Research on the Methods of Investment Project Evaluation: Comparison of NPV, IRR and MIRR

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Abstract: Which one of Net Present Value and Internal Rate of Return is better to use in different fields is the focus of current research. This paper analyzes the limitations and uniqueness of the use of NPV and IRR based on current research. The research topic of this paper is the relationship and difference between NPV and IRR. The research method of this paper is as follows: firstly, through the description of NPV and IRR respectively, then collect the data and examples used by NPV and IRR, secondly analyze the data and examples, and finally, this study found that in different situations, the use of IRR and NPV also has different advantages and disadvantages, and there is still a gap in the comparative analysis of the use of NPV and IRR in different situations. Therefore, this paper will supplement the gaps in the comparison of NPV, IRR and MIRR with an analysis.

Keywords: investment project evaluation, NPV, IRR, MIRR

1. Introduction

In the process of running a business, making the right decisions will lead to success. Every decision has a significant impact, and operators must consider every decision carefully. To help, there are a variety of decision-making techniques and tools to help make decisions, of which NPV and IRR are particularly critical. The financial world has long debated whether NPV or IRR is the better measure for capital planning.

The NPV focuses on how much the investment plan can contribute to the firm, whereas the IRR focuses on the projected rate of return. When we use these two indicators to analyze independent projects, we will get consistent trade-off results; nevertheless, there may be conflicts when analyzing mutually exclusive investment projects. To enhance the financial performance of investment projects, it is vital to further investigate the relationship and difference between these two measures. The scientificity and dependability of feasibility analysis [1]. The net present value method enhances the assessment of investment economics by taking into account the value of time relative to money. The process's entire net cash flow is also taken into account. Second, the discount rate considers investment risk, with a high discount rate applied when the risk is considerable [2].

NPV is the best measure for analyzing the value created by a project [3]. Other experts, however, believe that the IRR is the most essential indication for determining the worth of a project. In real-life project investment, IRR is a ratio and NPV is a specific value; in comparison, IRR may be better because it is a relative value, whereas NPV is only an absolute value, regardless of the size of the investment. After all, a 500,000 NPV investment is 50,000, and a 5 million NPV investment is also

50,000. However, the profitability of the two investments is vastly different. However, because IRR is not ideal, academics have proposed MIRR. A separate phase of cash flow reinvestment yield based on the cost of using funds for prospective multi-solution situations is often introduced by MIRR; for potential multi-solution problems, MIRR tends to perform equivalent conversions, converting unconventional projects into regular projects to eliminate multiple symbol transformations [4].

This paper aims to analyze the relationship between NPV and IRR in terms of formula to explain the connection between the two, because this is the basis for analyzing the two. Then describe NPV and IRR respectively, and then use MIRR as an example to demonstrate. Finally, a comparative analysis of the three came to a conclusion. This article will supplement the gaps in the horizontal comparison of NPV, IRR, and MIRR.

2. First Section

2.1. Definition of NPV

NPV compares the current value of a dollar to the future value of the same dollar, allowing for both inflation and deflation. Is the difference between the present value of cash inflows and the present value of cash outflows over time.

The following is the calculation formula of NPV

$$NPV = \frac{CF}{(1+r)^t} - C_0 \tag{1}$$

Where, CF = Annual cash inflows; r=Discount rate; t=Project cycle;C_0=Initial investment cost.

The absolute profitability of a company on the particular item is shown by NPV, which truly indicates an increase or reduction in shareholder wealth. NPV>0 indicates that the project can generate returns above the benchmark rate of return, indicating that it can be approved; NPV=0 indicates that the project's cash flow simply covers the investment, which is also acceptable. The item cannot be approved if the NPV is 0 [5].

2.2. Disadvantages of NPV as an Evaluation Method

1. NPV is an estimate of future cash flow at present value, which may in fact be inaccurate. In fact, the inflow and outflow of cash flow may not occur in the future. So, NPV is not a perfect method.

2. There are three basic restrictions on the use of NPV. The following situations preclude the use of NPV: a) At least two cash flow direction changes. a) The initial investment of projects that are mutually exclusive varies b) Different time series of cash flows exist for mutually exclusive projects.

3. The measurement of the discount rate is also inaccurate. It is impossible to find the most accurate NPV calculation rate at any time, although great care is taken to properly measure the discount rate.

2.3. Example

Now let us suppose the company wants to fund a project, and there are two possibilities: A and B. The two strategies A and B are mutually exclusive. Project A's initial 15 million yuan investment has a NPV of 3 million yuan and an IRR of 20%; project B's initial 10 million yuan investment has a NPV of 2.5 million yuan and an IRR of 2.5 million yuan to 25%. According to the NPV decision criterion, NPV(A)>NPV(B), should invest in the A scheme; according to the IRR decision criterion, IRR(B)>IRR(A), should invest in the B scheme. This puts investors in a dilemma.

