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METHODS FOR EVALUATING THE ECONOMIC EFFICIENCY OF INVESTMENT PROJECTS AND MODERN APPROACHES TO THEIR APPLICATION



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Abstract: This article examines the theoretical and methodological foundations of traditional and modern methods used to evaluate the economic efficiency of investment projects. The economic substance, calculation mechanisms, advantages, and limitations of Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI), Payback Period (PP), Discounted Payback Period (DPP), Accounting Rate of Return (ARR), and Modified Internal Rate of Return (MIRR) are systematized.

The study substantiates that evaluating investment projects on the basis of a single financial criterion is insufficient in the contemporary economic environment. It demonstrates the need to jointly consider the cost of capital, inflation, risk and uncertainty, cash-flow volatility, managerial flexibility, and strategic factors when assessing project efficiency. A methodological approach is developed in which NPV is used as the core criterion and is integrated with IRR, MIRR, PI, DPP, sensitivity analysis, scenario analysis, Monte Carlo simulation, and real-options analysis.

Keywords: investment project, economic efficiency, NPV, IRR, PI, PP, DPP, MIRR, discount rate, WACC, risk, sensitivity analysis, Monte Carlo simulation, real options.

INTRODUCTION

Investment activity is one of the key drivers of a company's long-term economic development, modernization of production capacity, adoption of new technologies, reduction of production costs, and enhancement of competitiveness. At the same time, limited investment resources require companies to select the most economically efficient option from among available alternative projects.

The selection of an investment project requires consideration of future cash flows, initial capital expenditures, the cost of capital, project duration, and the level of risk. Therefore, the efficiency of an investment project should be assessed not merely by the amount of accounting profit, but by a set of comprehensive criteria that incorporate the time value of money.

In investment appraisal practice, NPV, IRR, PI, PP, and DPP are among the most widely used indicators. However, these methods have different economic interpretations and, in some cases, may produce conflicting results for the same project.

For example, NPV shows the absolute economic value that a project adds to the company, whereas IRR reflects the project's relative rate of return on invested capital. PI measures the present value generated per unit of investment, while PP and DPP characterize the speed at which the invested capital is recovered.

Accordingly, investment decisions should be justified with due consideration of the economic substance and methodological limitations of each appraisal method.

Research objective. The objective of the study is to systematize the methods used to evaluate the economic efficiency of investment projects, identify their advantages and limitations, and develop an improved methodological approach for their integrated application under contemporary economic conditions.

LITERATURE REVIEW

The evaluation of investment projects is a major area of research in corporate finance, capital budgeting, and investment analysis.

R. Brealey, S. Myers, and F. Allen regard the NPV criterion as the method that most fully corresponds to the principle of maximizing firm value when making investment decisions.

A. Damodaran emphasizes that the proper determination of the discount rate is one of the most important factors in estimating project value. Under this approach, the risk level of a project's cash flows should be consistent with the discount rate applied to those cash flows.

The treatment of uncertainty in investment decisions has been extensively developed in the work of A. Dixit and R. Pindyck. These authors demonstrate that an investment decision depends not only on expected future cash flows, but also on management's ability to delay, expand, contract, or abandon an investment project.

L. Trigeorgis further developed the real-options methodology and showed that managerial flexibility embedded in an investment project can create additional economic value.

Taken together, these studies indicate that investment efficiency should be assessed not only through traditional financial indicators, but also within an integrated framework that incorporates risk and managerial flexibility.

RESEARCH METHODOLOGY

The study employs a systems approach, comparative analysis, economic and mathematical modeling, discounted cash-flow analysis, sensitivity analysis, and scenario analysis.

Investment appraisal methods are divided into two main groups:

1. Static methods that do not rely on discounting:

- PP — Payback Period;
- ARR — Accounting Rate of Return.

2. Dynamic methods that account for the time value of money:

- NPV — Net Present Value;
- IRR — Internal Rate of Return;
- PI — Profitability Index;

- DPP — Discounted Payback Period;
- MIRR — Modified Internal Rate of Return.

