculating discounted indicators. According to the author, this approach creates an illusion of profitability, whereas in reality, many projects do not achieve the recovery threshold.

Addressing regional differences, B. Satyvaldieva (2024) found that the economic growth potential of regions is unevenly utilised. The study concluded that the lack of comprehensive management analysis and controlling tools limits the effectiveness of investment programmes, especially in agricultural and mountainous areas. It emphasised that implementing projects without strategic coordination turns investments into fragmented initiatives that are unable to create a multiplier effect. Kyrgyzstan's foreign economic orientation reinforces the importance of methodological consistency in evaluation. According to G. Duysen *et al.* (2025), the national participation in Chinese-Central Asian programmes requires the unification of approaches to analysing the effectiveness and transparency of calculation criteria. The study emphasised that the lack of consistency in methodological standards reduces investor confidence and hinders the implementation of transregional projects. Their conclusions confirmed the need to introduce controlling tools capable of synchronising national and international assessment procedures. The problem of investment risk management remained one of the key issues. As demonstrated by U. Nadirkhanov (2024), the use of a single discount rate without the incorporation of industry, inflation, and currency factors distorts net present value and internal rate of return indicators. The researcher noted that the practice of adjusting the discount rate using scenario modelling would improve the accuracy of forecasts and prevent overestimation of returns. An analysis of international experience conducted by T. Tyulebekov *et al.* (2025) confirmed that successful investment projects under intergovernmental agreements were based on the coordination of analytical methods. The authors demonstrated that the unification of assessment procedures and the use of comparative models (benchmarking) increases the reliability of results and facilitates the attraction of partner capital.

Several studies addressed the role of non-financial factors in shaping investment sustainability. In particular, R. Hassibullah & M. Ahmad (2023) used a comparative analysis of Kyrgyzstan and Afghanistan to show that environmental considerations are largely overlooked in capital investment planning. Underestimating long-term social and environmental effects decreases the overall effectiveness of investments, whereas integrating environmental and management criteria into the assessment system could significantly increase project sustainability. In the industrial sector, the emphasis was on the use of modern analytical tools. As noted by J. Shaturaev (2023), the use of discounted cash flow (DCF), net present value (NPV) and internal rate of return (IRR) methods can be used to analyse investments not in isolation, but in the context of the innovative transformation of enterprises. The study demonstrated that the use of these methods increases the accuracy of forecasts and reduces the likelihood of errors in choosing strategic directions. In the context of the Kyrgyz Republic's investment activities, the integration of investment appraisal procedures into the management control system is regarded as an element of improving monitoring and planning mechanisms. R. Karlibaeva *et al.* (2022) concluded that investment analysis should be viewed as a continuous cycle comprising the stages of planning, implementation, and post-investment monitoring. The authors emphasised that only the combination of financial and non-financial indicators provides a comprehensive overview of investment performance and creates a basis for strategic management control.

The combination of the reviewed studies revealed a general trend: the Kyrgyz investment project evaluation system is in the process of transitioning from static, accounting-based methods to dynamic models based on discounting, scenario analysis, and the integration of controlling elements. Despite growing attention to the methodological side of the issue, errors remain related to the use of incorrect discount rates, limited use of data, and a lack of connection between evaluation and corporate strategy. Solving these problems requires the development of a comprehensive approach that would not only improve the accuracy of analysis but also strengthen the management framework for investment activities in Kyrgyzstan.

The study aimed to analyse and improve methodological approaches to assessing the effectiveness of investment projects in the Kyrgyz Republic. The objectives of the study included theoretical generalisation and systematisation of approaches to evaluating investment projects, identifying methodological and practical limitations of controlling, developing recommendations for their improvement, and determining ways to adapt modern analytical tools to the economic conditions of the Kyrgyz Republic.

MATERIALS AND METHODS

The study was conducted in the Kyrgyz Republic between January and September 2025 and was theoretical and analytical in nature, with elements of quantitative modelling. The time frame of 2019-2024 ensured the use of up-to-date data from the National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), analysed using comparative economic and content analysis methods. In addition, materials from the Ministry of Economy and Commerce of the Kyrgyz Republic (n.d.) were considered, which clarified the dynamics of investment activity and the structural features of projects. Information from the Investment Portal of the

Kyrgyz Republic (n.d.) was also used, which clarified the structure of investment flows and the characteristics of their distribution. Analytical reports from the World Bank (n.d.) and the Asian Development Bank (Kyrgyz Republic: Country…, 2023) were processed using a structural-dynamic approach, ensuring the comparison of macroeconomic trends and sectoral changes (Kyrgyz Republic country…, 2023). The material basis of the study was formed by the regulatory and legal acts of the Kyrgyz Republic, including Law of the Kyrgyz Republic No. 66 "On Investments in the Kyrgyz Republic" (2003) and the National Development Programme of the Kyrgyz Republic until 2026 (2021), analysed using content analysis. To clarify the macroeconomic parameters, statistical yearbooks and fiscal reports were used, processed using the correlation-structural comparison method.

The methodological procedure consisted of three stages. The preparatory stage involved systematising sources, classifying DCF, NPV, IRR and payback period assessment approaches, as well as standardising terminology and verifying statistical data. During the analytical stage, the effectiveness of investment projects was modelled using key financial indicators. The basic tool was the DCF method, in which the net present value was calculated using formula (1):

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

where CF_t – cash flow during the period t; r – discount rate; I_0– initial investment; n – project duration.

Formula (2) was used to calculate the internal rate of return (IRR):

$$0 = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - I_0, \quad (2)$$

where IRR – Internal Rate of Return; at which $NPV = 0$, CF_t – finance flow at period t; t – sequence number of the accounting period; n – total number of periods; I_0 – initial investment.

Formula (3) was used to determine the payback period (PP):

$$PP = \frac{I_0}{\overleftarrow{CF}}, \quad (3)$$

where $\overleftarrow{CF}$ – average annual cash flow; P – investment project payback period; I_0 – initial investment.