The application of NPV in mutual exclusion scheme: In the above example, there are only two mutually exclusive schemes and no other investment opportunities. The A project will be decided by

investors. The investor will choose the combination of B and C projects and forego the A project if there is another independent investment project C with a NPV of 1 million yuan, a necessary investment of 4 million yuan, and a NPV rate of 25%. The two projects C and C together have a NPV of 3.5 million yuan (250+100), which is higher than the 3 million yuan NPV of the A project. Investors may therefore examine portfolios.

3. Investment Project Evaluation: IRR Method

3.1. Definition and Economic Implication of IRR

3.1.1. Definition of IRR

The discount rate at which the NPV equals zero and the present value of capital inflows equals the total present value of capital outflows has been known as the IRR [6]. In most cases, it is calculated using an electronic computer called Excel. The IRR, or the rate of return that an investment aims to achieve, is the discount rate at which the net present value of an investment project equals zero. When the IRR is approximately equal to the benchmark rate of return, the project is often feasible.

3.1.2. The Formula of IRR

$$0 = \text{NPV} = \sum_{t=1}^{T} \frac{C_t}{(1+\text{IRR})^t} - C_0 \tag{2}$$

Where, IRR=The internal rate of return; C_t=Net cash inflow during the period of time t; C_0 =Total investment finance charges; t=The number of time periods.

3.1.3. The Economic Implications of IRR

The IRR has the favorable position of showcasing the project's rate of return, attempting to compare it to the industry's benchmark investment rate of return, and providing links the project's lifetime income with its total investment to figure out if the project is worthwhile of being built. When the borrowing criteria are not absolutely obvious, the IRR technique can be used to bypass them instead using the IRR as the upper bound of the allowed borrowing rate.

3.2. Disadvantages of IRR

1. Neglecting Economies of Scale: One imperfection inside the IRR method is that it neglects to contribute for something like the economic advantages' actual economic value.

2. Impractical Implicit Reinvestment Rate Assumption: If one project has a low IRR, it will invest that money at a relatively low return on capital; when another proposal has a very slightly elevated IRR, it will presume a higher return on reinvestment, and this is the case. Actually, it doesn't hold.

3. Dependent or Contingent Projects: The project under consideration stimulates the desire to fund additional projects. For instance, purchasing a parking place is necessary when purchasing a vehicle.

4. Mutually Exclusive Projects: In cases where two projects are mutually exclusive, it is not sufficient to know whether they are worthwhile. Identifying the finest investments is difficult. The IRR approach will provide an explanatory number expressed as a percentage, however that is insufficient.

5. Projects with Varying Durations: The IRR approach does not take into account the situation where two projects have varying project durations.

6. A Project with a Mixture of Positive and Negative Future Cash Flows: When a project has both positive and negative future cash flows, the IRR method's equations satisfy multiple rates of return, resulting in multiple solutions.

7.In this situation, the IRR won't be determined if successive cash inflows are insufficient to pay the initial investment. IRR is a discount rate at which an investment's investment or present value of cash outflows equals the present value of cash inflows. Thus, in some special cases, the method of IRR will fail.

3.3. Example

A company plans to invest in a project, and the required minimum necessary rate of return is 30%. There are two options, A and B. Case A and Program B are two mutually exclusive programs. If you invest in plan A with an investment of 100,000 yuan, you will make a profit of 100,000 yuan, and the profit rate is 100%; if you invest in plan B, with an investment of 300,000 yuan, you will make a profit of 180,000 yuan, and the profit rate is 60%. So how should the management of the company make decisions [7]?

If only from the point of view of the necessary rate of return required by the company, the profit margins of the two schemes A and B are far more than 30%, and both schemes are feasible.

In reality, corporate investment cannot only consider profit rate, a relative quantitative factor that expresses investment efficiency. If the company invests 1,000 yuan, it can get a return of 2,000 yuan, and whether the return on investment is 200%. If the company invests 10 million yuan and can get a return of 5 million yuan, the return on investment is 50%, although the return rate of 200% is much higher than 50% rate of return, but for a company, the value of 2,000 yuan and 5 million yuan is different.

Therefore, when the company's management makes investment decisions, not only the relative amount of profit rate, but also the absolute amount of profit must be considered. Generally speaking, company managers will choose the plan with higher profit instead of the plan with higher rate of return, so "absolute amount NPV is better than relative amount IRR"

4. Investment Project Evaluation: MIRR Method

4.1. Definition of MIRR

MIRR is a modification of IRR, which refers to the IRR obtained when calculating income and expenditure with different interest rates, taking into account finance rate and reinvestment rate.

The formula of MIRR is as follows:

$$\sum_{t=0}^{n} \frac{COF_t}{(1+k)^t} = \frac{\sum_{t=0}^{n} CIF_t (1+k)^{n-t}}{(1+MIRR)^n} \tag{3}$$

COF (negative value): shows the cost of the investment project or the cash outflow.; CIF (positive value): Indicates cash inflow; k: represents the required rate of return; MIRR: Modified IRR.