In addition, the following methods of modern investment analysis were examined:

- sensitivity analysis;
- scenario analysis;
- Monte Carlo simulation;
- real-options analysis;
- multi-criteria assessment.

RESULTS AND DISCUSSION

1. Net Present Value (NPV) Method

NPV represents the difference between the present value of the net cash flows expected from an investment project and the amount of the initial investment.

NPV is calculated as follows:

$$NPV = -I_0 + \sum CF_t / (1 + r)^t$$

where:

I_0 — initial investment;

CF_t — net cash flow in period t ;

r — discount rate;

t — time period;

n — project duration.

Decision rule:

$NPV > 0$ — the project is accepted;

$NPV = 0$ — the project provides the minimum required return expected by the investor;

$NPV < 0$ — the project is rejected.

The main advantage of NPV is that it directly expresses, in monetary terms, the amount by which the project is expected to increase the value of the company.

Its main limitation is the high sensitivity of the result to the selected discount rate and to the accuracy of projected cash flows.

2. Internal Rate of Return (IRR)

IRR is the discount rate at which the NPV of an investment project equals zero:

$$0 = -I_0 + \sum CF_t / (1 + IRR)^t$$

Decision rule:

$IRR > WACC \rightarrow$ the project is accepted;

$IRR < WACC \rightarrow$ the project is rejected.

For example, if a project has an IRR of 24% while the company's cost of capital is 16%, the project may be considered financially acceptable.

The advantage of IRR is that it is expressed as a percentage and is therefore intuitive for investors.

However, projects whose cash flows change sign more than once may produce multiple IRRs.

In addition, when mutually exclusive projects differ in scale, IRR and NPV may lead to conflicting decisions. In such cases, priority should be given to the NPV criterion.

3. Profitability Index (PI)

The Profitability Index is calculated as the ratio of the present value of project cash flows to the initial investment:

$$PI = PV(CF) / I_0$$

Decision rule:

PI > 1 — the project is efficient;

PI = 1 — the project is at the break-even threshold;

PI < 1 — the project is inefficient.

PI is particularly useful for ranking projects when investment resources are limited.

For example: Project A: PI = 1.35; Project B: PI = 1.22; Project C: PI = 1.10. If capital is constrained, Project A may be given priority.

However, PI does not show the absolute amount of economic value created by a project.

4. Payback Period (PP)

PP indicates the period required to recover the funds invested in a project.

If annual cash flows are equal, PP is calculated as:

$$PP = I_0 / CF$$

Example: initial investment — UZS 1,000 million; annual cash flow — UZS 250 million. Therefore: $PP = 1,000 / 250 = 4$ years.

The advantage of the PP method is its simplicity and ease of interpretation. Its principal limitations are that it does not account for the time value of money, ignores cash flows received after the payback period, and does not reflect the project's overall profitability.

For this reason, PP should be used as a supplementary rather than a primary decision criterion.

5. Discounted Payback Period (DPP)

Unlike the conventional payback period, DPP accounts for the time value of money.

The discounted payback period is the time at which the following condition is satisfied:

$$\sum CF_t / (1 + r)^t \geq I_0$$

As a rule, $DPP > PP$ because the present value of future cash flows is lower than their nominal value.

DPP provides a more accurate measure of investment recovery risk than PP.

6. Accounting Rate of Return (ARR)

ARR is calculated as follows:

$$ARR = \text{Average annual accounting profit} / \text{Average investment} \times 100\%$$

Because this indicator is based on accounting data, it is relatively simple to calculate in practice.

However, ARR is based on accounting profit rather than cash flows, does not account for the time value of money, and does not fully reflect economic value creation.

Therefore, ARR is generally regarded as a secondary indicator in modern investment analysis.

7. Modified Internal Rate of Return (MIRR)

MIRR is used to address certain methodological shortcomings of IRR.

In general form:

$$\text{MIRR} = (\text{FV of positive cash flows} / \text{PV of negative cash flows})^{(1/n)} - 1$$

MIRR assumes that intermediate positive cash flows are reinvested not at the IRR itself, but at a realistic reinvestment rate.

