The Analysis of NPV and IRR and Its Alternative Methods

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Abstract. Based on the analysis of the net present value method and the internal rate of return method, this paper lists the pros and cons of these two different investment rules and gives some alternative approaches. With improvement and optimization, these two investment rules can be more efficient convenient, and widely used than before. This essay further enriched and developed the internal rate of return and net present value rules by analyzing the advantages and disadvantages of the measurement methods in detail. In addition, it provides implications for investors to better evaluate the corporate or project value.

Keywords: net present value, internal rate of return, preferred methods, investment rule.

1. Introduction

Many firms and companies preferred to evaluate an investment or a project via IRR or NPV method in today's financial market. Most investors believe these two investment rules can measure the value of the investments and projects accurately. This paper aims to summarize the principles of these two investment rules and provide some practical suggestions to investors. It offers some alternative approaches which help improve the calculations of the traditional methods based on the drawbacks of the rules. The finding enriches the literature on NPV and IRR methods and provides investors with some implications.

The paper is organized as follows. First and foremost, the paper provides some basic theories about the net present value and internal rate of return including the basic definition and the formula. It explains the advantages and limitations of the two methods with some simple examples and graphs. The comparison of these approaches will be demonstrated in the paper, explaining the difference and similarities between the two approaches. Next, it will introduce two ways of calculating the IRR and NPV with some improvements base on the limitations of the investment rules mentioned in the former section. The paper also provides some examples to explain the new methods in detail.

2. Description of Related investment rules

2.1 Net Present Value (NPV)

2.1.1 Basic Introduction of NPV

It will provide some basic definitions of the net present value below.

Net present value is one of the most common investment rules for the financial evaluation of long-term projects. This approach evaluates the program's benefits and drawbacks based on the number of NPVs. If the NPV exceeds zero, the program is feasible; the higher the NPV, the better the program and the bigger the investment benefits. By definition, the formula of NPV is as follows.

$$\text{NPV} = C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \ldots + \frac{C_n}{(1+r)^n}$$

where
n: number of years period
r: discount rate
C0: the present value of the original investment

The discount rate plays a significant role during this process, which calculates the present value of the future cash flow. It is determined by our intuition on the level of risk of the projects. A higher rate means a greater perceived risk associated with the investment opportunity.

There are also some academic approaches to thinking about the discount rate one of the most common ones is the build-up method, adding the risk of operating, market, and credit as well as the liquidity risk premium to the risk-free rate and getting the discount rate [1]. Usually, the projects with higher NPV will be accepted priority.

2.1.2 Advantages of the NPV method

It is convenient to evaluate a project or investment by the NPV method in the financial market.

NPV recognizes the time value of money which is critically and entirely appropriate for making long-term investment decisions. The long-term projects may have more uncertainly in cash flows which can be adjusted by estimating the expected cash flow and the interest rate in an appropriate way.

What's more, the calculation of net present value is quite simple than others. That is the reason why many investors prefer to use it as their main way of measuring the value of the projects.

2.1.3 Limitation of NPV method

Even if many companies and firms adopt the NPV method, there are still some drawbacks to the investment rule that can not be ignored.

The project with a higher NPV will become the main priority if there are two mutually exclusive projects are being considered, even if both the two projects have positive NPVs [2]. The two projects are mutually exclusive which means the investor or the company can only undertake one of them. For example, if an enterprise gets a limited grant from the government to construct a power station and has a choice of building a hydroelectric power station or a coal-fired power station, then these are mutually exclusive projects. Nowadays, the evaluation of the mutually exclusive project shows a tendency that the project may have competition with itself [3]. The changes in the various projects step up the difficulty of making investment decisions, and NPV is becoming a less valuable financial method than before.

The NPV is expressed in absolute terms rather than relative terms, and the size of the investment is not taken into consideration. A higher NPV does not always represent a better investment. A project with a relatively larger investment scale may have a higher NPV because of a larger original investment, in other words, a larger outlay. For example, a project with a value of $10 million will be more likely to have a much greater NPV than a $10,000 project, even if the project with less value provides better returns in percentage terms. And it can be considered that the NPV method ignores the "ability to earn" of a project.