4.2. Both Benefits and Drawbacks of MIRR

Since MIRR is a more accurate measure used to assess the profitability of future projects, traders can use MIRR to determine if the forecasts generated by MIRR are too pessimistic.

It is more accurate than reinvesting cash flow with IRR because MIRR assumes that all cash flow is reinvested at a reinvested rate.

The main disadvantages of using MIRR is that the cost of capital must be estimated before a decision can be made. In addition, there is controversy in academia about the theoretical background of MIRR computing [8].

4.3. Example

The cash flow for each period of a project is as follows in table 1. ① The interest rate paid by the funds used in the cash flow (Finance Rate) is 0.09; ②The rate of return on the reinvestment of cash flow (Reinvest Rate) is 0.12.
    Cash flow for each period of a project:

Table 1: The cash flow for each period of a project.

period	0	1	2	3	4	5
Cash flow	-100	20	-10	30	38	50

$$-100 - \frac{100}{(1 + 0.09)^2} = -108.417 \tag{4}$$

At the conclusion of the project's economic life cycle, convert the positive cash flow to the terminal value at the rate of return on cash flow reinvestment:

$$20 * (1 + 0.12)^4 + 30 * (1 + 0.12)^2 + 38 * (1 + 0.12) + 50 = 161.662 \tag{5}$$

The modified IRR is the discount rate when the final income value is equal to the starting input value after discounting (MIRR):

$$\frac{161.662}{(1 + \text{MIRR})^2} = 108.417 \tag{6}$$

MIRR=0.083

5.   Comparison of NPV, IRR and MIRR

5.1. Comparison of NPV and IRR

Theoretical analysis that NPV is better than IRR in the decision of mutually exclusive scheme:
    (A) The fundamental criteria of project evaluation indicators are better met by NPV: The following three requirements should be met by a good evaluation index: 1) The evaluation index must take into account every financial flow throughout the project's life cycle. 2) The cost of capital or the required rate of return by investors must be considered in this evaluation indication. 3) This evaluation indicator needs to be in line with the objectives of the business.
    (B) The notion of enterprise value additivity can be better reflected via NPV: The evaluation criteria of NPV is consistent with the company's value maximization objective since, in a sense, the company's value is equal to the sum of all the values of its projects based on the concept of value additivity. The IRR indicator is a relative quantity, and its values cannot be added like NPV, which upholds the value additivity concept. Instead, the IRR of each combination must be recalculated, which is difficult to do and frequently does not agree with the NPV indicator's results for making decisions.
    (C) When making decisions on atypical investment initiatives, NPV is simpler to use. If an investment project's cash flow is staggered, the number of IRRs it may have depends on how many times the sign of the cash flow sequence has changed. most appropriate for evaluation In a different scenario, the IRR problem cannot be solved if no discount rate can make NPV=0 true. By using a predetermined cost of capital or the required rate of return on investment as the discount rate, the NPV metric, in contrast, overcomes this issue.

5.2. Comparison of MIRR and IRR

Using the MIRR method instead of IRR for project evaluation has the following advantages:

1. Compared with the IRR evaluation method, the MIRR evaluation method is more accurate and robust. MIRR separates the rate of return from the reinvestment rate of free cash inflow. It will be more scientific in the process of evaluating projects, the calculated results will be more realistic, and the results obtained in the process of project evaluation will be more accurate than IRR.

2. Compared with the IRR methods of assessment, the MIRR methods of assessment is easier to calculate. The IRR evaluation method adopts the establishment and solution of high-order equations, and it is difficult to obtain accurate solutions in general calculations. The IRR calculated by the linear method is only an approximate value. In order to obtain the IRR value more accurately, the positive NPV and negative NPV should be as close to zero as possible during calculation, which often requires multiple calculations. Usually, the value of MIRR It can be obtained directly by the formula, and the calculation ease and accuracy are much higher than the IRR evaluation method.

3. Compared with the IRR evaluation method, MIRR is suitable for project evaluation in a dynamic environment. An important flaw of IRR itself is the assumption that the return on reinvestment is the IRR itself. Generally speaking, the return on investment of a company is smaller than that of the IRR itself [9]. This assumption is not very accurate. MIRR fixes this flaw of IRR [10].

6. Conclusion

The main research finding in this paper is that different methods are applied in different industries or scenarios. NPV and IRR, IRR and MIRR are compared using the method of comparative argumentation. Meanwhile, it is determined through comparison that: First, when compared to IRR, NPV has the advantages of being more in line with the fundamental requirements of project evaluation indicators and more reflective of the principle of enterprise value additionality; Second, when compared to IRR, MIRR has the advantages of being more accurate and suitable for project evaluation in a dynamic environment; therefore, different evaluation methods should be chosen depending on the situation when choosing beyond that, the revised assumption of the IRR relative to the IRR is the most reasonable. However, the analysis in this article is still not comprehensive enough, and more comprehensive interpretation and analysis will be needed in the future.

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