To assess the stability of financial indicators, sensitivity analysis was additionally applied to determine the degree of influence of macroeconomic parameters (discount rate, inflation, exchange rate) on changes in NPV.

The sensitivity analysis of the results to macroeconomic factors was performed using formula (4):

$$S_{NPV} = \frac{(\Delta NPV/NPV)}{(\Delta X/X)}, \quad (4)$$

where ΔNPV – change in Net Present Value; NPV – base Net Present Value; ΔX – change in the macroeconomic parameter under investigation; X – variable factor, including inflation π, exchange rate E and discount rate r.

The cumulative effect of efficiency factors was described by the functional formula (5):

$$E = f(I, r, \sigma), \quad (5)$$

where E – integral performance indicator; I – investment volume; r – discount rate; σ – aggregate risk modifier (inflationary and currency).

The calculation was based on a generalised sample of data on 27 typical investment projects distributed across four sectors of the Kyrgyz Republic's economy: energy, agriculture, infrastructure and renewable solar power generation. In the energy sector, an example of the construction of a small hydroelectric power plant similar to the projects presented in the United Nations Development Programme report (n.d.) was analysed. For the agro-industrial complex, data comparable to the Agriculture Productivity and Nutrition Improvement Project (APNIP) (World Bank, n.d.) was used. In the renewable energy sector, materials from the International Renewable Energy Agency (2022) were used, which emphasised the economic feasibility of distributed photovoltaic systems. The infrastructure case reflected logistics and construction projects comparable to the initiatives of the Asian Development Bank (Kyrgyz Republic: Country..., 2023). The general principles and institutional parameters were agreed with the Kyrgyz Republic country partnership framework 2024-2028 (2023). Calculations and scenario modelling were performed in MS Excel 2021 and IBM SPSS Statistics 28.0 (IBM Corp.). The parameterisation of scenarios (baseline, optimistic and pessimistic) was performed with a deviation of ±3-5 p.p. relative to the base discount rate and projected cash flow values.

RESULTS

Investment activity dynamics and project structure in the Kyrgyz economy (2019-2024)

An analysis of investment activity in the Kyrgyz Republic for 2019-2024 showed steady, albeit uneven, growth in capital investment. According to data from the National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), in 2024, total investment in fixed capital increased by approximately 14% compared to 2019, reflecting a gradual recovery after the crisis year of 2020 and the intensification of projects under the state programme for industrial and innovative development. At the same time, growth rates vary across sectors: the greatest acceleration is observed in the infrastructure and energy sectors (on average +8-10% per year), while the agricultural sector shows moderate positive dynamics (+3-4% per year), due to its dependence on external investment and seasonality.

As shown by the summary materials of the Ministry of Economy and Commerce of the Kyrgyz Republic (n.d.), the structure of capital investments has shifted in favour of large infrastructure and transport-logistics projects financed by international programmes of the Asian Development Bank (Kyrgyz Republic: Country…, 2023) and the World Bank (2024). The share of the public sector in the

investment balance has stabilised at 32-35%, with private investment forming the core of economic growth (about 65%). This ratio confirms the trend towards expanding public-private partnerships (PPPs) and diversifying sources of financing, especially through the Investment Portal of the Kyrgyz Republic (n.d.). The dynamics of investment in the main sectors of the Kyrgyz Republic's economy for 2019-2024 are presented in Table 1.

Table 1. Investment dynamics by major sectors of the Kyrgyz Republic economy (2019-2024)

Economy branch	2019	2020	2021	2022	2023	2024	Average annual rate, %
Energy sector	25.1	22.8	26.3	28.5	30.4	31.9	5.8
Infrastructure and construction	19.7	18.4	20.5	22.9	23.8	24.5	4.4
Agriculture	14.6	13.8	15.1	15.4	16.3	16.8	2.8
Industry	13.4	12.7	14.3	14.9	15.2	15.8	2.9
Services sector	13.2	12.1	13.8	15.7	16.2	16.7	4.0
Other sectors	14.0	14.3	10.0	9.7	8.1	8.3	-6.5
Total, billion som	100	94.1	100	107.1	110	114	3.8

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), Ministry of Economy and Commerce of the Kyrgyz Republic (n.d.), Ministry of Finance of the Kyrgyz Republic (n.d.), Kyrgyz Republic: Country partnership strategy 2023-2027 (2023), World Bank (2024), Organisation for Economic Co-operation and Development (2024)

As shown in Table 1, the most intensive growth in capital investment in 2019-2024 was observed in energy and infrastructure, where investment increased by more than 25% compared to the base period. These sectors accounted for more than half of all capital investment in the country and provided the main recovery of the economy after the pandemic recession of 2020. Agriculture and industry developed more moderately, showing positive but limited dynamics, which is associated with low availability of credit resources and high dependence on external investment. This structure of capital investment distribution confirmed the priority of state policy on the development of infrastructure and energy projects, supported by programmes from the World Bank (2024) and the Asian Development Bank (Kyrgyz Republic: Country..., 2023). The increase in the private sector's share in 2022-2024, reflected in Figure 1, demonstrates a gradual transition to a public-private partnership (PPP) model, in which investment efficiency is determined by a combination of budgetary and market financing mechanisms.

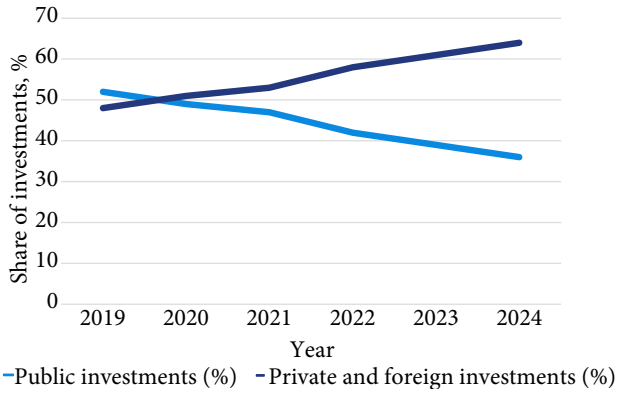

Figure 1. Structure and growth rates of investment activity: Private and public sectors, 2019-2024

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), Ministry of Finance of the Kyrgyz Republic (n.d.)

