

Comparative Analysis of NPV and IRR in Investment Decision Making

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Abstract. With the development of the global economy, enterprises are paying attention to the method of measuring investment projects. In the financial sector, different models represent different aspects of the data. Both IRR and NPV are important metrics in decision making. However, it's a matter that between NPV and IRR, which method is better for evaluation. Based on the definition of NPV and IRR, this paper analyzes the effects of different methods in different situations. Summarizing the different methods in which different situations are applicable. The study found that both IRR and NPV are helpful for investment decisions in different ways. However, NPV is more concise, can be understood quickly and is widely used. NPV can reflect the overall benefit of the project. IRR is more difficult to understand. In some special conditions IRR rule might make mistakes and the data will be inaccurate. IRR is more limited than NPV, so NPV is a more stable and reliable reference data than IRR in investment decisions. Investors should prioritize the data provided by NPV rule.

Keywords: Finance; net present value (NPV); internal rate of return (IRR).

1. Introduction

All investors want to find the most appropriate way to measure the value of the project and get the maximum benefit. Financial models are very important for investment measurement and decision making. With the development of society, more and more financial models have been discovered, but which model we should choose when making decisions has become a problem. In different conditions, sometimes if we use the inappropriate models, we might make a wrong decision and cause serious property damage. For today's enterprises, both NPV and IRR are common models to use. The question is between NPV and IRR, which is the best measurement index? How can we make a good decision by collecting NPV and IRR data? How can we make a choice when the conclusions of NPV and IRR are contradictory? Based on the properties of NPV and IRR, this study uses comparative analysis to explore the answer. In the study we summarize the advantages and disadvantages of both NPV and IRR. This study takes commercial projects as an example to find which model should be used to find the best strategy in the investment process of investment enterprises. It provides inspiration and reference for the investment decision of the investment enterprises, and provides suggestions for the government to formulate relevant policies. The study compared their applicability in different situations and illustrated specific situations with examples.

2. Literature Review

Based on CNKI database, this paper systematically combs, summarizes and comments on the research status in the financial field in the past five years.

2.1. Definition of NPV

The NPV principle is often used in discussions about how businesses might employ tactics to seize profitable deals [1]. NPV is the sum of the cash inflow and outflow at the beginning of maturity [2]. The calculating formula is as follows in order to determine whether the project adds value to the company:

$$NPV = \sum(CI - CO)(1 + i)^{-t}. \quad (1)$$

In this formula: When the first input is calculated with $t=0$, the cash flow in the first year following the input is $t=1$. CI stands for cash inflow, CO for cash outflow, and (CI-CO) for net cash flow for year t , i stands for benchmark discount rate.

After entering the numbers, the net present value (NPV) calculation result shows whether the business is appropriate to invest in the project and whether the corresponding strategy can add value to the business. If the NPV calculation result is negative, the business, theoretically, is not appropriate to invest in the project [3]. According to the NPV rule, if an enterprise wants to maintain the value increase, that is, the NPV is positive, it needs to increase the cash flow of various projects and reduce the investment cost to achieve it [4].

2.2. Advantages of NPV Rule

NPV method adopts cash flow assessment, and enterprises can directly use the cash flow obtained by the project. NPV rule can calculate the cash flow of the whole investment project scientifically and reasonably, calculate the time value of cash, and reduce the influence of error [5]. The NPV rule aids in comparing the investment project with the financial market's investment options. The project is worthwhile investing in if the predicted rate of return on the financial market is used as the discount rate and the NPV calculation result is positive. If the NPV is negative, the company should stop investing in the project and look to the financial market instead [1].

2.3. Disadvantages of NPV Rule

The NPV technique may examine an investment's profit and loss and determine the profit and loss limit, but it is unable to explain the advantages that investors or businesses may have, and it is unclear how to calculate the actual rate of return. This will also result in the actual investment process neglecting projects with low investment, low return, but high return rates [5].

2.4. Definition of IRR

IRR is the discount rate that during the project calculation period, might result in a cumulative present value of net cash flow equal to zero [6]. IRR stands for internal rate of return, and it is the project's ability to repay the initial investment or its maximum bearing capacity for the loan interest rate when the investment cost is equal to the present value of the investment revenue that the project investment will produce in the future [7]. The following is the calculating formula:

$$\sum(CI - CO) (1 + IRR)^{-t} = 0. \quad (2)$$

In this formula: When the first input is calculated with $t=0$, the cash flow in the first year following the input is $t=1$. CI stands for cash inflow, CO for cash outflow, and (CI-CO) for net cash flow for year [8].