Also, the typical NPV method ignores the manager's timely adjustments to future changes and assumes that future changes will always occur by the environment specified at the beginning of the decision, whether in terms of future cash flows or the risk discount rate to be used [9]. The investment and operation of many projects come with a set amount of time during which the manager can alter the project's operation now or in the future in response to shifting market conditions, which means that the decision-making process for projects shifts from static to a dynamic one. If the market conditions are favorable, the decision-maker may make extra expenditures to grow the project. By contrast, if the market situation is adverse, the manager can temporarily halt operations or resell the project, cut back production, or change to a different line of business when the price of the project product is less than the variable cost of the product. It is challenging to predict future cash flows with accuracy due to the operational decisions' flexibility, which alters the risk of project operations and opens the opportunity for risk avoidance. The value of flexibility in the project investment process, however, is not considered by the conventional NPV technique, therefore it cannot be evaluated.

2.2 Internal rate of return (IRR)

2.2.1 Basic Introduction of IRR method

It will provide some basic definitions of the net present value below.

Engineers and economists have long used the Internal Rate of Return to measure the profitability (or potential profitability) of projects (IRR). The basis for describing this notion is the methods of Discounted Cash Flow (DCF), a methodology used to "weight" cash flows occurring at the "present period" in some fair manner to show their value in comparison to "future" cash flows in following years [6].

The investment strives to increase a specific rate of return, and a greater indication is preferable. In general, a project is feasible if the IRR is greater than or equal to the benchmark yield. The capacity of a project's investment returns to resist currency depreciation and inflation is most frequently referred to as the internal rate of return, which is a macro-concept indicator. For example, if the IRR of a project is 7% and it can be understood that this project can stand up to maximum currency devaluation of 7% or inflation of 7%. It also indicates the risk resistance during the investment operation. If the IRR is 7%, it represents the maximum risk that can be taken during the project operation is 7% per year. Thus, when investing in a new project, the investors will accept the one with a higher IRR. The reason is that the company or firm prefers a more positive return. By contrast, a loan with a lower internal rate of risk will be given priority because of lower risk. Mathematically, the internal rate of return is the discount rate with a net present value equal to zero.

$$C_0 + \frac{C_1}{1+I} + \frac{C_2}{(1+I)^2} + \frac{C_3}{(1+I)^3} + \ldots + \frac{C_n}{(1+I)^n} = 0$$

where
n: number of years period
I: internal rate of return
C0: the present value of the original investment

2.2.2 Advantages of the IRR Method

Here are some benefits of using the IRR method.

Time worth of money is considered via the IRR approach. Even though the cash inflows vary from year to year, it considers the time worth of money. By determining the present value of future cash flows equal to the required capital investment's interest rate, one will get the internal rate of return. It discloses the maximum rate of return that a project can give, specifying the maximization of profitability.

Because the decision maker must first establish a benchmark discount rate i0 for net present value (NPV) calculations, which is a challenging and contentious issue, the internal rate of return (IRR) method has clear advantages over the net present value (NPV) methods for making decisions about investment projects. The internal rate of return (IRR), which is estimated from the project cash flows and is better, is endogenously decided rather than exogenously fixed in advance [10]. The IRR technique, a crucial tool for financial dynamic analysis, may reveal the viability of a project's investment as well as its security and profitability.

2.2.3 Limitation of the IRR Method

Some limitations of the IRR methods will be explained below.

While certain special investment programs may compute numerous IRRs, unlike regular investment programs, they can demand considerable financial outlays during the program's benefit term in addition to the initial investment outlays, which makes evaluating the IRR approach more challenging [8].