Following Figure 1, the share of public sources in total investment declined steadily from 52% in 2019 to 36% in 2024, while private and foreign capital increased its presence from 48% to 64%, with the trend reversal occurring after 2021-2022, reflecting a shift towards market-based financing instruments and the expansion of PPP mechanisms. The analysis confirms that the period 2019-2024 was a transitional one for Kyrgyzstan's investment policy: the country moved from an extensive financing model to structural modernisation and digitalisation of the investment sphere. Data from the Investment Portal of the Kyrgyz Republic (n.d.) show an increase in the number of online project registrations and greater transparency in capital investments.

Quantitative assessment of investment project effectiveness using DCF, NPV and IRR methods

The application of basic cash flow discounting methods can be used for a quantitative assessment of the effectiveness of typical investment projects in key sectors of the Kyrgyz Republic's economy. Calculations are performed using average discount rates of 10-12% and projected CF_t flows based on official macroeconomic data. The analysis includes four representative types of projects – energy, agriculture, infrastructure and solar power generation – reflecting the structure of national investments. The results of the modelling are presented in Table 2. Following Table 2, energy projects will provide the greatest sustainability and investment attractiveness: with an average investment of KGS 60 million, the net present value will be KGS +8.7 million, the internal rate of return will be 14.5%, and the payback period will be approximately 7 years. Agricultural projects will demonstrate a higher nominal IRR (up to 18%), but actual returns may decline with fluctuations in exchange rates and resource prices, indicating the need for a risk-adjusted approach. The solar power generation sector will be characterised by a minimum payback period (around 5 years) and stable long-term returns, making it promising for small and medium-sized businesses. Infrastructure

projects will maintain moderate profitability (IRR≈13%) and high NPV values (KGS ≈6.2 million) due to their scale and multiplier effect, although their long investment cycle will require effective capital expenditure management. This distribution of results confirms that efficiency and sensitivity to the discount rate vary across sectors: energy remains the least vulnerable, while agriculture and infrastructure require the implementation of comprehensive analysis models that incorporate risk modifiers and scenario fluctuations in macroeconomic parameters. Figure 2 shows a comparative distribution of IRR and NPV indicators by economic sector.

Table 2. Estimated values of NPV, IRR and Payback Period for typical investment projects

Project type	Investment volume, million som	Average annual CF, million som	Rate r, %	NPV, million som	IRR, %	PP, years	Economic interpretation
Mini-HPP (Narynsk region)	60	10	12	8.7	14.5	7.0	High profitability with stable cash flows
Agricultural project (southern Kyrgyzstan)	25	4.5	11	2.1	18.0	5.5	Sensitive to currency risks
Solar panels (residential sector)	10	2.3	10	1.4	15.2	5.0	Fast return on investment, long life cycle
Infrastructure (logistics)	80	11	12	6.2	13.0	7.5	Average return on long-term investments

Note: CF – cash flow, NPV – net present value, IRR – internal rate of return

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), Ministry of Finance of the Kyrgyz Republic (n.d.), United Nations Development Programme (n.d.), World Bank (n.d.), Investment Portal of the Kyrgyz Republic (n.d.), Kyrgyz Republic: Country partnership strategy 2023-2027 (2023)

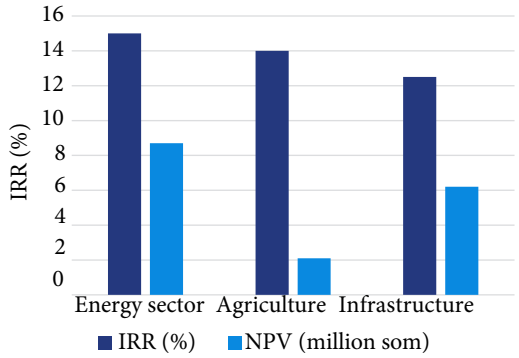

Figure 2. Comparison of IRR and NPV values by sector (energy, agribusiness, infrastructure)

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), Ministry of Finance of the Kyrgyz Republic (n.d.), United Nations Development Programme (n.d.), World Bank (n.d.), Investment Portal of the Kyrgyz Republic (n.d.), Kyrgyz Republic: Country partnership strategy 2023-2027 (2023)

Based on the data in Figure 2, it is possible to note that the energy sector demonstrated the highest rate of return (IRR≈15%) with the maximum NPV (KGS ~8.7 million), which confirmed the sector's resistance to changes in the cost of capital and the predictability of cash flows. Infrastructure projects, on the other hand, showed a moderate IRR (~12.5%), but a high NPV (KGS ~6.2 million), reflecting economies of scale, long asset life cycles and a multiplier effect on related sectors. The agro-industrial complex had a rate of return close to that of the energy sector at the upper limit (up to ~14% in some cases), but a significantly lower NPV (KGS ~2.1 million), which was explained by the lower capital intensity of projects and sensitivity to price and currency shocks. A comparison of IRR and NPV indicated that when ranking projects according to controlling priorities, it is advisable to consider energy and infrastructure initiatives as the basis for portfolio stability, while agricultural projects required more stringent assumptions regarding exchange rates, inflation and operating costs. Thus, the analysis of estimated indicators using the DCF, NPV and IRR methods confirms that capital-intensive industries with predictable cash flows have the greatest investment stability, while agriculture requires the introduction of adaptive controlling and risk modelling tools.

