

## Comparison between NPV and IRR

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**Abstract:** This study examines the pros and cons of IRR and NPV primarily through their advantages, limitations, and other metrics. Bring practical examples into the research for data calculation and analysis. Getting the result that IRR and VPN have their each own differences, can have their own advantages in different situations, and they are not substitutes for each other.

### 1. Introduction

The emergence and spread of COVID-19 has forced a large number of densely populated factories and companies to cease operations. A large number of employees are stagnant in work and have no income, but during the epidemic, the living expenses are still unabated and they cannot make ends meet. So people started looking for other ways to make money to make a living. For example, the current emerging industry: live streaming with goods. On the other hand, in order to control the spread of COVID-19, the number of people working normally in the company has plummeted, so the performance that can be generated for the company will also decrease. This can lead to a company's economic downturn, losses, and ultimately, the tragedy of bankruptcy. In order to minimize such tragedies, many companies make prudent choices to invest in other powerful corporations in order to generate profits and subsidize their own financial losses.

However, investment needs to refer to many factors to decide, because the success or failure of investment will affect the profit and loss of a company. Next, this article will focus on two important factors in investing - Internal Rate of Return (IRR) and Net Present Value (NPV). Mainly from various aspects to study their nature, role and importance.

NPV is the sum of all future cash flows in US dollars. NPV is calculated as:

$$NPV = \sum_{t=1}^n \frac{R_t}{(1+i)^t}$$

IRR is presented as a percentage. IRR is the discount rate when the net present value (NPV) of all cash flows equals zero. IRR is calculated as:

$$IRR = \sum_{t=1}^T \frac{C_t}{(1+r)^t} - C_0$$

Next, we will start to discuss the themes of this paper in turn - IRR and NPV

### 2. Net Present Value

#### 2.1 Introduction to net present value

Net present value, abbreviated as NPV, is an important indicator for financial analysis. To calculate

NPV, current value of future cash flows should be determined first which is the sum of future cash flow of each term divided by one plus discount rate to the power of number of terms. Then, the net present value is the present value of expected cash flows minus present value of invested cash. NPV clearly shows the time value of money and it is usually used to compare mutually exclusive projects because it is easy to calculate and straightforward to compare among projects. However, there is no perfect indicator in finance analysis. Thus, the limitations and drawbacks of NPV will be discussed later. In finance analysis, investors should combine indicators in order to fit the local conditions to form a better analysis method. Thus, several indicators that cooperate with NPV well will then be presented.

## **2.2 The advantages of net present value**

When it comes to comparing among alternative projects, there are three popular methods: net present value method, internal rate method, and payback method. According to professor Knight (2014), NPV method is mostly-used among the three methods mainly because NPV takes the time value of cash into consideration and the results are easily to be calculated and straightforward to be compared. It is known for all that money received today is preferable to (or has more value than) money received after a year. Therefore, the word discount rate is defined as the interest rate in the analysis of future cash flows which helps investors know the current price of future cash flows for each future period. As time passes by, the cash inflows will have little and little effect to the investors and NPV method considers this situation and transfer all the expected cash flows into current price to ensure the accuracy (Louise, 2020). Take an easy example to show the straightforwardness of NPV method: both project A and project B's cash outflow in year 0 are 100 dollars. Project A earns 70 dollars both in year 1 and year 2, while project B earns 40 dollars in the first two years and earns 70 dollars in the third year. Apply NPV method to these two projects, when discount rate is 5%, NPV of project A is 30.16 and project B is 34.85, however when discount rate is 10%, NPV of project A and project B are respectively 21.49 and 16.71. Investors can then choose the biggest NPV value among the project according to their local conditions. Also, Borad (2021) discussed in his article that NPV has some other advantages compared to other indicators. First, the NPV method is calculating the net value, so it can easily deal with the mixture of cash inflows and outflows. Second, unlike some methods which only consider the initial and the final cash flows, NPV method calculate all cash flows that happen in the project.