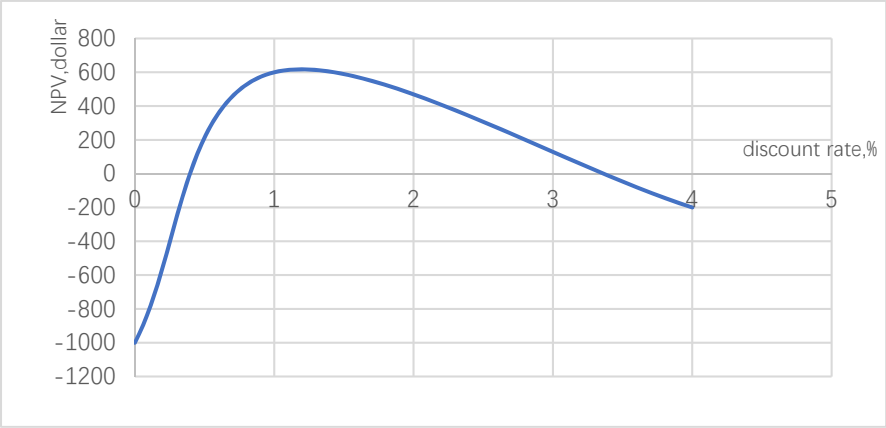

Fig 1. The curve of NPV and discount rate

The graph shows that there are two discount rates for which NPV is equal to zero, which can be regarded as two different internal rates of return. In this case, it is hard to evaluate a project by the IRR rule.

When choosing from mutually exclusive projects, it is quite easy for investors to make wrong decisions.

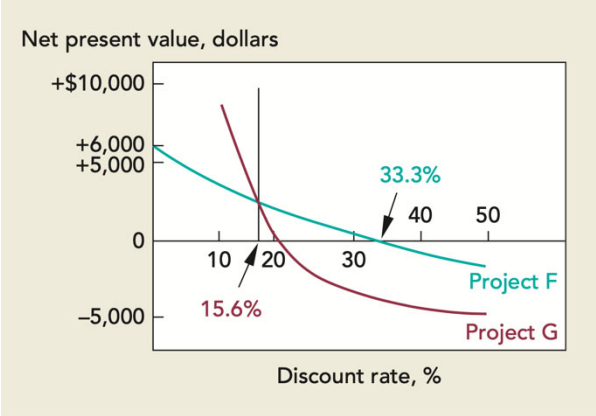

Fig 2. curve of NPV and discount rate

(Source: Zvi Bodie, Alex Kane, Alan J. Marcus. investment—9th.ed)

When the discount rate is less than 15.6%, project G will have a higher NPV. When the discount rate is higher than 15.6%, F has a higher NPV. Thus, we usually choose to value the project by NPV in this case.

The project's overall size and scope are disregarded by the IRR technique. The method does not use the project's size or scope for comparison. Cash flows are simply compared to the quantity of capital used to produce such cash flows. The larger project will frequently be worth less than the smaller one according to the IRR calculation if two distinct projects demand quite different amounts of capital. Companies can find themselves avoiding long-term investments that could eventually provide greater positive cash flows if this is the only way employed as a tool.

2.3 Comparison of IRR and NPV method

When evaluating investment projects based on discounted cash flow, one of the techniques that are used most commonly is the net present value (NPV). Another is the internal rate of return (IRR). The approaches apply to a wide range of investment project evaluation scenarios and have a universal nature. The degree of dependability of the approaches is equal somewhere. And there are both differences and similarities between these two investment rules.

One of the differences is that the NPV measure is the absolute term, but the IRR measure is the relative term. For instance, a 17% IRR may be acceptable or unacceptable. The resulting IRR is first compared to the company's acceptance rate of return.

And net present value method is expressed in form of the cash return value, whereas the IRR is expressed as a rate. The IRR method is not applicable to measure the value of a project or investment with varied cash flow. In such cases, NPV is a better capital budgeting as it never ignores each cash flow.

According to the principle of the internal rate of return, it is more difficult to make an investment decision when evaluating an investment by it. Any projects or investments with positive value (NPV > 0) can be considered acceptable and may be valuable to the firm. In contrast, the rate of return is compared to the acceptable rate of return of the business, making the decision more difficult. When the initial investment is very high, the NPV shows a strong inflow of cash. In such cases, the IRR will score better because it reflects the percentage of return without taking into account the initial cash flows.