Scenario and sensitivity analysis of project effectiveness

The scenario analysis conducted made it possible to assess how changes in macroeconomic parameters affect the performance indicators of typical projects in the energy, agricultural and infrastructure sectors. The results of the scenario calculations are summarised in Table 3. Following Table 3, energy projects will demonstrate the greatest stability in the long term: even under unfavourable macroeconomic conditions, their NPV remains in positive territory (around KGS 5.4-10.2 million), IRR remains above 12%, and the payback period varies from 6.5 to 8.2 years, indicating low sensitivity to inflation and capital rate growth. Agricultural projects, on the contrary, will be most sensitive to currency and price fluctuations: in an optimistic scenario, they will provide a high IRR (up to 20%), but under unfavourable conditions, the net present value may decrease almost threefold (to KGS 0.6 million), which highlights the need to apply risk-adjusted discount rates. Infrastructure projects will maintain balanced performance indicators: NPV within KGS 3.3-7.5 million, IRR – 11.5-14.2%, payback period – 7-8.9 years. Despite rising costs, economies of scale and a long-life cycle will ensure the sustainability

of their financial results. Thus, scenario analysis shows that energy will remain the core and least risky sector, agricultural projects will be the most sensitive to macroeconomic fluctuations, and infrastructure initiatives will be stable, provided that costs and capital resources are managed effectively. Figure 3 demonstrates the comparative sensitivity of the NPV of investment projects in various sectors of the Kyrgyz Republic's economy to changes in key macroeconomic parameters: the discount rate (r), inflation (π), exchange rate (E) and volatility (σ).

Table 3. Scenario calculations of NPV, IRR and PP for baseline, optimistic and pessimistic scenarios

Project type	Scenario	NPV (million som)	IRR (%)	PP (years)	Economic interpretation
Mini-HPP (Narynsk region)	Optimistic	10.2	16.1	6.5	Resistance to inflationary fluctuations
	Basic	8.7	14.5	7.0	High predictability of flows
	Pessimistic	5.4	12.2	8.2	Decrease in margin due to interest rate increase
Agricultural project (southern Kyrgyzstan)	Optimistic	3.4	20.0	5.0	Sensitive to currency stability
	Basic	2.1	18.0	5.5	Average profitability
	Pessimistic	0.6	10.8	7.1	Loss of profitability as prices rise
Infrastructure (logistics)	Optimistic	7.5	14.2	7.0	Economies of scale, high capital intensity
	Basic	6.2	13.0	7.5	Balanced profile
	Pessimistic	3.3	11.5	8.9	Increased costs reduce NPV

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), Ministry of Finance of the Kyrgyz Republic (n.d.), United Nations Development Programme (n.d.), World Bank (n.d.), Investment Portal of the Kyrgyz Republic (n.d.), Kyrgyz Republic: Country partnership strategy 2023-2027 (2023)

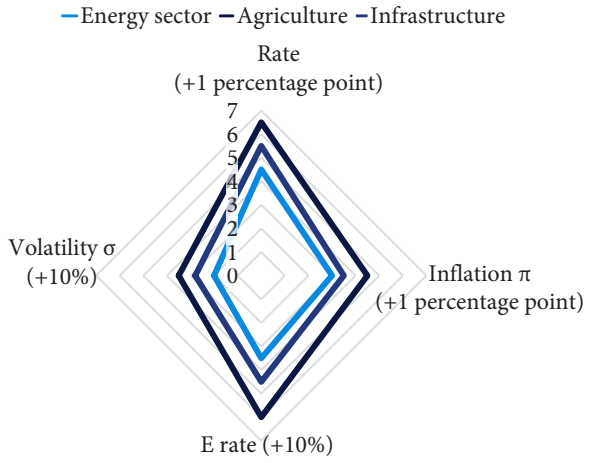

Figure 3. Diagram showing the sensitivity of NPV to changes in the rate r, inflation π, exchange rate E, and volatility σ

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), Ministry of Finance of the Kyrgyz Republic (n.d.), United Nations Development Programme (n.d.), World Bank (n.d.), Investment Portal of the Kyrgyz Republic (n.d.), Kyrgyz Republic: Country partnership strategy 2023-2027 (2023)

Following Figure 3, energy projects are characterised by the lowest NPV sensitivity: when the rate r changes by 1 percentage point or inflation changes by 1 percentage point, the NPV decreases by only 4-5%, which indicates high predictability of cash flows and relative independence from inflation risks. In the agro-industrial sector, sensitivity is higher: a change in the rate or exchange rate per unit leads to a 6-7% decrease in NPV, reflecting the high dependence of profitability on price fluctuations and currency instability. Infrastructure projects occupy an intermediate position: their NPV responds to changes in macro parameters in the range of 4-5%, which is associated with capital intensity, but also with the presence of a multiplier effect that compensates for part of the risks. Overall, the results presented show that the cost of capital has the main impact on the sustainability of investment projects, while inflationary and currency factors have a secondary but cumulative effect. This highlights the need for regular adjustments to financial models to take into account macroeconomic volatility, the introduction of scenario calculations and risk-oriented controlling tools to maintain the stability of investment decisions.

Econometric interpretation of the integral model of efficiency

Analysis of the regression relationship between the main parameters of investment analysis showed that the integral efficiency indicator E is formed under the dominant influence of the volume of investment (I) and the cost of capital (r), while the risk factor (σ) has a compensatory but less pronounced effect. The results of the regression analysis are presented in Table 4. As Table 4 shows, the overall effectiveness of investment projects is largely influenced by the amount of investment: a coefficient of $\beta = 0.63$ indicates that even a moderate increase in investment flow provides a noticeable increase in overall performance, which is particularly characteristic of capital-intensive industries. The cost of capital is a limiting factor: the negative coefficient $\beta = -0.27$ indicates that an increase in the discount rate by each percentage point systematically reduces efficiency, narrowing the range of acceptable projects and increasing the requirements for their profitability. The risk factor (σ) also has a noticeable impact ($\beta = -0.18$), with its influence being most pronounced in the agro-industrial sector, where the volatility of macroeconomic parameters and seasonal fluctuations directly affect cash flow. The high

value of the coefficient of determination ($R^2 = 0.76$) confirms that the proposed model has high explanatory power and adequately reflects the relationships between investment, financial and risk parameters. Figure 4 illustrates the comparative contribution of three key factors – investment volume (I), cost of capital (r) and aggregate risk (σ) – to the formation of integral efficiency (E) across the main sectors of the Kyrgyz Republic's economy.