## **2.3 The limitations of net present value**

As mentioned before, there is no perfect indicators in the world. Although NPV has many advantages and it is widely used in financial analysis, it definitely has certain limitations and drawbacks. Using NPV to measure the profitability of an investment relies heavily on assumptions and estimates and therefore has a large margin of error. Investment expenses, discount rates, and expected returns are all elements in the estimation process. Unexpected costs to get a project started, as well as additional costs at the end of the project, are common (Fernando, 2021). Choosing an exactly correct discount rate is difficult for individual investors. Actually, the discount rate is correlated with risk, but only use a single percentage to represent risk is not a science and precise method. Calculation of NPV is based on discount rate, and if the discount rate is not determined the result might be much different from the reality which leads to inaccuracy of the assumptions. Then, NPV might mislead the investors when analyzing projects of different size (Nasdaq, 2015) because NPV only measures the absolute value rather than relative value. For project A with initial cash outflows of 100 dollars and NPV of 30 dollars and project B with initial cash outflows of 50 dollars and NPV of 20 dollars. If NPV method is applied in this mutually exclusive project choosing, project A will be selected. But for many individuals and companies, it is really hard to tell the reasons for not choosing project B. So, it is difficult to choose between these two projects only applying NPV method. In addition, some companies will hold some short-term projects with high net present value. But these projects may not increase earnings per share (EPS) or return on equity (ROE). And these two factors play important role in raising shareholder value. Thus, these high NPV projects often conflict with shareholders' benefit (Borad, 2021).

## 2.4 Other indicators with net present value

Each factor has certain defects, so investors should combine several indicators to create a more accurate analysis method rather than using one single indicator to determine the selection of projects. The first is payback period. The payback period is the period of time that the project earn back cash when investing. Compared to NPV, payback period has some defects like not considering time value, risk, and inflation (The Strategic CFO, 2019). Cam (2019) stated that many enterprises combine NPV and payback period when making decisions among multiple projects. It is suggested to reduce the selection range by using payback period first and then select the best projects by ranking the rest projects by NPV. Another method is to pick a benchmark NPV first, and choose the shortest projects among the list that is higher than the benchmark. Because one of the defects of NPV is ignoring the size, NPV combined with some indicators using relative value or percentage number can also form a better analysis method.

## 3. Internal rate of return

### 3.1 Introduction to internal rate of return

The internal rate of return which is also called IRR is also an important financial evaluating indicator using relative value. To determine the value of IRR, we should first write down formula that calculates NPV, and then change the discount rate in the formula to IRR and let the formula equals zero, just as shown below.

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

Though IRR does not show information as direct as NPV, it can be used to compare among alternative projects. Investors should choose higher IRR rather than lower if other conditions are in the same range. Though IRR does not show information as clear as NPV, the two indicators have some similar advantages like simplicity and consideration of time. After showing the advantages of IRR, disadvantages will then be demonstrated. Finally, indicators which cooperate with IRR well will be discussed.

### 3.2 The advantages of internal rate of return

Because the formula calculating IRR is the transformation of the formula that determines NPV, the advantages of IRR is similar to NPV. Compared to NPV, though IRR seems to be hard to determine, its simplicity is reflected in the comparison among multiple projects. Investors only needs to pick the highest IRR when other conditions are in the same level or select the highest range of projects and then compare other indicators. Also, IRR is a special discount rate which brings the net present value in the periods equal exactly to zero (Fernando, 2021). Thus, IRR also takes time value of cash into consideration like NPV does. Except this, Lanctot (2019) demonstrates in his essay that one of the benefits of IRR is that it does not take into account the hurdle rate. The hurdle rate is a ratio indicator that investors are acceptable to invest a project. Thus, it is sometimes individual thinking and might be subjective and not accurate. IRR does not need to consider the hurdle rate which ensures its accuracy.

