NPV and IRR's Comparative Analysis in Enterprises Investment Decision Making

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Abstract. In the economic evaluation of engineering projects, the net present value and internal rate of return (IRR) are generally used to measure the economic benefits of the project. However, the analysis of the two indices is sometimes self-contradictory. This article points out that the net present value method is more scientific and reasonable than the internal rate of return through specific case analysis of the causes of this problem. Especially in the feasibility analysis of mutually exclusive scheme under certain circumstances, when the net present value index and the internal rate of return index conclusion contradict, it is better to choose the net present value method as the preferred decision method.

Keywords: Investment · Net present value · Internal rate of return

1 Introduction

1.1 Research Background and Motivation

With the development of science and technology and the change of social environment, the evaluation methods and evaluation skills have been greatly developed in the feasibility evaluation of investment projects, and enterprises have formed an interdisciplinary research field. There are many methods for economic evaluation of projects, most of which are still in the theoretical research stage. Currently, there are six or seven common methods, which are mainly divided into two categories: dynamic evaluation indexes considering net present value (NPV), profit index (PI) and internal rate of return (IRR); the other is static evaluation method not considering the time value of capital, such as payback period and return rate. Different evaluation methods investigate the feasibility of the project scheme from different angles, so in the evaluation of the scheme, a variety of evaluation methods should be selected for comprehensive evaluation, in order to obtain the most favorable scheme for the project investment. However, when using these evaluation indicators and methods for project analysis and decision-making, contradictory results will sometimes occur when evaluating the same project with different economic indicators. This paper mainly uses specific cases to explain the project investment decision, under certain conditions, when the analysis results of net present value and internal rate of return have opposite conclusions, which evaluation index will be more scientific and more favorable to the investment and development of enterprises.

V. Gaikar et al. (Eds.): FMET 2022, AEBMR 227, pp. 157–165, 2023.
https://doi.org/10.2991/978-94-6463-054-1_18

1.2 Literature Review

Net present value is the present value of a project's cash flows over the life of the project [1, 2]. Net present value is an internal assessment applied in financial and financial terms to determine the security of an investment, to evaluate a new business, to assess the value of a business, or to seek ways to reduce costs. IRR or internal rate of return is a measure of capital budgeting [3–5]. This is used to evaluate potential corporate profits [6, 7]. This is a discount rate that turns pure cash flow to zero [8, 9]. In the net present value method, the present value is calculated by discounting the future cash flows of the project at a predetermined interest rate (i.e., the interest rate to maturity) [10, 11]. However, in the IRR method, the cash flow is appropriately discounted using a trial and error method equal to the present value. The value now equals the investment made [12]. If IRR is chosen, the discount rate is generally not determined in advance, as is the case with NPV. Both research methods show comparative results for independent investment advice in relation to "agree or not" [13]. In this case, the two proposals are not competing with each other, and they will decide whether to accept or not according to the minimum market rate of return. Traditional schemes tend to include capital outflows in the initial stages, followed by large capital inflows [14]. When it came time to decide, there were similarities. For NPV, advice is generally accepted, provided that the advice is net positive [15]. Conversely, if the final IRR is higher than the current maturity ratio, the IRR will generally be used. A project with a positive net present value also has a higher intrinsic rate of return than the underlying value [16]. For those mutually exclusive programs, choosing one of them will hinder the acceptance of the other programs, and NPV and IRR tend to come to the opposite conclusion [17]. NPV can make project managers or engineers accept a project proposal, and at the same time, the internal rate of return will show another better solution [18, 19]. The contradiction is rooted in many problems. Net present value and internal rate of return are both analytical tools. However, they do not always align with our needs, especially when there are two options with the same advantages. That said, most project managers tend to use NPV because they feel it is best to evaluate a mutually exclusive project.

1.3 Research Contents and Framework

In order to scientifically evaluate the feasibility of investment projects, this paper conducts a comparative analysis of specific cases based on the existing NPV and IRR two popular evaluation methods, trying to explore the analysis when enterprises make project investment decisions. When the results come to the opposite conclusion, which evaluation index is more scientific and more conducive to the investment and development of the project. The structure of the paper is as follows: The first part is the introduction, including the research background, research motivation and literature review; the second part is the method, which explains the calculation methods and principles of NPV and IRR, and the third part is the result analysis based on specific cases; and finally is conclusion.

2 Methodology

2.1 Calculation Formulas for NPV and IRR

The discounted value of cash flow, implied rate of return, profit index, etc. are important indicators to measure cash flow. The net cash flow after the investment project is put into use shall be converted into the present value according to the company's capital cost rate or the company's specified rate of return. The remainder after deducting the initial investment is called the net present value. The formula is:

$$NPV = [\frac{NCF_1}{(1+K)^1} + \frac{NCF_2}{(1+K)^2} + \cdots + \frac{NCF_n}{(1+K)^n}] - C \tag{1}$$

The main principle of the NPV method is to use a positive NPV rather than a negative one when there is only one alternative. Among multiple alternative mutually exclusive projects, the largest positive NPV should be optimal. The net present value method is a method that comprehensively considers the time value of funds, which can better reflect the net income of different investment portfolios, so it is a better choice. The downside is that the actual return of each investment option cannot be disclosed. The principle of internal remuneration can remedy this deficiency.

