What is the better investment rule for investing in the financial markets – NPV or IRR? Why? Are there alternatives we should consider instead?

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Abstract. Based on the principal reasons behind economic problems, investors are forced to make decisions in order to ration out investments based on rules.

Keywords: Mutually exclusive; Net present value; Internal rate of return; Cashflows; Discount rate; Time values.

1. Introduction

In economics, there are limited number of resources but human has unlimited wants and needs. Thus, investors are compulsory in making decisions. When investors invest in mutually exclusive investments, they need to make choices. "Mutually exclusive is a statical term describing two or more events that cannot happen simultaneously." (Young, 2022) Therefore, economists utilize different investment rules to evaluate investments or capital projects such as NPV and IRR. Personally, I think NPV and IRR both have their own strength, investors should suit the remedy to the case, decide which one to use considering its own case. Besides, NPV and IRR are not the only investment rule that could be use.

2. What is NPV (Net Present Value)?

Net Present Value (NPV) is one of the most common used investment rules for evaluating investments or capital projects. The rule Net Present Value is defined as "the difference between the present value of cash inflows and cash outflows over a period of time". (Beers, 2021) In an investment project, cashflows will be generated. Cashflow is "the amount of cash (currency) that is generated or consumed in a given time period" (Team, 2022) In other words, cashflow represents the value of assets.

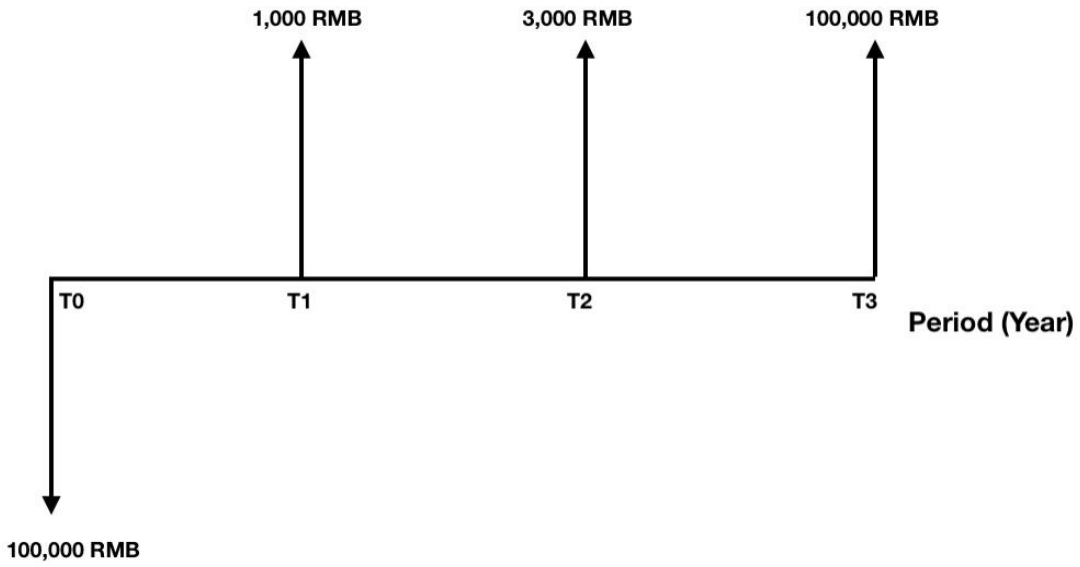

Figure 1. Cash Flow Diagram

The graph above is a cashflow diagram. In the diagram, the horizontal axis represents the time period in the investment. The vertical arrows represent cashflows in an investment, arrow pointing down means cash outflow, arrow pointing up means cash inflow.

In this example, the investor invests 100,000 RMB at T0 which is presented in the diagram as an arrow pointing downwards at T0. After one year, at T1, the investment gained a return of 1,000 RMB. It is presented as an arrow pointing upwards at T1. Then, after another year, at T2, the investment gained 3,000 of cash inflow. It is shown in the diagram as an arrow pointing upwards at T2. Finally, at T3, the investment received a 100,000 RMB of cash inflow.