### 3.3 The limitations of internal rate of return

Though IRR has many advantages, it has certain defects when it is used alone. Like NPV, IRR method does not take investment scale into consideration. For example, investors will take \$100 with 50% rate of return rather than \$10000 with 40% rate of return using IRR method simply because 50% is larger than 40%. Actually, for the first project we will get \$150, while for the second one we will get \$14000. Thus, IRR is sometimes not good when choosing among mutually exclusive projects. IRR method implicitly shows that the positive future cash flows will be reinvested at IRR over the projects' remaining time span when used to analyze a project. According to this, a project is assumed to be low in rate of return on reinvestment if the project does not perform well in IRR. On the other hand, a

project will perform well in rate of return on reinvestment if the project has a relatively high IRR. This condition is unworkable in practice. Having the same amount of investing opportunities when you receive those cash flows is rare (Borad, 2021). Compared to NPV method, IRR seems to be imperfect because it is not accurate to deal with the project with multiple cash flow or mixture of cash inflows and outflows. To determine whether to choose a project with a mixture of cash inflows and outflows using IRR method will lead to a problem of multiple roots of IRR which will bring trouble to investors when judging. If a project is always losing money, we could not even get an IRR value because in this case there is no such discount rate that will lead to zero NPV. Also, IRR is a good indicator designed for investors who puts future profit in the first place, but not for people who aim for recouping his initial cash outflow (Gaille, 2018). Using IRR method to judge the recouping period sometimes might be misleading.

### **3.4 Other indicators with internal rate of return**

Most individual investors and companies will not just simply use IRR to analyze due to the limitation of the indicator. The weighted average cost of capital abbreviated as WACC is the average interest rate paid by an enterprise to all security holders to finance its assets. The calculation of WACC includes all kinds of capital, so it is considered as a good indicator to analyze an enterprise. In order to recoup the investing financial costs, most individual investors and enterprises want a relatively higher calculation on IRR compared to WACC (Nilantha, 2021). Another indicator, the required rate of return, is the least benefit that an individual investor or an enterprise are acceptable for taking on the risk of investment. Each individual investor or a company has their own benchmark of setting the required rate of return according to their local conditions. In projects analysis, WACC usually cannot exceed RRR (the required rate of return). Thus, it is clear that if a project's IRR is higher than RRR, then the project should be profitable. And the more the difference between internal rate of return and required rate of return, the more desirable investors should choose the project.

## **4. NPV vs IRR**

NPV and IRR reflect the company's expected performance over a specific period. Comparing NPV and IRR, they have several similarities and differences. The ways to calculate are the most significant differences that they can reflect. In public life, people can choose the suitable way when calculating the benefit of the companies. This article will talk about the similarities and differences between NPV and IRR. In addition, the article will introduce some cases to discuss which solutions to choose when facing different situations.

### **4.1 NPV and IRR's similarity**

While using IRR and NPV to calculate the benefits, both ways may give the exact solutions and results because they all use discounted cash flow methods in many cases. In easy calculation, people can find that NPV and IRR consider the time of value and the cash flow through the project. When calculating independent project proposals, NPV and IRR also can bring the same results to investors; both NPV and IRR can be easily used to decide because of intuitive presentation. Many similarities will arise during the process of decision-making. For NPV, a net positive value will be admissible in a proposal. For IRR, if the final rate is more significant than the cost of capital, identical to NPV, the rate will be accepted.

### **4.2 NPV and IRR's difference**

After discussing the similarities, the differences between NPV and IRR are more critical. Firstly, NPV uses cash flow to calculate, making the results more apparent and efficient for people to accept. However, IRR cannot be admissible if people do not know the cost of capital when comparing them. IRR is used to evaluate which investment offers a better rate of return (Arshad, 2012). So, people prefer using IRR, but IRR seems more impractical because of the assumption of the IRR that all incoming cash flows can be reinvested at the same rate of IRR, while NPV assumes that cash inflows are reinvested at the required rate of return each time (Arshad, 2012). That sounds more practical in

daily life. So, people using NPV to compare projects may be more reliable. However, to correct the assumption of IRR, a modified internal rate of return is used. What is more, when facing non-normal cash flows, a large cash flow at the end of the project will make the IRR not be used. However, NPV can still be employed (Bosri, 2016).

