# Research on Project Investment: Methods of NPV, IRR and MIRR

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**Abstract**

This article introduced three methods which can show the investment value. Net present value (NPV) and internal rate of return (IRR) are two useful tools to help investors to decide between different mutually exclusive projects. Both NPV and IRR have advantages and disadvantages. As the investment concept developed quickly, neither NPV nor IRR shows any reinvestment problems when making investment decisions. A new method named Modified internal rate of return (MIRR) solves these problems which improves IRR's version. MIRR considers the capital cost as reinvestment rate and give a more accurate evaluation of the investment return. To conduct the methods research and implement related provement, a specific case of Mahjong Inc. was used as example for anaylsis. Some applications of MIRR were also introduced in this article.

***Keywords:*** *Net present value, internal rate of return, Modified internal rate of return, Investment decisions.*

## 1.INTRODUCTION

In general, the net worth (NPV) and internal rate of return (IRR) methods are one of the commonly used methods for mutually rejecting project decisions based on cash flow. These techniques have sufficient methodological basis, valid logic and wide application in investment project decision-making and other fields such as university education or financial investment analysis. In most of the case, conclusions derived from the net present value (NPV) and internal income (IRR) methods would be similar. However, there are sometimes differences in the following two situations :(1) the initial investment is inconsistent, and the initial investment is inconsistent. One project is bigger than the other. (2) The time of cash inflow is not even. The cash inflow of one project in the past few years is more than the cash inflow of the previous project several years ago. This makes it difficult for them to compare the net worth (NPV) and internal revenue (IRR) of two mutually exclusive projects objectively and effectively. Therefore, we discussed a new model to modify the internal rate of return (MIRR) and announced it in the 18th century. Describe these cash flows. This paper describes the challenges faced by NPV and IRR, evaluates the application of MIRR, and identifies how MIRR addresses the weaknesses revealed in NPV and IRR.

This paper is divided into two parts. The first part obtains data from net value and IRR by calculating two mutually exclusive scenarios. We will then compare the NPV and IRR of these two mutually exclusive projects. In second part, we constructively demonstrate an improved internal revenue model as a financial method for measuring project revenue and comparing it with other potential projects.

## 2.NPV AND IRR

### *2.1.Net Present Value*

Net worth (NPV) is the sum of all future cash flows determined at current value. Cash flows consist of reflective inflows and outflows at a constant rate, subject to project risk. The calculation formula is (1),

$$NPV = -CF_0 + \frac{CF_1}{(1+i)^1} + \frac{CF_2}{(1+i)^2} + \cdots\cdots + \frac{CF_n}{(1+i)^n} \quad (1)$$

where the cash flow (CFT) is the net cash flow at t-t, R is the discount rate, and n is the investment period.


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The concept of future cash flow is smaller than the concept of current cash flow. Discounted in the 16th century [5]. Gioja (1817) also provided a classic compound interest formula to determine the present value of future cash flows by discounting interest rates. NPV was obtained from these studies. NPV also has its advantages and disadvantages.

The advantage of NPV is that it takes into account the time value of money. You can display the absolute size of an investment project, and the maximum profit of the project can be obtained through the net value of each project. NPV also has prerequisites. In the case of NPV, the annual net profit of the project is reinvested at the start-up cost of the fund [1].

The disadvantage of the NPV rule is that by showing the net dollar value of the project, the value of the value does not provide information about the rate of return [7]. He also pointed out that another disadvantage of the NPV rule is due to the failure to improve the establishment of the project. Information within an organization [11].

## *2.2. Internal Rate of Return*

The origin of the internal rate of return (IRR) can be traced back to Keynes (1936). This approach is widely used as an aspect of management decision-making. IRR decisions suggest their IRR classification of mutually exclusive items: higher IRR item records [9].

The internal rate of return is the zero cash inflow rate that reduces the sum of all discounted cash outflows. The present value of cash inflows and the present value of cash flows [10] show that the rate of return is NPV = 0. The internal rate of return formula can be expressed as (2):

$$NPV = -CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots\cdots + \frac{CF_n}{(1+r)^n} \quad (2)$$

This is the return on investment. Net value should make the answer equal to zero.

According to the experience of capital operation and maintenance, IRR has the following rules. When IRR&GT, the project will be approved by capital. When IRR < LT, if IRR = cost of capital, then the project will not be approved. If IRR = cost of capital, the project loses money [6]. Table 1 shows some advantages and disadvantages of IRR.

**Table 1:** Advance and disadvantage

| IRR | |
|---|---|
| **Advantage:** | Disadvantage: |
| **1.It considers all cash flows.** | 1.It computes quite difficult. |
| **2.It is a true measure of profitability.** | 2.It is a ratio, not an absolute value. |
| **3.It considers time value of money.** | 3.Does not hold the value additive principle |
| **4.It consists with profit maximization principle.** | 4.There may be more than one result. |

## *2.3. Example*

Mahjong, Inc., has identified the following two mutually exclusive projects (table 2) and there is a significant and same between the starting capital investments. The useful life-span is 4 years. The first investment version can be realized by a 450 million$ capital engrossment and results in different net yield every year.