However, people might think in order to evaluate the investment, we can just simply use the cash inflow subtract cash out flow. This is clearly wrong. Hence, this is when Value of Time is introduced in investments. Time has values. The concept of Time Value can be precisely explained by an example. When a person put their money in a bank, after a period of time, he or she will receive a sum of principal and interest. On the other hand, if this person decides not to invest or keep the money in the bank, then, the money will remain the same after a period of time. Thus, with same amount of money in the present, the value of the principal will increase if investor invests. In other words, the time value of money will be added to the original value of money. In this case, people need to discount the time value in order to get its present value.

The formula of NPV is displayed below:

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t} \tag{1}$$

Where:

Rt = net cash inflow – outflows during a single period t

i = discount rate or return that could be earned in alternative investments

t = number of time periods (Fernando, 2022)

As the formula established, we need to use the amount of money and discount it with interest rate in order to calculate its present value. In simplify term, to convert how much the money in the future is worth at present (T0). This formula was evolved from the compound interest formula.

The connection between Compound interest formula and NPV formula can be proved by an example.

Table 1. Compound interest calculation

T0	T1	T2	T3
100	110	121	133.1

For example, Peter put 100 dollars in the bank with an interest rate of 10% per year. After one year, at T1, he will receive an interest of 10 dollars which has come from:

100 x 10% = 10

100+10=110

Hence, in Peter's bank account he will be resulting 110 dollars at T1. Furthermore, after another year, at T2, the money in his account (110) will receive an interest of 11 dollars by:

110 x 10% =11

110+11=121

Therefore, his account will be resulting 121 dollars at T2. In addition, when we know the value at T1, we can simply calculate its value at T0 (present) by using its value at T1 divided by (1+interest rate). In this example, we can use 110 divided by (1+10%) in order to get 100.

110/(1+10%)=100

As well as at T2, since 121 has come from 100 x (1+10%) x (1+10%), then we can get the present value by discounting (1+10%) x (1+10%):

121/(1+10%)^2=100

This is the same when investor invest in an investment. We have the value of cash inflows we can evaluate its present value by discounting its discount rate.

To sum up, in order to calculate NPV of an investment, we should: firstly, determine its nominal cashflow; secondly, discount the cash flow by its discount rate; thirdly, sum the discounted cashflow.

For example, in this circumstance, we assume it has a discount rate of 10%. The present value of 1000 at T1 will be:

1000/(1+10%)=909.0909… (approximately 909)

The present value of 3000 at T2 will be approximately 2479:

3000/(1+10%)^2=2479.33884…(approximately 2479)

The present value of 100000 at T3 will be approximately 75131:

100000/(1+10%)^3=75131.4801…(approximately 75131)

Therefore,

NPV= -100000+909+2479+75131=-21481

The result indicates the investment will lose -21481 dollars after three years.

As a conclusion, when NPV is positive the investment is considering an approved and profitable investment. In a set of Mutually exclusive investments the higher the NPV the more profitable the investment is.

3. What is IRR (Internal rate of return)?

IRR, the internal rate of return is another measure economist use to evaluate investments or capital projects. The investment rule, IRR is defined as "a metric used in financial analysis to estimate the profitability of potential investments." (Fernando, 2022) To simplify, Internal rate of return is the discount rate that makes Net present value equals to zero. The formula of IRR is displayed below:

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

Where:

Ct=Net cash inflow during the period t

C0 = Total initial investment costs

IRR = Internal Rate of Return

t = The number of time periods (Fernando, 2022)

In order to calculate Internal rate of return we should: firstly, determine the nominal cashflow; secondly, make NPV equals to zero; lastly, calculate the discount rate that makes NPV equals zero.