Table 4. Results of regression analysis of the influence of I, r, and σ on integral efficiency E

Indicator	B coefficient	Statistical value (p)	Interpretation
I (investment)	0.63	<0.01	A 1% increase in investment volume raises integral efficiency by 0.63 units.
r (discount rate)	-0.27	<0.05	A 1 percentage point increase in the capital rate reduces efficiency by 0.27 units.
σ (risk)	-0.18	<0.05	Increased volatility reduces the stability of projects, especially in the agricultural sector.
Constant	0.92	<0.01	Basic level of efficiency under average conditions.
R^2	0.76	-	High explanatory power of the model.

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.a; n.d.b), Ministry of Finance of the Kyrgyz Republic (n.d.), United Nations Development Programme (n.d.), World Bank (n.d.), Kyrgyz Republic country partnership framework 2024-2028 (2023), Organisation for Economic Co-operation and Development (2024)

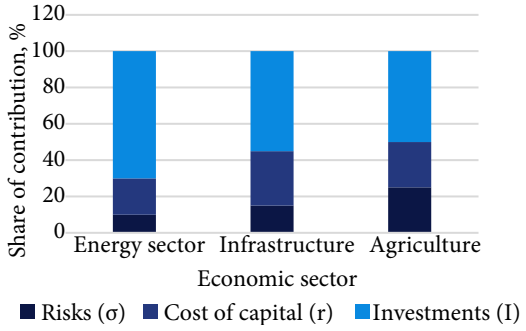

Figure 4. Contribution of factors I, r and σ to integral efficiency E (by sector)

Source: ccompiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.b), Ministry of Finance of the Kyrgyz Republic (n.d.), World Bank (n.d.), Kyrgyz Republic country partnership framework 2024-2028 (2023), Organisation for Economic Co-operation and Development (2024)

According to the data presented in Figure 4, the energy sector is characterised by the dominance of the investment factor, which accounts for about 70% of overall efficiency, indicating the high capital intensity and stability of the industry. In infrastructure projects, the contribution structure is more balanced: the impact of capital costs increases to 30%, and risks to 15%, reflecting the long implementation cycle and dependence on credit conditions. In the agricultural sector, the share of the investment factor decreases to 50%, while risk reaches 25%, demonstrating the greatest sensitivity to macroeconomic volatility, seasonality and price fluctuations. Overall, the results of the regression analysis and visualised decomposition confirm that the overall effectiveness of investment activity in Kyrgyzstan is determined not by a single factor, but by their interrelated action. The scale of investment provides the basis for economic growth, the cost of capital sets the limit for financial stability, and the level of risk is an indicator of the adaptability of projects to macroeconomic fluctuations. This structure of interdependencies points to the need to optimise investment policy by balancing investment expansion and risk control, as well as the importance of introducing long-term financial planning and capital source diversification mechanisms as part of a sustainable development strategy.

Comparison of calculated results with national strategic goals and typical controlling errors

A comparison of the calculated efficiency indicators with the target parameters of national policy shows that investment projects in the energy, agricultural and infrastructure sectors are generally in line with the priorities stipulated in the National Development Programme of the Kyrgyz Republic until 2026 (2021) and the strategic documents of the Ministry of Economy and Commerce of the Kyrgyz Republic (n.d.). The average values of integral efficiency ($E \approx 1.15$-1.25) and internal rate of return (IRR = 13-16%) are consistent with the projected targets for productivity growth and investment attractiveness. However, in practice, there is a discrepancy between the modelled and actual results, which is largely due to errors in management control and insufficient verification of input parameters (Table 5).

Table 5. Typical controlling errors in evaluating investment projects and their impact on NPV

Error type	Core	Consequences for NPV and IRR	Comment
Incorrect r rate	Use of the average market rate of capital instead of the industry rate	Overestimation of NPV by 5-10%	Risk premiums and financing structures must be addressed.
Neglect of the σ factor	Lack of analysis of macroeconomic volatility	Underestimation of the NPV decline risk to 15%	Stress analysis and scenario modelling are required.
Errors in CF_t	Incorrect flow forecast due to optimistic assumptions	Distortion of the payback period by 1-2 years	An independent examination of the input data is recommended.

Table 5. Continued

Error type	Core	Consequences for NPV and IRR	Comment
Incomplete accounting for investments I	Exclusion of intangible assets and indirect costs	Decrease in the accuracy of E and IRR calculations	Integration with management accounting is required.
Absence of post-audit	No comparison of forecast and actual results is made	Accumulation of systemic errors	Feedback and model adjustment mechanisms are required.

