Research on investment project evaluation: Comparative analysis based on NPV and IRR

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Abstract. Whether a project is viable, determining whether a project is viable requires some metrics. The indicators that are most frequently utilized are the Net Present Value (NPV) and the internal rate of return (IRR). They are very representative and scientific. The same decision can be made by applying both in independent and non-independent projects When there are many contradictions between NPV and IRR, it is necessary to introduce new indicators to continue to judge the project, such as △IRR, incremental IRR method, modified IRR (MIRR) method, selective IRR method, payback period method, Equivalent Annual Annuity (EAA) method and static analysis method. The investment is selected by comparing the internal rate of return △IRR with the benchmark rate of return (ic) or the social discount rate. The MIRR approach determines the IRR of each scheme, compares it to ic, chooses the scheme that have IRR is larger than or the same as ic, and then determines the incremental IRR of the two neighboring schemes to make the choice. In addition to the investment payback period approach and the selective internal rate of return method. EAA method is in the comparison of investment projects, investors should choose the project with higher EAA when comparing. In the process of investment projects, different enterprises can adopt static analysis method to carry out project investment, but there are two forms of static analysis method, such as payback period method and basic income method. Using reasonable indicators and methods to evaluate the investment project, so as to select the best project.

Keywords: NPV; IRR; MIRR; EAA; Investment project evaluation.

1. Introduction

In traditional investment project evaluation, NPV and IRR are frequently used tools. However, with the continuous changes and development of global financial markets, traditional investment project evaluation methods may need to be further studied and improved. Therefore, this paper aims to explore the advantages and disadvantages of investment project evaluation methods based on NPV and IRR through comparative analysis, so as to provide a more accurate and comprehensive basis for decision making.

The problem investigated in this paper is how to judge the best investment plan when NPV and IRR contradict each other. In Section 2, NPV, IRR and how they are applied are presented. In Section 3 below, the consistency of NPV and IRR, as well as the contradictions and solutions between them are specifically analyzed. Finally, the paper introduces more methods and indicators for judging investment decisions and their applications.

2. Basic Information of NPV and IRR

The present value of an investment's anticipated future net cash flows is calculated using a discount rate, and the net present value (NPV) is the value obtained after deducting the amount of capital invested. It indicates whether the projected returns of an investment exceed the opportunity cost of capital. The NPV method is a way to assess a project's benefits and drawbacks focus on its NPV. The scheme is workable if NPV is higher than zero. The scheme is better and the investment benefit is better the higher the NPV. The following is the formula for the IRR.

$$NPV = \sum \frac{CF_t}{(1+r)^t} \tag{1}$$

The internal rate of return, or IRR, measures how much an investment is anticipated to earn in the future and determines whether all cash flows from investments—positive and negative—have a net present value of zero. IRR is the discount rate that makes the net present value of future cash flows from an investment equal to the initial amount invested. In other words, it is the rate of return that makes the present value of all future cash receipts from the investment (positive cash flows) equal to the present value of all cash outlays for the investment (negative cash flows). The IRR can also be defined as the discount rate at which the net present value of an investment is equal to zero. The formula to calculate the IRR is provided below.

$$CF0+\frac{CF_1}{1+IRR}+\frac{CF_2}{(1+IRR)\,2}+\ldots+\frac{CF_T}{(1+IRR)T}=0 \quad (2)$$

In formula (2), CF is the cash flow, and t is the period.

2.1. Precautions and Applications of NPV in the Calculation Process

In the calculation process of NPV, it first needs to pay attention to the amount of investment, that is, the total cost of the investment project, including the purchase of equipment, the construction of houses, the payment of wages and other expenses. Second, attention needs to be paid to cash flow, which refers to the cash inflow and cash outflow generated by the investment project in the future period of time, including income, expenditure, depreciation, etc. Third, discount rate: that is, the discount rate of investment projects, refers to the interest rate needed to convert future cash flows into current value. Fourth, investment horizon: that is, the duration of the investment project, usually in years. Through the rough and project NPV calculation of those factors, the future cash flow discounted minus investment. If the NPV is positive, it indicates that the project has investment value, the project is lacking in investment value if the net present value is negative over time.