For instance, a company invest 200,000 dollars in a project. The project will last 2 years and has a discount rate of 10%. The cashflow will be presented as below:

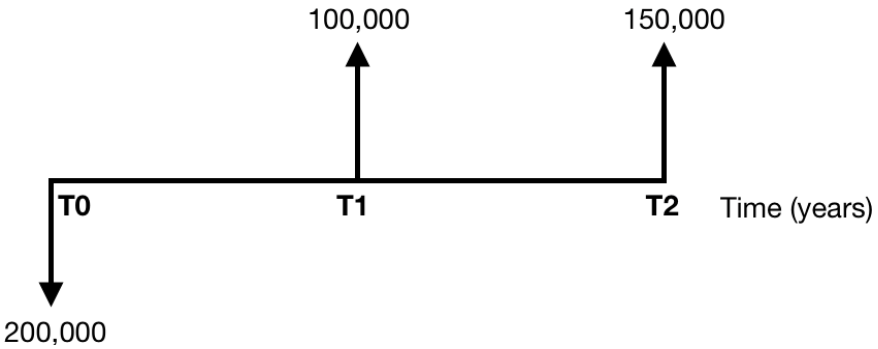

Figure 2. Two-year cash flow diagram of a company's project

As the diagram implies, at present the company invest 200,000 dollars. The project will return 100,000 after one year and return another 150,000 after two years. The present value of return at T1 can be calculated by:

PV= 100000/(1+10%)=90909.0909… (approximately 90909)

The present value of return at T2 can be calculated by:

PV= 150000/(1+10%)^2 = 123966.942…(approximately 123967)

Therefore, the net present value of this project will be:

NPV= -200000 +100000/(1+10%) + 150000/(1+10%)^2

NPV= -200000 + 90909 + 123967 = 14876

Intending to calculate the Internal rate of return, we need to make NPV equals to zero:

NPV= -200000 +100000/(1+IRR) + 150000/(1+IRR) ^2=0

IRR=0.151388 (approximately 15%)

Hence, the Internal rate of return indicates when the discount rate of the investment is lower than 15%, then the investment will make profit. Otherwise, when the discount rate of the investment is higher than 15%, then the investment will result with a negative return.

To conclude, when IRR of an investment or capital project is higher than its discount rate, then this investment or capital project is considered a profitable investment; when IRR of an investment or capital project is lower than its discount rate, then this investment or capital project is considered a non-profitable investment. In a set of mutually exclusive investments, the higher the IRR the higher potential the investment.

4. Comparison: NPV vs IRR

Both NPV and IRR has their own distinct advantages and disadvantages.

Net Present Value has a lot of strength in contrast with Internal rate of Return. Firstly, net present value is presented as an absolute value instead of a percentage. For this reason, Net present value is more straightforward as it shows an actual value for investor to evaluate. Moreover, since NPV is an absolute value, then it reflects the size of the project. In the case of IRR, we can only compare its percentage but cannot visualize its scale. Next, in the case of non-conventional cash flow, more than one IRR will be generated. “An unconventional cash flow is a series of inward and outward cash flows over time in which there is more than one change in the cashflow direction.” (Kenton, 2021) Therefore, IRR will not be referenceable even though NPV becomes more complicated. Furthermore, in reinvestment assumption, “the NPV method assumes that cashflows from a project are reinvested at the cost of capital, whereas the IRR technique assumes they are reinvested at the IRR.” (Corporate Finance, 2011) Due to the fact that IRR is often higher than the cost of capital when the project is profitable, thus, using IRR as the return rate may be too high and over optimistic. In this case, using NPV will be more reasonable. (Gallant, 2022)

On the other hand, the method using internal rate of return also has a lot of advantages over calculating the net present value. One of its main advantages is the Internal rate of return are often more relevant when you are making comparisons between multiple projects or investments, or when it is difficult to determine an adequate discount rate. As well, it can be compared to different cost of capital.