Source: compiled by the author based on the Ministry of Economy and Commerce of the Kyrgyz Republic (n.d.), National Development Program of the Kyrgyz Republic until 2026 (2021), World Bank (2024), Organisation for Economic Co-operation and Development (2024)

As Table 5 shows, the greatest impact on the distortion of performance indicators is caused by errors related to the incorrect selection of the discount rate r and ignoring the σ factor, which leads to an overstatement of the net present value (NPV) by 5-10% and an underestimation of risks by up to 15%. Errors in cash flow forecasting (CF_t) are caused by overly optimistic assumptions and lead to a 1-2 year shift in the payback period, especially in projects with high capital intensity and seasonal fluctuations. Incomplete reflection of the investment volume (I), including intangible assets and indirect costs, reduces the accuracy of the calculation of integral efficiency (E) and internal rate of return (IRR), creating the illusion of greater profitability. The absence of post-audit increases the accumulation of systemic errors, as there is no feedback between planned and actual results. Together, the identified deviations indicate the need to transition to risk-adjusted models, integrate management and financial accounting, and make post-audits mandatory as a tool for improving the reliability of investment control. The results of comparing the calculated indicators with national strategic guidelines confirm that most of the investment projects studied meet the objectives of state policy to increase the efficiency of capital investments, modernise infrastructure and develop energy-intensive industries. At the same time, the main discrepancy between planned and actual results is not due to shortcomings in the econometric methods used, but rather to errors in management control and the untimely adaptation of financial models to changes in the macroeconomic environment. To achieve sustainable alignment of project decisions with strategic objectives, it is necessary to strengthen the analytical function of controlling, introduce risk-adjusted models (incorporating r and σ), integrate budgeting and management accounting systems, and conduct mandatory post-audits of investment programmes. The implementation of these measures will increase the transparency of assessments, reduce the probability of systemic distortions, and ensure the strategic alignment of the Kyrgyz Republic's investment policy with the principles of effectiveness and sustainable growth.

A summary interpretation of the results of modelling, sensitivity analysis and verification against strategic benchmarks shows that investment projects in the Kyrgyz Republic have a moderate level of integral efficiency ($E \approx 1.15\text{-}1.25$) and demonstrate a positive correlation between investment volume and cash flow sustainability. At the same time, the greatest stability is observed in the energy and infrastructure sectors, while agricultural projects are characterised by increased sensitivity to currency, inflationary and seasonal fluctuations. Financial parameters, primarily the cost of capital (r) and the level of risk (σ), have a systemic impact on net present value and internal rate of return, creating the need for risk-adjusted discounting and stress testing models. Table 6 summarises the impact of macroeconomic, financial and institutional factors on investment performance, highlighting key areas for improvement in controlling and strategic planning.

Table 6. Final comparison of macroeconomic, financial and institutional factors affecting efficiency

Groups of factors	Main parameters	Impact on efficiency	Management recommendations
Macroeconomic	Inflation (π), exchange rate (E)	Moderate, indirect impact on NPV (-3-5%)	Regular updating of forecasts, inclusion of stress scenarios
Finance	Discount rate (r), capital structure, risk (σ)	High, direct impact (up to -0.3 E units with an increase in r by 1 percentage point)	Apply Weighted Average Cost of Capital (WACC) with industry premiums and conduct sensitivity analysis
Investment	Volume and structure of investments (I)	Positive, dominant influence (+0.6 units of E with a 1% increase in I)	Improve the quality of investment planning and post-audit
Institutional	Regulatory framework, transparency, and management control	Indirect influence through risks and deadlines	Strengthen interdepartmental coordination and digitisation of control procedures

Source: compiled by the author based on National Statistical Committee of the Kyrgyz Republic (n.d.b), Ministry of Economy and Commerce of the Kyrgyz Republic (n.d.), Kyrgyz Republic: Country partnership strategy 2023-2027 (2023), World Bank (2024), Organisation for Economic Co-operation and Development (2024)

Following Table 6, financial and investment factors have a decisive influence on the overall effectiveness of investment activities, primarily the discount rate (r), the level of risk (σ) and the volume of capital investment (I). Macroeconomic parameters such as inflation and exchange rates have a predominantly indirect impact through changes in

the cost of capital and cash flows, reducing NPV by an average of 3-5%. Institutional factors, such as regulatory stability, transparency of procedures and quality of management control, have a systemic but less pronounced impact, creating conditions for predictability and reducing the volatility of results. Agricultural sector projects remain the most sensitive to changes in parameters, with the cumulative impact of external factors reaching 25%, while energy and infrastructure demonstrate more stable performance profiles. Thus, the results confirm the need for a comprehensive approach to investment risk management, combining macroeconomic monitoring, financial modelling and institutional measures to increase the transparency of control.

Overall, the results of the analysis confirm the need to move from formal accounting to analytical controlling based on quantitative verification of parameters, comprehensive risk assessment, and constant feedback between the modelling stages and the actual implementation of investment programmes. To improve the accuracy of forecasts and the sustainability of investment policy, it is advisable to introduce dynamic discounted cash flow models adapted to macroeconomic changes, as well as to integrate risk modules (σ) and stress scenarios into standard financial analysis tools. The use of industry-specific WACC rates instead of average values can adequately reflect the specifics of individual sectors and minimise distortions in NPV and IRR calculations. In addition, it is necessary to strengthen independent expertise in source data, systematise post-project evaluation, and develop digital monitoring platforms that ensure transparency and comparability of information. The implementation of these measures will improve the manageability of the investment cycle, reduce the likelihood of systemic errors in controlling, and ensure that investment decisions are consistent with the national sustainable economic development goals of the Kyrgyz Republic.