NPV is mainly applied to independent project investment decisions, but it can also be applied to the comparison of investment decisions of mutually exclusive projects. Independent projects refer to projects that exist independently in the investment process and will not affect other project decisions, and there is no mutually exclusive relationship. It can co-exist with other decisions or with other decisions [1, 2].

2.2. Precautions and Applications of IRR in the Calculation Process

Selecting a term that encompasses the cash flows' net present value necessitates finding the annuity value coefficient, which is then utilized to compute the IRR. The results for the nearby terms are subsequently collected. The final IRR is generated using multiplication based on the net present values associated with the adjacent terms. When employing IRR, the annuity value coefficient must be generated, the neighbor term's outcome must be determined, and finally the interpolation method must be used to get the final result. The base moment is not mandatory for scrutiny using the IRR.

While the present value of the money emanating in matches the money going out throughout the process, it is clear that the core idea underlying IRR is to finance projects at a discount rate of zero NPV. Throughout the year, the cash flow conversion is constant. It is evident that the fundamental idea behind IRR is to finance projects at a discount rate of zero NPV when the present value of the money coming in equals the money going out during the process. Throughout the entire year of cash flow conversion, the values of inflows and outflows remain constant. There is no cash flow and all profits after the investment are reinvested; the internal rate of return dictates the amount to be returned. The study of cash flows called an IRR considers the eroding worth of money over time. The greater the expected IRR of a project, the more reasonable it is. Additionally, IRR tends to favor short plans and undervalue firms that return value over time.

The internal rate of return (IRR) may be employed in order to assess a variety of investment projects, including independent projects, projects that are mutually exclusive along with the same timeline and upfront cost, and complementary limited assignments along with the same timeline but

different initial capital requirements. IRR is an effective way to illustrate which investment option will be the most profitable given these various situations during project selection [3, 4].

3. Comparsion of NPV and IRR

IRR is a rate of return given as a percentage, whereas NPV is expressed as a number. There are contrasts, currently there is also a link. IRR is a method to figure out the discount rate when NPV is exactly zero. IRR may be utilized in practically all investment computations and is a key indicator to quantify investment income, but NPV is more frequently used for permanent project investment investigation, which aims to establish whether the expenditure on the project is possible.

3.1. Consistency and Application between NPV and IRR

The NPV and discount rate curves for projects A and B, respectively, are shown in Figure 1, where the intersection of the two curves is the X point, and the intersection of the two curves with the X axis is the IRR of A and the IRR of B, respectively. To the right of point X, the discount rate increases and one can see that IRR A is greater than IRR B. NPV is decreasing, but NPV A is always larger than NPV B, where there is consistency. Based on these two indicators, investment projects are selected.

3.2. Contradictions and Solutions between NPV and IRR

From Figure 1, we can see that the discount rate on the left side of point X is getting smaller and smaller, while NPV is getting higher and higher. At this point, the NPV B is greater than the NPV A, and the IRR B is less than the IRR A, so there is a contradiction. They make their decisions based on different presumptions and conceptions of how the money recovered from the investment program will be reinvested, which influences the process they use to evaluate which projects to invest in. The annual growth in net cash flow is calculated using the NPV technique utilizing the investor's specified reinvestment rate as the discount rate. According to the IRR rule, the reinvestment rate used for evaluating the rise brought on by the net cash flow of every passing year corresponds to a project's internal rate of return.