However, there are circumstances when NPV and IRR disagree. The graph below presents graphs of conventional cash flow and non-conventional cashflow:

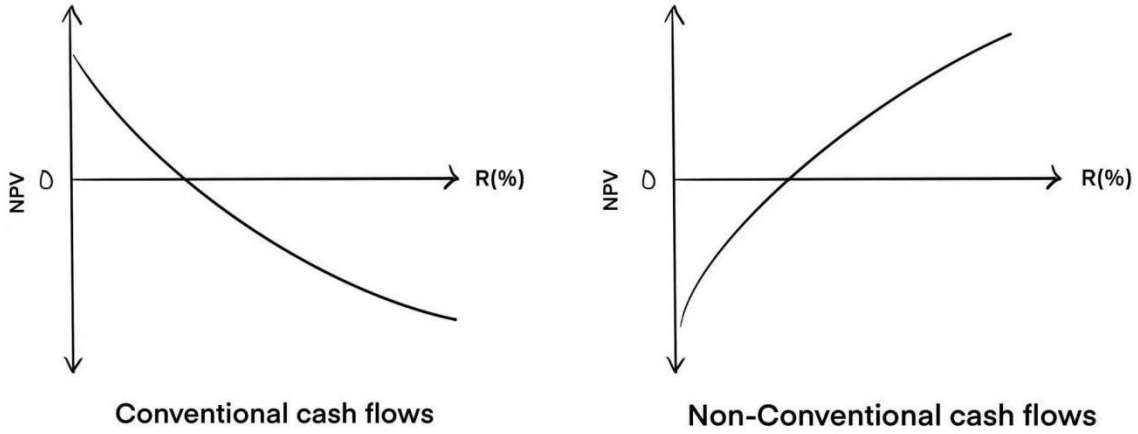

Figure 3. Conventional versus non-conventional cash flows

Refering to our investment rule: Investors should invest on investment with positive NPV and discount rate lower than IRR. These two rules agree with each other only when the cash flow is conventional. By contrast, in a non-conventional cash flow, NPV and IRR will disagree with each other. As shown in the graph of non-conventional cash flow, the zone where NPV is positive, the discount rate of the investment resulted to be larger than the internal rate of return.

As a conclusion, NPV and IRR can only be used as a reference. NPV and IRR are both a relatively referenceable method for investors to evaluate capital projects or investments. Yet, both methods have weaknesses. Investors should decide which one to use depending on each circumstance. Hence, investors may use wider range of valuation for measuring investments and capital projects in order to eliminate the possibility of error occurs.

5. Alternatives

As mentioned at the start, NPV and IRR are only two of the many investment rules that evaluate Investments and capital projects. There are varies of alternatives that investors can use to evaluate the investment.

5.1 MIRR

MIRR is a simplified term for Modified Internal Rate of Return. “The modified internal rate of return (MIRR) assumes that positive cash flows are reinvested at the firm's cost of capital and that the initial outlays are financed at the firm's financing cost.” (Hayes, 2022) Due to the error occurred for IRR in reinvestment assumption, investors can eliminate errors caused by IRR by using MIRR. It evolved from the method using IRR by “assuming that positive cash flows are reinvested at the firm's cost of capital”. (Hayes, 2022).

5.2 PI

PI is simplified term of Profitability index. It infers the ratio determined by the present value of all the cashflows and the initial cash input of the investment.(Chen, 2022) Investors should choose project or investments with higher profitability index as it infers the project is the most productive. A project with a profitability index greater than 1 is considered as a project approved.

5.3 PBP

PBP is a simplified term for payback period. “The term payback period refers to the amount of time it takes to recover the cost of an investment.” (Kagan, 2022) A smaller value of PBP conveys the investment takes shorter time to recover the cost of an investment. Therefore, the smaller the value of PBP, the better the investment.

5.4 WACC

WACC is also known as Weighted Average Cost of Capital. WACC "represents a firm's average after-tax cost of capital from all sources." (Hargrave, 2022) Oftenly, investors uses WACC with IRR and NPV to evaluate the project. Theoretically, when NPV is negative, then IRR should be less than WACC. In this case investor should reject the project. On the other hand, when NPV is positive, then IRR should be greater than WACC. Hence, the project should be profitable in most cases. However, combining these three cannot guarantee the profitability of an investment. Investor should consider other factors as well in order to evaluate the project or investment.

6. Conclusion

In conclusion, NPV and IRR both have their distinct advantages and disadvantages. Both methods are referenceable but not perfect. Therefore, investors should use other investment rules to eliminate its possibility of the occurance of error, such as MIRR, PI, PBP, etc. Investors should choose different rules depending on its own circumstance.

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