DISCUSSION

The results obtained demonstrated that the effectiveness of investment programmes in Kyrgyzstan is determined not only by the volume of capital investments but also by the quality of financial modelling and risk management. This is consistent with the findings of J. Fabianová *et al.* (2023), demonstrating that the use of Monte Carlo simulation can correctly estimate the ranges of net present value and internal rate of return, reducing the uncertainty of the final indicators. A similar relationship was observed in a study where the use of probabilistic models confirmed the significant impact of parameter volatility on forecast reliability. The results also correlate with the conclusions of Y. Yang (2024), noting that the assessment of investment risks should include dynamic scenario models. In the analysis of projects in Kyrgyzstan, a similar approach confirmed the significance of adapting discounted cash flows to changing macroeconomic conditions, which improved the accuracy of forecasts. A comparison with the study by C. Nwangele *et al.* (2021) showed that the inclusion of social and environmental indicators in financial models provides a more comprehensive assessment of project sustainability. A similar conclusion was confirmed by the research data, where the integration of non-financial factors into the controlling system made it possible to increase the objectivity of decisions. The results were compared with those of C. Karnavas (2024), proposing coverage of uncertainty through risk-adjusted discount rates. This approach was confirmed by research: the use of industry-specific WACC values reduced systematic NPV distortions and increased the consistency of indicators with market conditions. Research by J. Lin (2023) identified differences in the applicability of NPV and IRR methods for projects with atypical cash flow structures. A comparison with the results of the analysis in Kyrgyzstan showed a similar trend: in long-term infrastructure projects, the internal rate of return should be supplemented with net present value calculations for more reliable conclusions. The conclusions of K. Abdullayev *et al.* (2024) and H. Liang (2025) on the comparison of three key evaluation methods confirmed that the return-on-investment period indicator has limited value for strategic investments. This was consistent with the findings that the payback period criterion was effective only for small projects but did not reflect their long-term profitability.

The results obtained were also consistent with those of H. Dai *et al.* (2022), demonstrating that discrepancies between NPV, IRR, and PP are related to the choice of discount rate and price assumptions. A similar effect was observed in the Kyrgyz examples, where rising inflation and currency risks changed the cash flow structure and reduced the real return on investment. Following the conclusions of L. Vilani *et al.* (2024), the sustainability of agricultural projects depends on coverage of external factors and climate risks. The results of the study confirmed that the instability of the agricultural sector in Kyrgyzstan requires the adaptation of financial models to consider seasonal fluctuations and subsidies. A comparison with J. Cohen (2024) showed that the use of a fixed discount rate of 3% does not reflect the real cost of capital. The study found that the use of a flexible discount range of 3.5 to 8% increases the accuracy of the assessment of socially significant infrastructure projects. Arguments of R. Baerenbold (2023) on "reference class forecasting" confirmed the advisability of calibrating models based on similar completed projects. A similar principle was applied when constructing Kyrgyzstan scenarios, which reduced the probability of systematic error in forecasting timelines and costs. In addition, the results were compared with those of J. Eliasson (2025), estimating that cost overruns and delays in infrastructure projects are statistically stable. These results confirmed the need to include penalty coefficients in the controlling model, which increased the reliability of calculations and correlated with international practices for assessing investment risks.

Additional comparative analysis confirmed that improving the accuracy of investment forecasting in Kyrgyzstan is possible by integrating artificial intelligence models and scenario analysis. The results obtained are consistent with the conclusions of S. Chen *et al.* (2024),

determining that combining the reference class forecasting method with a radial basis function neural network provides a more robust assessment of investment viability and minimises systematic errors. A similar effect was observed in the study: the use of trainable models made it possible to improve the reliability of forecasts in the context of multi-parameter uncertainty. The results correlate with the study by A. Akinsulire *et al.* (2024), demonstrating that strategic planning increases the viability of investment projects in the housing sector, provided that financial analysis and socio-economic factors are integrated. In the context of Kyrgyzstan, similar patterns were observed in construction projects, where the implementation of long-term sustainable housing programmes required the coordination of investment and social priorities. These results confirm the conclusions of S. Shao & A. Sorourkhah (2024), proposing combining robustness analysis with the net present value model. A comparison with national indicators showed that integrating robustness analysis with classical NPV models reduced the dispersion of expected results and increased the reliability of long-term forecasts. J. Zhan & A. Santos-Paulino (2021) demonstrated that mobilising investment for sustainable development is only possible through a combination of public and private capital. A comparison with the conditions in Kyrgyzstan showed that investment efficiency increased when mixed forms of financing were used, including grants and concessional loans from international organisations, which ensured resilience to macroeconomic risks. The results were also consistent with the study by F. Mahmood *et al.* (2024), which confirmed that behavioural biases among investors reduce the rationality of investment decisions. A similar effect was identified in Kyrgyzstan, where insufficient financial literacy and inflated expectations of returns led to errors in determining the discount rate and return on investment period.

A comparison with J. Huang *et al.* (2022) demonstrated that the application of NPV and IRR methods requires accurate identification of cash flow and coordination of time parameters. This conclusion coincided with the results of an analysis of national investment projects, where deviations in calculations on the time scale led to significant discrepancies in the final performance indicators. In turn, C. Magni & J. Martin (2025) highlighted the duality of reinvestment assumptions in NPV and IRR methods, which explains the discrepancies between these criteria. The results of the study confirmed that the use of adjusted models that consider the real possibilities of reinvestment increases the reliability of estimates and reduces the risk of project overvaluation. A comparison with A. Singh & V. Chatterjee (2025) demonstrated that the combined use of NPV and IRR provides the most balanced decision-making in capital budgeting. A similar conclusion was confirmed by the analysis of Kyrgyzstan examples, where the combined use of both criteria eliminated the distortions that arose when IRR was used alone. The results also correlate with M. Bara (2025), who demonstrated that an improved Monte Carlo simulation combining cost analysis and schedule analysis significantly increases the reliability of investment risk assessment. Applying this model in the Kyrgyz context reduced the range of uncertainty and assessed the impact of time shifts on the overall effectiveness of projects. Lastly, the results are consistent with K. Arjunan (2022), proposing a new method for calculating NPV and IRR based on a capital depreciation schedule, which simplifies the processing of financial data. A similar approach has proven effective in processing statistics on investment projects in Kyrgyzstan, ensuring transparency and automation of calculation procedures.