The feasibility of a project can be judged by comparing the internal rate of return (IRR) with the benchmark rate of return. If $IRR > \text{Benchmark discount rate}$, project feasible; if $IRR < \text{benchmark discount rate}$, project not feasible [9].

2.5. Advantages of IRR Rule

IRR is a well understood metric that calculates a project's return on investment. The economic significance of IRR is that businesses are concerned with "how much net profit per dollar invested per year." IRR is a relative numerical indicator that helps measure efficiency [10].

2.6. Disadvantages of IRR Rule

The intricate IRR computation technique necessitates the creation of numerous cash flow statements, and there are many forms of IRR, which is difficult to understand. IRR cannot be used directly for comparison between projects and needs to be combined with the size of the NPV [6].

2.7. NPV Vs IRR

NPV index and IRR index are two commonly used project decision indicators. The application of the two indicators can typically result in the same evaluation judgment and conclusion in separate project plans. However, discrepancies as significant as the shield can arise when it comes to goods that are mutually exclusive. Time value is considered by both the NPV and IRR indicators, which use cash flow as their study foundation. Different reference standards are offered in the analysis of investment decisions in accordance with the requirements of various investors, which is a crucial judgment base in the project investment choice. In general, choosing investment projects with the highest NPV can benefit businesses more, hence the NPV index is more frequently used than the IRR index [2].

3. Examples of NPV Versus IRR

3.1. Preliminary Assessment

An investment company wants to evaluate whether this project will be profitable for the company based on NPV and IRR, Table 1 shows the cash flow of the project.

Table 1. Cash flow statement

Cash flow 0	Cash flow 1	Cash flow 2
-4000	+2000	+4000

The discount rate is 10.

If we calculate NPV of the project:

$$\text{NPV} = -4000 + 2000/1.1 + 4000/1.1^2 = 1123.96, \quad (3)$$

$$-4000 + 2000/(1 + \text{IRR}) + 4000/((1 + \text{IRR})^2) = 0, \quad (4)$$

$$\text{IRR} = 28\%. \quad (5)$$

NPV is a positive number and IRR is bigger than 10%, both NPV and IRR show us this project is profitable.

In this situation both NPV and IRR are Effective and standard measurement methods.

3.2. Comparison Between Two Projects

Table 2. Cash flow statement for project A and B

Project	Cash flow 0	Cash flow 1
A	-1000	+1500
B	+1000	-1500

The discount rate is 10% (see Table 2).

An investment company wants to know which of the two projects is worth investing in. We need to calculate the NPV and IRR of the two projects respectively.

About NPV method:

$$\text{NPV A} = -1000 + 1500/1.1 = 363.63, \quad (6)$$

$$\text{NPV B} = 1000 - 1500/1.1 = -363.63, \quad (7)$$

About IRR method:

$$\text{IRR A} = \text{IRR B} = 50\% \quad (8)$$

In this condition project A and project B got the same IRR index. However, the profitability of the two projects is obviously different, the results of NP and IRR are obviously contradictory. Project A is much better than project B, IRR index is inaccurate this time.

3.3. Considering Multiple Rates of Return

A new strip mine is being proposed by a steel business. The mine requires a \$3 billion initial investment and is anticipated to bring in \$1 billion annually for the next nine years. After that, the corporation will have to spend \$6.5 billion on remediation.

The discount rate is 10%.

Table 3 shows the cash flow:

Table 3. Cash flow statement of the project

Cash flow 0	Cash flow 1	...	Cash flow 9	Cash flow 10
-3	+1		+1	-6.5

If we calculate the NPV and IRR of the project, we will find that this project got two IRR index (see Table 4).

Table 4. NPV and IRR of the project

IRR	NPV
3.5% and 19.54%	253 million

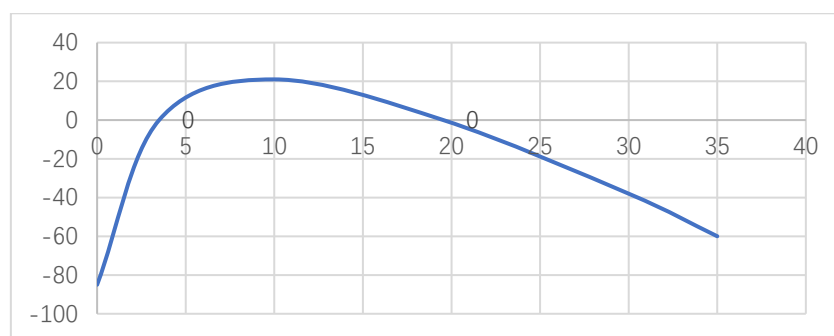


Fig. 1 The relationship between NPV and discount rate

Figure 1 roughly depicts this special condition, with discount rates on the X-axis and NPV on the Y-axis.