Therefore, in many practical situations, MIRR provides a more realistic measure of project profitability than IRR.

Table 1.

COMPARATIVE ANALYSIS OF THE MAIN INVESTMENT APPRAISAL METHODS

Indicator	Time Value of Money	Direct Consideration of Risk	Main Advantage	Main Limitation
NPV	Yes	Partly	Shows the increase in firm value	Depends on the discount rate
IRR	Yes	Partly	Expressed as a percentage	Multiple IRRs may arise
PI	Yes	Partly	Useful under capital constraints	Does not show absolute value created
PP	No	No	Simple and easy to understand	Ignores the time value of money
DPP	Yes	No	Indicates capital recovery risk	Ignores cash flows after payback
ARR	No	No	Easy to calculate	Based on accounting profit
MIRR	Yes	Partly	Reduces certain IRR limitations	Relatively more complex to calculate

Source: systematized by the author.

The table demonstrates that no single method can fully satisfy all investment appraisal requirements at the same time.

THE IMPORTANCE OF DETERMINING THE DISCOUNT RATE

One of the most important issues in investment analysis is the determination of an appropriate discount rate.

For corporate projects, the Weighted Average Cost of Capital (WACC) may be used:

$$WACC = E/(D + E) \times K_e + D/(D + E) \times K_d \times (1 - T)$$

where:

E — equity capital;

D — debt capital;

K_e — required return on equity;

K_d — cost of debt;

T — corporate income tax rate.

If the discount rate is set unjustifiably high, promising long-term projects may be rejected. Conversely, if the rate is set too low relative to the project's risk level, economically inefficient projects may appear to have a positive NPV.

Accordingly, aligning the discount rate with project risk is one of the key methodological conditions of sound investment analysis.

MODERN APPROACHES TO INVESTMENT PROJECT APPRAISAL

1. Sensitivity Analysis

Sensitivity analysis determines the extent to which project outcomes depend on changes in key variables.

For example, the following changes may be tested: product price –10%; sales volume –15%; raw-material costs +20%; investment expenditures +15%; and the discount rate +3 percentage points.

NPV is recalculated for each change. The sensitivity coefficient may be expressed as:

$$S_i = (\Delta NPV / NPV) / (\Delta X_i / X_i)$$

A larger absolute value of the coefficient indicates that the project is more sensitive to the corresponding factor.

2. Scenario Analysis

At least three scenarios should be developed for an investment project: an optimistic scenario, a base-case scenario, and a pessimistic scenario.

Expected NPV may be determined as follows:

$$E(NPV) = \sum P_i \times NPV_i$$

where P_i is the probability of scenario i , and NPV_i is the NPV under the corresponding scenario.

This approach supports more reliable decision-making than reliance on a single forecast.

3. Monte Carlo Simulation

Monte Carlo simulation assigns probability distributions to the key parameters of an investment project and calculates project outcomes using thousands of randomly generated combinations.

For example, sales volume, product price, raw-material costs, exchange rates, interest rates, CAPEX, and OPEX may be modeled as stochastic variables.

As a result, the analysis may estimate the mean NPV, the variance of NPV, the probability that $NPV < 0$, and the project's Value-at-Risk indicator.

This makes it possible to evaluate not only the project's expected return, but also the distribution of its risk.

4. Real-Options Approach

Traditional NPV analysis evaluates a project largely as a passive investment commitment.

In practice, however, management may delay the investment, expand production, reduce the scale of the project, replace technology, or abandon the project.

Therefore, the expanded project value can be expressed as:

$$ENPV = NPV + ROV$$

where ROV is the Real Option Value.

Thus, even if conventional NPV is negative, some projects with substantial strategic flexibility may become economically acceptable after the value of real options is incorporated.

PROPOSED MODERN APPRAISAL METHODOLOGY

Based on the results of the study, it is proposed that the economic efficiency of investment projects be evaluated through a three-stage system.