Thus, in comparison with international and regional approaches, the results obtained show that Kyrgyzstan's investment control system is in the process of transitioning from a formal accounting model to an integrated analytical structure based on the principles of risk-adaptive management and quantitative verification of performance parameters. The analysis confirmed that the accuracy of investment decision-making can be improved using probabilistic methods, uncertainty modelling and dynamic discounting, which reflects the real cost of capital in a volatile economy. The study determined that the integration of risk-adjusted models, flexible discount rates and post-audit can minimise systematic errors and increase the sustainability of investment projects. In a broader context, the research results indicate that the effectiveness of Kyrgyzstan's investment policy directly depends on the ability of the national controlling system to combine financial modelling, risk analysis and strategic planning into a single digital platform. Such a transformation creates the conditions for a transition from reactive control to proactive capital investment management, increases transparency, reliability and consistency of investment decisions with the country's sustainable economic development goals.

CONCLUSIONS

The study provided a comprehensive assessment of investment activity dynamics, efficiency and sustainability of capital investments in the economy of the Kyrgyz Republic for 2019-2024. During this period, the total volume of investment in fixed capital increased by approximately 14%, with the highest average annual growth rates recorded in the energy (+5.8%) and infrastructure (+4.4%) sectors, while the agricultural and industrial sectors showed more moderate positive dynamics. The structure of investments shifted towards projects with high capital intensity and long payback periods, which correlates with the priorities of the state strategy for industrial and innovative development and the guidelines of the Ministry of Economy and Commerce. An analysis of performance indicators using DCF, NPV and IRR methods showed that energy projects provide the highest sustainability, NPV = KGS + 8.7 million, IRR = 14.5%, payback period of about 7 years, while agricultural programmes are highly sensitive to currency and inflation risks. Solar generation projects demonstrated the shortest payback period (≈5 years) with long-term profitability, making them promising for small and medium-sized businesses. Scenario and sensitivity analysis showed that a 1

percentage point change in the discount rate reduces NPV by an average of 4-7% depending on the sector: in energy by 4-5%, in agriculture by 6-7%, and in infrastructure projects by 4-5%, with energy remaining the least sensitive to fluctuations in macroeconomic parameters. The regression model $E = f(I, r, \sigma)$ showed that the main contribution to integral efficiency (E) is made by the volume of investment ($\beta = 0.63$), while the growth in the cost of capital (r) and the level of risk (σ) reduces E by 0.27 and 0.18, respectively.

A comparison of the calculated results with national strategic objectives revealed that the project indicators were generally consistent with government policy objectives; however, practical implementation is complicated by typical controlling errors, such as an incorrect discount rate, underestimation of risks, and lack of post-audit, which leads to a 5-10% distortion of NPV and the accumulation of systemic inaccuracies. A summary interpretation of the effectiveness factors showed that financial parameters (r, σ, I) have a decisive impact on investment stability, while macroeconomic and institutional conditions shape the environment of predictability. Overall, the results confirm the need to transition to an analytical type of investment controlling based on quantitative verification, scenario modelling, and risk module integration. To improve the accuracy of forecasts and align investment policy with national strategic goals, it is recommended to implement dynamic DCF models, use industry WACC rates, conduct independent expert reviews of source data, and develop digital monitoring platforms. This approach will minimise systemic distortions, increase the transparency and adaptability of the investment process, and ensure the sustainable development of the Kyrgyz Republic's economy based on a balance between the scale of investment, the cost of capital, and risk management.

The study is limited using aggregated statistical data, which renders micro-level analysis of investment projects considering management decisions impossible, while the time lag in macroeconomic indicators and the lack of a unified post-audit database reduce the accuracy of forecasts and the reliability of NPV and IRR calculations. Promising areas for development include the development of multi-level econometric models, the integration of artificial intelligence technologies into investment controlling, and the creation of a national digital monitoring platform to improve the accuracy, transparency, and comparability of investment decisions.

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Оцінка інвестиційних проектів у Киргизстані: сучасні методи та помилки у практиці контролінгу

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Анотація. Мета дослідження полягала у вдосконаленні методичних підходів до оцінки ефективності інвестиційних проектів у Киргизькій Республіці. Робота заснована на застосуванні порівняльно-економічного, структурно-динамічного, кореляційно-регресійного та сценарного аналізу, а також методів контент-аналізу нормативних актів та фінансового моделювання, що включає розрахунки дисконтованих грошових потоків, чистої наведеної вартості, внутрішньої норми прибутковості та терміну окупності. Результати показали, що у 2024 році загальний обсяг інвестицій в основний капітал збільшився на 14 % порівняно з 2019 роком, що свідчило про поступове відновлення інвестиційного циклу та перехід до більш активної фази капітальних вкладень. Найбільші темпи зростання фіксувалися в енергетичному (+5,8 %) та інфраструктурному (+4,4 %) секторах, де спостерігалося стале розширення проектного портфеля та посилення ролі довгострокових вкладень. Проведений сценарний аналіз підтвердив високу стабільність енергетичних проектів при коливаннях ключових макроекономічних показників, тоді як аграрні та інфраструктурні ініціативи демонстрували підвищену чутливість до інфляційних та валютних ризиків, що потребувало застосування ризик-скоригованих методів оцінки. Паралельно структура джерел фінансування змістилася у бік приватного та змішаного капіталу, відображаючи зміцнення механізмів державно-приватного партнерства та прискорену цифровізацію інвестиційного процесу, включаючи використання онлайн-платформ для реєстрації та моніторингу проектів. Економетрична модель $E = f(I, r, \sigma)$ показала, що збільшення інвестицій на 1 % підвищило інтегральну ефективність на 0,63 одиниці, тоді як зростання ставки капіталу на 1 п.п. знизило її на 0,27 одиниці, що підкреслило значущість вартості капіталу та структури фінансування для стійкості інвестиційних рішень. Отримані результати можуть використовуватись державними органами, фінансово-аналітичними підрозділами та консалтинговими структурами для вдосконалення процесів оцінки, планування та контролю інвестиційних проектів

Ключові слова: фінансове моделювання; дисконтування; чиста наведена вартість; внутрішня норма доходності; інтегральна ефективність; термін окупності