However, the internal rate of return is actually an actual return on investment. At present, there are more and more methods for enterprises to evaluate investment projects. The internal compensation ratio is expressed by the following formula:

$$\frac{NCF_1}{(1+r)^1} + \frac{NCF_2}{(1+r)^2} + \cdots + \frac{NCF_n}{(1+r)^n} - C = 0 \tag{2}$$

Under the IRR method, if only one option is available, the IRR obtained by this method is much higher than the cost of capital of the business or the required rate of return. Otherwise, it will be eliminated. In a variety of portfolios, choose an investment with a higher or higher ROI than the cost of capital. Using the internal rate of return method to calculate the time value of capital can truly reflect the actual rate of return of investment projects, and has strong operability. However, this method is relatively cumbersome to calculate, especially in investment projects with different NCFs each year, which often require multiple calculations.

2.2 Comparative Theory of NPV and IRR

In a project, if the investment scale of one project is larger than that of another project, the internal rate of return of the project will be higher and the net present value will be lower. For example, assume that project A has an embedded return rate of 30% and A NET present value of $1 million, while Project B has an embedded return rate of 20% and A net present value of $2 million. The choice between these two mutually exclusive items is really a choice between more wealth and higher IRR, and it is clear that the decision maker will choose wealth. Therefore, when the investment scale is different and the capital scale meets the investment demand, the net present value decision criterion has more advantages than the internal rate of return method.

The cash flow pattern of unconventional projects differs from that of conventional projects in some respects, such as cash outflows not occurring at the beginning of the period, or multiple cash outflows at the beginning and subsequent periods. Unconventional projects may lead to a discrepancy between the NPV decision rules and the IRR decision rules. A more complicated situation is that when future cash flows are positive or negative from year to year, there will be multiple internal rate of return problems.

3 Empirical Results Analysis

3.1 Varying Scale of Investment

Assume that Company A has two projects D and E, and their initial investment is inconsistent, as shown in Table 1.

The net present value of the two projects at different discount rates is calculated below.

Now plot the net present value calculated at different discount rates in Table 2 into Fig. 1.

Table 1. Relevant data tables for project D and project E. Unit: RMB

Indicators	Time	Project D	Project E
The initial investment	0	110 000	10 000
Operating cash flow	1	50 000	5 050
	2	50 000	5 050
	3	50 000	5 050
NPV		6 100	1 726
IRR (%)		17.28	24.03
PI		1.06	1.17
Capital cost ratio (%)		14	14

Table 2. Net present value of two projects under different discount rates. Unit: RMB

The discount rate (%)	NPVD	NPVE
0	40 000	5 150
5	26 150	3 751
10	14 350	2 559
15	4 150	1 529
20	−4 700	635
25	−12 400	−142

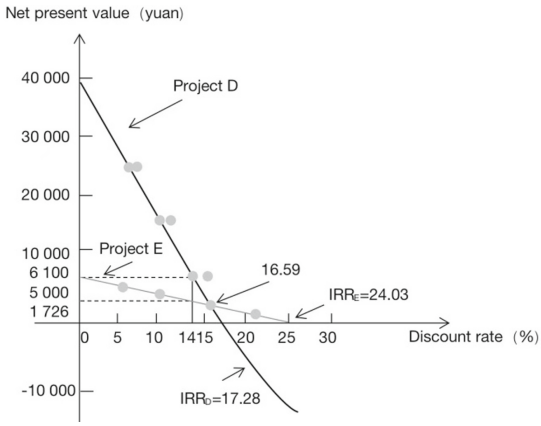

Fig. 1. Net present value curves at different discount rates

As shown in Table 2, in accordance with the IRR approach, item D should be rejected in favor of item E. If the present value method is used, item D shall prevail, and item E shall be rejected. The source of the above difference is that the IRR method assumes that if in the first two stages of Project D, there will be a rate of return equivalent to 17.28% (in RMB for the first and second years). However, if the cash flow of the first and second years of plan E (5,050 yuan) is invested in plan E, a return of 24.03% can be obtained. In contrast, the NPV method assumes that the capital flows from the first two stages will be reinvested with a similar return, a cost of capital ratio of 14%. As can be seen from Fig. 1, the NPV curves of these two projects cross at 16.59%. With a cost of capital ratio less than 16.59%, D's NPV is higher than E, and D is better than E. If the cost of capital ratio is greater than 16.59%, it can be seen from the chart that the present value of E is greater than D, that is, E is greater than D. Therefore, when the cost of capital ratio is 14%, whether there are capital constraints, the investment scale of project D is larger, and the net present value is higher; it can create more wealth for the company, which is a better plan. When the capital expense ratio exceeds 16.59%, the return on investment and the net present value of the E project are better than those of the D class. In other words, NPV is always right, and IRR can sometimes lead to wrong decisions. Therefore, under the condition of not being constrained by funds, the net present value method is a better choice.