Stage 1 — Basic financial appraisal

$$NPV + IRR + MIRR + PI + PP + DPP.$$

At this stage, the project's economic profitability and the speed of capital recovery are assessed.

Stage 2 — Risk-adjusted appraisal

Sensitivity analysis + scenario analysis + Monte Carlo simulation.

This stage evaluates the robustness of project outcomes under conditions of uncertainty.

Stage 3 — Strategic appraisal

Real options + strategic fit + technological efficiency + environmental and social impact.

As a result, the investment decision follows the sequence:

Financial efficiency → Risk resilience → Strategic value

AUTHOR'S METHODOLOGICAL APPROACH

Table 2.

For investment project evaluation, the following comprehensive investment decision matrix is proposed:

NPV	IRR and MIRR	Risk Level	Strategic Value	Decision
Positive	Above WACC	Low	High	Accept
Positive	Above WACC	High	High	Accept subject to risk mitigation

Positive	Close to WACC	High	Low	Reconsider
Negative	Below WACC	High	Low	Reject
Negative	Marginal	Medium	Very high	Reassess using real-options analysis

Source: developed by the author.

The distinctive feature of this approach is that it evaluates an investment project not on the basis of a single number, but as an interconnected system of profitability, liquidity, risk, and strategic value.

PROPOSED ALGORITHM FOR APPLYING INVESTMENT APPRAISAL METHODS

Investment project → cash-flow forecasting → determination of CAPEX and OPEX → calculation of WACC → NPV → IRR → MIRR → PI → PP → DPP → sensitivity analysis → scenario analysis → Monte Carlo analysis → real-options valuation → comparison of alternative projects → investment decision → post-investment monitoring.

This algorithm provides for monitoring project efficiency both before the investment decision is made and after the project has been implemented.

SCIENTIFIC NOVELTY

The study produces the following elements of scientific novelty:

First, investment project appraisal methods are systematized according to the extent to which they account for the time value of money, their decision rules, sensitivity to risk, and scope of application.

Second, NPV is substantiated as the basic value-creation criterion, and a methodological sequence is proposed for its joint application with IRR, MIRR, PI, and DPP.

Third, a three-stage investment appraisal system is developed that integrates traditional financial evaluation with sensitivity analysis, scenario analysis, Monte Carlo simulation, and real-options analysis.

Fourth, when different appraisal indicators produce conflicting results, NPV is substantiated as the primary criterion for increasing firm value, MIRR as a supplementary criterion for refining relative profitability, and DPP as an additional criterion for risk and liquidity.

Fifth, a comprehensive investment decision matrix is proposed that enables investment decisions to be made jointly on the basis of profitability, risk, and strategic value.

CONCLUSION

Reliable evaluation of the economic efficiency of investment projects is an important prerequisite for the optimal allocation of corporate capital.

The findings show that NPV, IRR, PI, PP, and DPP each reflect a different economic dimension of an investment project.

Because NPV measures the absolute economic value added to the company, it is appropriate to regard it as the primary criterion for investment decision-making.

Although IRR is convenient for expressing project profitability as a percentage, it may create methodological problems in projects with non-conventional cash flows and in comparisons of mutually exclusive projects.

MIRR addresses some of these limitations and allows the relative efficiency of investment to be assessed more realistically.

PI is useful for ranking projects when capital is constrained, while PP and DPP are useful for evaluating the speed of capital recovery and liquidity risk.

Under contemporary economic conditions, however, the final appraisal of an investment project should not be limited to these indicators alone. Sensitivity, scenario, and Monte Carlo analyses should be used to incorporate risk and uncertainty, while real-options analysis should be used to assess managerial flexibility.

Accordingly, the following approach is recommended for investment project appraisal in enterprises:

NPV + IRR + MIRR + PI + DPP → Risk analysis → Real options → Strategic appraisal → Final investment decision.

This methodology can improve the economic justification of investment decisions, reduce the risk of selecting inefficient investments, and increase the effectiveness of corporate capital utilization.

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