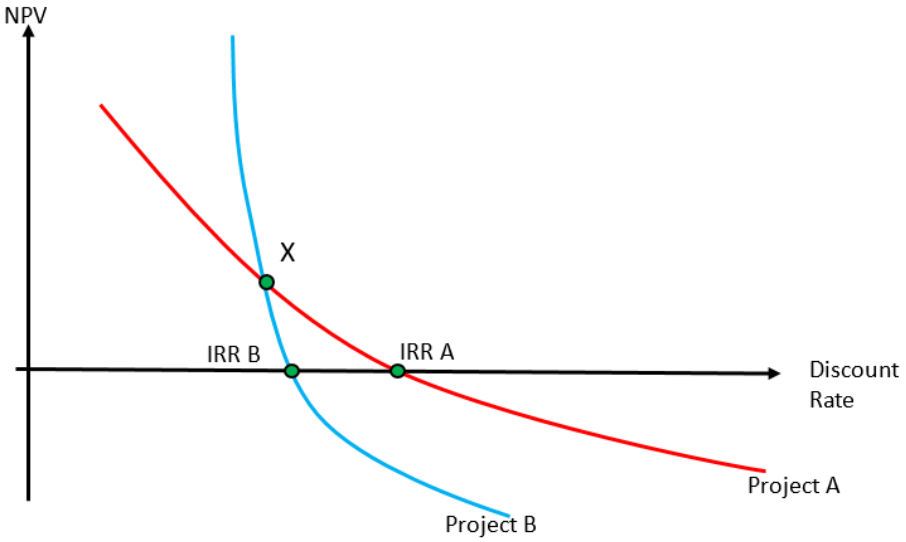

Fig 1. NPV versus discount rate for two different projects (Photo/Picture credit: Original).

The irregular service life, initial investment, net cash flow of every single year, and their combined influence amongst schemes are found to be the main contributors to the difference between NPV and IRR through investigation and implementation. We may infer from the NPV formula that it is a linear transformation, meaning that adding more cash flow periods will only affect the NPV value and leave the other formula variables unchanged. It is nonlinear to calculate IRR. Each calculation's NPV and IRR values will alter if the cash flow from another period is added to the formula [5].

3.2.1. △IRR difference investment internal rate of return method

The fact is, the discount rate that is reached when the difference in cash flows between the two schemes based on every year's present value added together comes to zero.

$$\sum_{t=0}^{n}[(CI-CO)_2-(CI-CO)_1]_t\,(1+\Delta IRR)^{-t}=0 \tag{3}$$

In formula (3), $(CI-CO)_2$ is the scenario's every year net cash flow with more money being invested, and $(CI-CO)_1$ is the annual net cash flow of the scenario with less investment.

Calculate the internal rate of return of investment △IRR and the benchmark rate of return ic (the minimum standard level of return of an acceptable investment project determined by an enterprise or industry or investor with a dynamic view). Or Social discount rate is (A typical metric for the economic assessment of construction projects is the social discount rate. It demonstrates how society values time in relation to money.) In contrast, in situations where △IRR goes beyond or approaches ic, the scheme with more investment is the best. If △IRR is less than or equal to ic, the solution with less investment is the best. The social discount rate seems the minimum acceptable rate of return, and we regulate that it is 7% or 12%. The mandated rate of return is converted into the industry benchmarking rate of exchange ic, which is now 10%, while financial review remains conducted. [6].

3.2.2. MIRR

After reinvesting at a rate that reflects the investment's risk profile and potential for growth, the free cash flows generated by the project over a specified time horizon are taken together to estimate the IRR. While this occurs, the initial payment is discounted using a rate of return that takes the project's natural danger into consideration. The internal rate of return that makes the net present value of cash flows equal to the discounted initial investment has been determined by iterating the discount rate.

$$\sum_{t=0}^{n}\ \mathrm{COF}_t/(1+k)^t=\ \sum_{t=0}^{n}\ \mathrm{CIF}_t(1+k)^{n-t}/(1+\mathrm{MIRR})^n \tag{4}$$

COF represents the amount of cash outflow or the cost of investment scheme (negative value), CIF represents the amount of cash inflow (positive value), k represents the necessary rate of return, and MIRR represents the internal rate of return after correction [7].

3.2.3. Average internal rate of return method

First, the IRR of each choice is first calculated and evaluated in relation to the standard rate of return ic. Not chosen if IRR has become less than ic.

Second, the plans of IRR are greater or equal to ic were arranged from small to large according to the initial investment.

Finally, the incremental internal rate of return of investment (AIRR) of the two adjacent schemes is calculated according to the initial investment from small to large. If AIRR is less than ic, the scheme with small investment is selected. Until all schemes are relatively completed, the last retained scheme is the best scheme [8].