The second investment version needs also a 450 million $ capital investment and benefits in the realization of net cash inflow all years.

The investment changes are evaluated based on internal rate of return (IRR) with net present value dervived by discount rate of 0, 10%, 20%, and 30% respectively for each project.

A graph is plotted with the discount rates data points on the horizontal axis and the corresponding NPVs derived by the NPV function on the vertical axis.

**Table2**: Project cashflow (Unit: million $)

| Projects | CF0 | CF1 | CF2 | CF3 | CF4 |
|---|---|---|---|---|---|
| A | -450 | 240 | 180 | 121 | 95 |
| B | -450 | 80 | 140 | 245 | 255 |

**Table 3:** Project A (Unit: million $)

| CF0 | -450 | Project A IRR |
|---|---|---|
| CF1 | 240 | 18.72% |
| CF2 | 180 | |
| CF3 | 121 | |
| CF4 | 95 | |

IRR of project A=18.72%

**Table 4:** Project B (Unit: million $)

| CF0 | -450 | Project B IRR |
|---|---|---|
| CF1 | 80 | 17.90% |
| CF2 | 140 | |
| CF3 | 245 | |
| CF4 | 255 | |

IRR of project B=17.90%

According to Excel (Tables 3 and 4), we can obtain that the IRR of this project is 18.72%, while the IRR of project B is 17.90%.

It is well known that for mutually excluded items, the irR is acceptable than the expected rate of return. Project A has A higher IRR than Project B, so the company should accept Project A.

By using formula of NPV, NPV can be calculated easily.

When the discount rate equals to 0.

NPV of project A:

186

NPV of project B:

270

When the discount rate equals to 10%.

NPV of project A:

72.74

NPV of project B:

96.67

When the discount rate equals to 20%

NPV of project A:

-9.16

NPV of project B:

-21.35

The graph with project A's NPV on the vertical axis and discount rate on the horizontal axis (Fig.1).

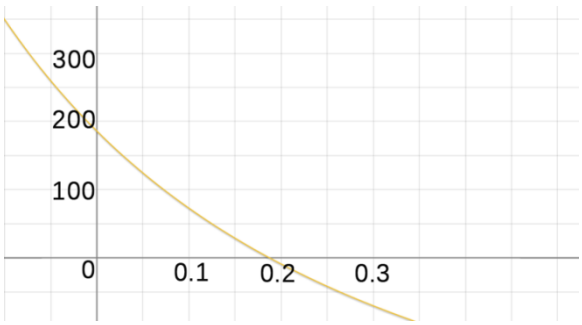


**Fig.1:** Project A

The graph with project B's NPV on the vertical axis and discount rate on the horizontal axis (Fig.2).

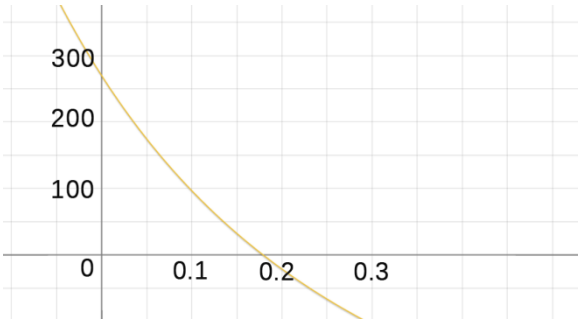


**Fig.2:** Project B

### *2.4. Choice between Project A and Project B*

From calculation. NPV and IRR show the determination of investors when facing different projects. When the discount rate is between 0 and 16% (when the NPV of project B is equal to the NPV of project A), the NPV of project B is higher than that in project A, and the investor will choose project B. Between 16% and 17.9%, Project A's NPV is higher than Project B's NPV. The investor will select Project A.

However, NPV and IRR also need to be improved. IRR has not explain perfectly about the problem of reinvestment and capital cost. To solve these problems, MIRR was created in this situation.

## 3.THE MODIFIED INTERNAL RATE OF RETURN

### *3.1. Definition*

The revised IRR is a financial formula used to measure a project's return which could be used to compare to other potential projects. The formula was developed to allow the application of the traditional internal return on investment, assuming that there is a difference between the formula reinvestment rate and project rate of return. In order to improve the IRR, MRR is proposed, and the investment amount can be calculated using MRR with the garantation of cash flow [3]. The cost of capital is the ratio of the RE-RE-organization's positive cash flow. The timing of the financing cost will cause the investment cash flow to deteriorate. Using MRR, the internal return can be calculated more comprehensively.

MIRR assessment for a particular project begins by finding the context of the cash flow, the value of the cash flow and discounting the cost to the organization. After calculation, if the result obtained is greater than the expected return, the organization should consider setting the investment as [2]. If the results are less than expected, the company shall reject the project. In two mutually exclusive projects, the company should consider undertaking the project at a higher IRR.