Generally speaking, we must seek an IRR that is lower than the capital opportunity cost.

In this case, we need to think about which IRR data is correct, and IRR method will be more complex and mistakable than NPV.

3.4. Project with No IRR

Project C got positive NPV without IRR. The discount rate is 10%, Table 5 is the cash flow:

Table 5. Cash flow statement of project C

Cash flow 0	Cash flow 1	Cash flow 2	IRR	NPV
+1000	-3000	+2500	No solution	339

In this case IRR method can't help us in evaluation.

3.5. Projects with Different Cash Flow Patterns

When comparing projects with various long-term cash flow patterns, IRR is unreliable. Here is the example about project D and project E when the discount rate is 10% (see Table 6):

Table 6. Cash flow statement of project D and project E

Project	Cash flow 0	Cash flow 1	Cash flow 2	Cash flow 3	Cash flow 4	Cash flow 5	...	IRR	NPV
D	-9000	+6000	+5000	+4000	0	0	...	33%	3592
E	-9000	+1800	+1800	+1800	+1800	+1800	...	20%	9000

Project D got the higher IRR but project E got the higher NPV as a perpetuity. Obviously, project E is a better choice. Because project E's overall cash inflow is higher yet tends to materialize later, the IRR is misleading. With a 20% discount rate, E has a negative NPV while F has a positive NPV based on the two projects' rates of return. Investors would place a higher value on the shorter-lived project F if the capital opportunity cost in this case was 20%. However, instead of 20%, the potential cost of capital in our situation is 10%. The project with a longer lifespan will therefore command a higher premium from Enterprise. At a 10% cost of capital, an investment in E has an NPV of \$9,000 while an investment in D only has an NPV of \$3,592.

IRR cannot be utilized to rank projects when there is a capital limitation, whether it be actual or self-imposed. The set of investment projects with the biggest net present value and that satisfy the capital limitation cannot be found by using IRR.

Based on these examples, we can infer that IRR has certain defects in data presentation. In example 2, IRR data and NPV data present conflicting results, increasing the probability that we will make bad decisions. Inaccurate data is absolutely unnecessary when making decisions, which can cause confusion among investors. Example 3 shows us another problem with using IRR as a criterion is that some projects have two different IRR data at the same time, in which case investors need to consider which IRR data should be used. In most cases, investors will choose IRR below the discount rate, which causes a lot of trouble. Example 4 is a very special condition makes it impossible to calculate the IRR data as a comparison criterion. In this condition investors are not able to use IRR index in evaluation. Calculating data without solutions is just a waste of time. Example 5 proves that IRR won't work when different projects have different cash flow patterns, IRR is unable to present accurate and appropriate data. Different cash flow patterns will cause IRR data confusion, and it is impossible to correctly compare the combined value of two projects, so investors cannot rely on IRR data to make decisions in this case. To sum up, IRR has more limitations than NPV. Therefore, after comprehensive consideration, NPV is a higher priority than IRR.

4. Conclusion

In this study, we can learn that both IRR and NPV can help investors measure the value of projects in different aspects. However, the differences and importance between the two methods are still worth exploring.

NPV is the sum of the cash inflow and outflow at the beginning of maturity. NPV may succinctly and directly indicate the project's cash flow value, which lowers inaccuracy. Investors can invest in the project if the NPV is positive; however, if it is negative, investors shouldn't. Because NPV does not take into account the project's rate of return, investors may pass over initiatives with minimal investment and poor return but high investment rates.

IRR is the discount rate that could lead to a cumulative present value of net cash flow of zero during the project calculation term. The maximum carrying capability of the loan interest rate is displayed by IRR. IRR, a relative numerical metric that aids in gauging efficiency, shows investors how much net profit is generated for every dollar invested year. However, because of the complexity of the IRR calculation, it cannot be used to compare projects directly and must be paired with NPV size.

If we compare NPV with IRR, we will find that IRR has more limitations than NPV. Both the NPV and IRR indicators, which employ cash flow as their study's base, take time value into account. The NPV index, as opposed to the IRR index, is more widely employed since selecting investment

projects with the highest NPV might be more advantageous to firms. The most crucial fact is that IRR is far less accurate than NPV.

Conflicting outcomes between IRR and NPV data could increase the likelihood that we will choose poorly. Investors must decide which IRR data to utilize if a project has two alternative IRR statistics available at the same time. The IRR data as a comparison criterion cannot be calculated under specific unique circumstances. IRR is unable to provide accurate and pertinent statistics when various projects have diverse cash flow patterns.

Therefore, after comprehensive consideration and comparison, NPV method is better than IRR method.

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