3.2 Unconventional Projects

Company B initially invests \$16,000 in a project with \$100,000 in cash flow in the first year; \$100,000 in cash flow in the second year and \$200,000 in cash flow. So, over the past two years, our net cash flow has been positive and negative, see Table 3. This is an unconventional investment.

$$\mathrm{NPV} = -1.6 + \frac{10}{(1+\mathrm{IRR})^1} - \frac{10}{(1+\mathrm{IRR})^2} = 0 \tag{3}$$

Table 3. Cash flow of company B's investment projects. Unit: RMB

Net cash flow		
t_0	t_1	t_2
−1.6	10	−10

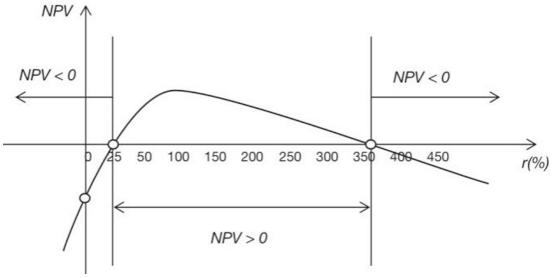

Fig. 2. Multiple investment projects with embedded rates of return

According to the above formula, the following results can be obtained: $IRR_1 = 25\%$, $IRR_2 = 400\%$.

That is, the rate of return for this project is 25%, 400%, which is the ratio of the two capital costs, making the net present value 0. The problem is shown in Fig. 2: During the discount rate period of 0 to 25%, the NPV turns from negative to positive; when the discount rate exceeds 400%, the NPV turns from positive to negative again.

In this context, the company's internal rate of return judgment criterion is meaningless. If the internal rate of return is used as the judging criterion, it will cause serious errors. Generally, in an investment project, if there are multiple internal rates of return, its internal rate of return cannot exceed the number of changes in the sign of cash flows at various stages of the project. Since the expected cash flow changes only once in a cycle, that is, one cash flow is negative and the other is several positive cash flows. At this time, if the net present value method is used, the above problem that there are multiple net present value will not arise. If the capital ratio is 10% and the NFV is $10,700, the investment proposal will be rejected. At a capital expense ratio of 25% to 400%, the NPV is positive.

3.3 Results

In order to explore the effective investment decision-making of enterprises, this paper has carried out theoretical and empirical research on it. In theory, the relationship between mutually exclusive projects and non-traditional projects of different scales is analyzed according to previous research results. The study found that when the investment scale of a certain project is large, the use of the net present value method is more advantageous than the implied income method; in addition, since the IRR method will generate multiple IRRs, the NPV method is used in the investment of non-traditional projects. It also has

advantages over the IRR method in decision making; the non-direct cost method does not have the above problems. Through the above analysis, it can be found that the project feasibility analysis and evaluation is a very complex system. The calculation results of the net present value and the internal rate of return of the project evaluation of each independent project are consistent. In the two cases, the correlation results between the net present value and the internal rate of return were used, and the net present value method was used for comparison, and it was found that the net present value method was significantly better than the internal rate of return method. Using the present value method is the best option.

4 Conclusion

Of these assessments, the most common are net present value and internal rate of return. Although these two evaluation metrics are able to make the same investment decisions for independent formal investment projects with cash flow, they are ranked differently. For those investment projects that need to be classified and screened and mutually exclusive, the NPV evaluation index has its advantages. First, the NPV evaluation index reflects the absolute return of an investment project, while the IRR evaluation index does not. General investors care not only about the price of bidding, but also the level of profit. Second, the net present value evaluation indicator assumes that the investment project is based on the cost of capital, and the IRR evaluation is based on the rate of return of the project itself, making it more acceptable; since these projects are not relevant to current investment decisions, they are always acceptable. The investment value of the current project cannot be considered beyond the period of the cost of capital. Third, investment assumptions are important. When it is assumed that the cost of capital will change over the next few years, the IRR evaluation metric is no longer valid. The reason is that a single rate of return is no longer valid compared to shorter-term rates. Fourth, NPV is not only better than IRR in theory, but also has significant technical advantages in the case of abnormal cash flow. The IRR of the project may not be deposited, and sometimes more than two IRRs exist at the same time. Therefore, after determining the future cash flow and capital cost of the investment project, the NPV can provide investors with the best investment decision. However, in practice, there is not only one way to analyze the investment projects of enterprises. Since most investors have diverse investment purposes, in order to reasonably evaluate investment projects, it is necessary to obtain investment project information from multiple perspectives and conduct scientific evaluations based on the actual situation of the project. The net present value method and the internal rate of return are good complements for project performance estimation.

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