### 3.2. Example

The basic internal rate of return is calculated as follows. Repairing a two-year project with an initial outlay of $195 and a capital cost of 12% yields a return of $121 in the first year and $131 in the second.

$$NPV = 0 = -195 + \frac{121}{(1+IRR)} + \frac{131}{(1+IRR)^2} \quad (3)$$

To calculate the project's MIRR, assuming that positive cash flow will be reinvested at 12% of the cost of capital. Therefore, when t=2, the future value of a positive cash flow is calculated as:

$$\$121 \times 1.12 + \$1.31 = \$266.52 \quad (4)$$

Next, divide the trend value of cash flow by the project investment amount to get the periodic profit and loss, and then use MIRR to control the period to get：

$$MIRR = \frac{266.52^{\frac{1}{2}}}{195} - 1 = 16.91 \quad (5)$$

It can be seen from the above examples that the calculation results of IRR will guide investors to invest, and the calculation results of single MIRR will make investors more aware of the reality.

### 3.3. How MIRR Deals with NPV and IRR Weaknesses

The idea behind MIRR is that it is easy to calculate; However, it may be difficult in practical since it requires an estimation of reinvestment rates. As shown in the example above, MIRR is calculated in the following three steps: the budgeted investment capital is discounted to current value at a favorable rate that fairly represents the investment risk, and free cash flow has been restored to the selected time within the expected future opening time range. Reinstam.isk is equal to investment risk and IRR is calculated [4]. In the calculation, MIRR is the discount rate, which can have investment value under future cash flows. NPV is zero, the period between early investment and future value is zero.

Through the above process, MIRR effectively addresses the weaknesses of NPV and IRR. Several disadvantages of IRR and NPV. When calculating size, time and incompetence, they fail to calculate the free cash flow between periods and provide different levels of mutually exclusive projects. When cash flow changes from negative to positive, IRR can provide multiple rates of return [12]. MIRR can reinvest the cash flow generated by the project to address these weaknesses. An investment return specification was introduced to take account of managed investment risk [8]. The management should also provide the specification of the rate of reinvestment provided the risks linked with the future investment of the cash flows. MIRR provides more accurate results since attractiveness relies on both rate of return and the anticipated return from the cash flows generated from the investment.

### 3.4. Application of MIRR

MIRR can be used by traders to determine the future stock price of a company and therefore can be used as part of a trader's basic analysis. On the one hand, a trader will increase his purchase of a company's stock if he expects the investment to yield a profit. On the other hand, if the estimated profit is conservative or overstated, the trader may be expected to undo the decline in the value of the company's stock. MIRR can also be used to analyze two mutually exclusive projects. After calculating the MIRR of the project, the investment should be made if the result is greater than the expected revenue. If MIRR is lower than expected, the project should be rejected. If both projects are condemned, the higher MIRR project is used. This approach takes into account all realistic possible reinvestment rates that can be used effectively to evaluate projects to avoid the disadvantages of choosing a non-profit project.

Finally, MIRR can also be used to explain the order of payment and receipt. The revised IRR is the IRR of payments and revenues at different interest rates. The MIRR function takes into account the cost of investment and the interest rate at which cash is reinvested. It uses the order of the median array to explain the order of payments and receipts so that payments and receipts are entered in the exact order.

## 4.CONCLUSIONS

From previous studies, NPV and IRR have been widely used in the field of investment as an effective method. Net present value reflects the level of real return on investment. Companies will choose projects with a greater net worth. The internal rate of return is the special discount rate that makes net worth zero. A higher IRR shows the ability of project investment income which can bear the inflation and can be preferred by most of investors. Although these two methods have great effect on the decision of choosing the investment projects, they also has some shortage. IRR sometimes can be calculated to two different numbers. It also can not consider the situation that investors may use the money they earn to reinvest other investments. Investors may be influenced by the wrong number and make a wrong decision. So, finding another method to calculate the benefit of investment project more accurate is absolutely important.

Modified internal rate of return can solve these problems perfectly. By using MIRR, investors can calculate more accurate data in order to provide the accordance for companies on their project selection. MIRR introduces a new term named reinvest rate. It can consider the cash flow investments between the first period and last period. More importantly, free cash flow

is compounded to a time horizon at the reinvestment rate of MIRR. This ratio represents expected future opportunities with investment risk. It can solve the problem that the internal rate of return may have different values when the cash flow turns from negative to positive more than once. MIRR shows a good way to consider effects such as reinvestment.

However, there are also some questions that MIRR cannot answer. Increasing MIRR becomes increasingly important in our future studies. Using MIRR has a basic prerequisite that all investments are of the same size. MIRR cannot solve this problem when projects require different investment amounts, funding is limited, or projects are mutually exclusive. Actually, some advanced methods have been found to get more reasonable benefits of projects. External rate of return is one of them. ERR assume that the reinvest rate equals to the basic discount rate. If using ERR to choose project, the final value will be basic determined standard. The basic discount rate is predicted by economic environment, investment project and some calculated ways. It means the lowest standard of this project available. So ERR's reinvestment rate is more accurate. These methods are important for investors to choose projects. More studies may gain better solution.

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