4. Future Research on NPV and IRR

In addition to NPV and IRR, there can be more indicators to judge how to choose the best project in the investment decision.

4.1. Consistency and Applications between NPV and IRR

Two indicators have been introduced in 3.2: △IRR and MIRR, then there are other ways to judge.

The selective IRR method, which involves choosing the IRR from multiple potential values, is mathematically equivalent to the net present value criterion. The payback period method calculates the length of time required for a project's cash inflows to recoup the initial investment. It is thus a measure of how quickly capital is recovered. The payback period can be calculated through either an

undiscounted (static) approach or by discounting cash flows. While the payback period considers the time to recover costs, it does not account for the time value of money or measure the full economic return of investments like net present value or internal rate of return can. Payback periods are commonly used alongside more sophisticated metrics.

$$\text{Payback period (year)} = n + \left(\frac{\text{unrecovered investment at the end of year n}}{\text{net cash flow of year n+1}}\right) \quad (5)$$

The duration of time needed for the recovery of the full investment is referred to as the payback period [4, 9].

4.2. New Methods and Their Applications

The equivalent annual annuity (EAA) method converts the cash flows of a project into a fixed annual payment over its lifetime, allowing comparison across investments in equivalent terms. It calculates what annual interest rate would produce the same present value as the project's actual cash flows. Investors should select projects with higher EAA values.

Investment projects for various companies can be evaluated using static analysis techniques like payback duration and accounting rate of return. In order for estimating that a project's predicted payback duration satisfies the necessary properties payback requirements, the payback time look at counts the years it is expected to require to fully repay the initial investment by annual net cash inflows.

In order to transform future normal net income into present value, the financial accounting rate of return method first predicts future normal net income for the project. While payback period focuses on recouping costs, it does not consider the full economic benefits of investments over time. Long payback periods also increase risk for companies. Static strategies have limitations in comparison to more advanced methods like net present value computation that take the time value of money into account and offer only a rudimentary assessment. Business decisions require balancing risks, costs, and potential returns both qualitatively and quantitatively

The duration of the payback period method's major flaw is its inability to accurately calculate the course of time [10, 11].

5. Conclusion

This paper presents the definition and calculation of NPV and IRR and lists the research methodologies used to evaluate investment projects. NPV and IRR are consistent in independent initiatives and can also determine the best course of action. The △IRR incremental IRR approach is presented for projects that are mutually exclusive. In other words, this is the rate of discount at which the combined amount of the cash flow variances between the two schemes for each year's present value is zero as well. The benchmark percentage of return on investment and IRR on investment are calculated. Or the societal discount rate, a common metric for assessing the financial sustainability of building projects. The ic reflects society's view of the time value of money. When comparing plans, if the incremental IRR (ΔIRR) is greater than or equal to ic, the plan with the larger investment is optimal. If ΔIRR is less than or equal to ic, the plan with smaller investment is preferred.

In order to account for investment risk, the modified IRR (MIRR) technique first discounts the original cash outlay at the projected rate of return. After that, it gradually reinvests the free cash flows at a rate that takes opportunity risk into account. This combines the cash flows, which are the source of MIRR. The average IRR approach can be utilized for evaluating various investment possibilities. By calculating the IRR of each alternative, it is compared with the benchmark yield ic respectively. If IRR is less than ic, is not selected. The plans are ranked from lowest to highest IRR and initial investment amount. The incremental IRR (AIRR) between adjacent plans is then calculated from lowest to highest initial investment. If the AIRR is greater than ic, the plan with the larger investment should be selected as it provides better returns. If the AIRR is less than ic, the smaller investment

plan is preferred. This process is repeated until all plans are evaluated, leaving the optimal plan with the highest IRR over ic. Methods like selective IRR, payback period, EAA and static analysis can effectively aid investors in project evaluation and selection. This study could be improved by expanding the sample size and scope of data as well as considering additional evaluation metrics to strengthen results. Broadening the data and incorporating multiple factors would enhance the reliability and applicability of the research findings.

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