### 4.3 Example for NPV and IRR to choose

In the situation of the Covid-19, the economy has faced significant challenges so far. Investors should know which solutions they choose in different situations. So, this article will continue to discuss when people in different situations should use IRR or NPV?

The same evaluation can usually be made when both are applied to the analysis and judgment of the feasibility of independent projects decision-making. However, in mutually exclusive projects, using two indicators will lead to the contradiction of analysis results, and unique methods are needed to solve the contradiction.

#### 4.3.1 Application to the comparison of independent project investment decisions.

Independent project means that when investors choose different projects, they will not influence each other. There is no mutual exclusion and can exist independently.

Example one: Assume the company's payback rate is 10%.

Table 1 Independent projects

Project/Time	CF0	CF1	NPV	IRR
A	-100	30	13.6	15.1

Flow this table, investors can easily find that NPV is more significant than 0, and because of the assumption of a 10% rate, IRR is bigger than 10%, so project A can be used for this company. In this situation, IRR and NPV can be used to evaluate.

#### 4.3.2 Application to investment decision comparison of mutually exclusive projects

Because of a cash shortage and time, investors can choose the best projects to use. That means mutually exclusive projects. In comparison, exclusive projects will face contradictions resulting in NPV and IRR. The first one is different devotion in cash flow zero; the second one is a different time in calculating.

#### 4.3.3 The exact time in calculating and same devotion at cash flow 0.

Example two: Assume the company's payback rate is 10%

Table 2 exclusive projects

Project/Time	CF0	CF1	CF2	CF3	CF4	NPV	IRR
A	-430	230	179	124	94	84.4	20.4%
B	-430	70	138	240	260	105.6	18.8%

Comparing these two projects,  $NPVB > NPVA > 0$ ,  $IRRA > IRRB > 10\%$ , there are some contradictions between IRR and NPV; in this situation, investors cannot choose which to use. Why will this situation exist? The reason is the difference between the assumption of IRR and NPV. As the article discussed before, IRR's assumption is more unreal than NPV. So, when IRR faces problems, people can introduce modified IRR to correct the problems.

To use MIRR, companies should first assume two rates: the finance rate and the second one is the reinvestment rate.

Table 3 Modified IRR

Project/Time	CF0	CF1	CF2	CF3	CF4	NPV	IRR	MIRR
A	-430	230	179	124	94	84.4	20.4%	17.63%
B	-430	70	138	240	260	105.5	18.8%	17.69%

In calculating modified IRR,  $MIRRA < MIRRB$ , because  $NPVA < NPVB$ , this company can choose project B.

Because of different reinvestment situations between NPV and IRR, companies can introduce different solutions to modify the number to make the results more reasonable.

#### 4.3.4 Different devotion in cash flow zero

Table 4 Different devotion in cash flow zero

Project/Time	CF0	CF1-10	NPV	IRR
A	-100	20	20.8	15.1%
B	-200	39	36.0	14.4%

Following this table,  $NPVA < NPVB$ , but  $IRRA > IRRB$ , in different devotion at first time, this comparison still gives the contractions between A and B.

In conclusion of these comparisons, the main reason why the IRR method and NPV method have conflict in the decision-making of analysis is that the two evaluation methods have different assumptions on investment: IRR method is that this assumption is not reasonable. Because the rate of return of investment projects in each period may not achieve IRR. The NPV rule assumes that the net cash flow obtained from the project can be reinvested according to the rate of return of the investment project.

## 5. Conclusion

In conclusion, both NPV and IRR are relatively reliable analytical tools that investors can use when conducting economic analysis during the investment process. NPV is usually presented as cash flow in dollars, while IRR is usually presented as a percentage. The calculation method of VPN will be much simpler than IRR. Therefore, most investors prefer to choose NPV as an analysis tool for economic analysis. Of course, some investors like to use IRR for economic analysis. Finally, the NPV and IRR methods have their own advantages, disadvantages and limitations, so when the two methods are compared, it cannot be concluded that which method is better, nor can they replace each other.

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