One of the obvious similarities is that f the business does not face financial constraints that prevent it from accepting all profitable projects, NPV and IRR techniques provide the identical accept-or-reject decision in the case of traditional investments, which are economically independent of one another [7]. As a result, it is discovered that when it comes to accepting or rejecting separate traditional investments, NPV and IRR techniques are identical.

Traditional proposals often involve cash outflows in the early years, and usually some cash inflows. This similar situation arises in the decision-making process. For NPV, if the proposal has a positive net positive value, it will usually be accepted. And if the rate of return is greater than or equal to the benchmark yield, then the IRR is usually accepted. Projects with a positive NPV also indicate an IRR that is higher than the baseline value.

NPV and IRR are both excellent investing guidelines. However, they don't always match up and provide investors with the information they need, particularly when two projects are in competition and provide equally profitable choices. Therefore, when rating mutually incompatible projects, the NPV technique is preferred by the majority of project managers.

3. Description of The Preferred Methods

3.1 Improvement of Net Present Value Rule

3.1.1 Brief Introduction of the New NPV Method

This section will introduce a new NPV method.

Adding a varying discount that may affect the net income or investment can help adapt the inconstant discount rate [4]. The formula is as follows:

$$\mathrm{NPV} = C_0 + \frac{(1-d_1)C_1}{1+r} + \frac{(1-d_2)C_2}{(1+r)^2} + \frac{(1-d_3)C_3}{(1+r)^3} + \ldots + \frac{(1-d_n)C_n}{(1+r)^n}$$

3.1.2 Examples of the New NPV Method

Some examples will be provided below to show the advantages of the new net present value investment method after the improvement.

There is an example of calculating the net present value by the traditional NPV formula.

Table 1. Example of traditional NPV method

Cashflow(dollar)	C0 -1000	C1 2000	C2 2000	C3 2000
r(%)		5%	5%	5%
Present value(dollar)		1904.8	1814.1	1727.7
				NPV = $4446.6

Adding another rate to evaluate the project or investment in a more comprehensive way and the calculation of net present value will be different.

Table 2. Example of new NPV method

Cashflow(dollar)	C0 -1000	C1 2000	C2 2000	C3 2000
d(%)		10%	15%	20%
r(%)		5%	5%	5%
Present value(dollar)		1714.3	1542.0	1382.1
				NPV = $3638.4

The newly added rate can provide investors an opportunity to consider more sort of factors that may affect the cash flow. In other words, the risk of the investment can be relatively lower than measured by the traditional NPV method since the investors can compare different projects more accurately.

3.2 The modified internal rate of return method

3.2.1 Brief Introduction of the New IRR Method

The modified IRR is calculated by discounting the cash flows from the different cash flows of two conventional investment projects at the base discount rate [5]. The negative cash flow should be discounted to the time zone before calculating the modified IRR. The improvement of the IRR method aims to address the problem of multiple calculations when the cash flow exhibits more than one change of sign.

3.2.2 Examples of the New IRR Method

Some examples will be provided below to show the advantages of the new internal rate of return investment method after the improvement.

There are two projects, project A and project B. Assuming the discount rate used to deal with the negative cash flow is 5%.

Table 3. The cash flow of project A and project B

Cashflow(dollar)	C0	C1	C2	C3
A	-600	200	-100	500
B	-650	550	-200	200

The difference between cash flow A and cash flow B:

$$C0 = -650 - (-600) = -50$$
$$C1 = 550 - 200 = 350$$
$$C2 = -200 - (-100) = -100$$
$$C3 = 200 - 500 = -300$$

Table 4. The Cash Flow Difference between Project A and Project B

Cashflow Difference (dollar)	C0	C1	C2	C3
△F	-50	350	-100	-300

Table 5. The Cash Flow Difference between Project A and Project B After Discounting

Cashflow Difference (dollar)	C0	C1	C2	C3
△F	-331.2	350	0	0

$$331.2 = 350 \div (1 + \triangle \text{IRR})$$
$$\triangle \text{IRR} = 0.057 = 5.7\%$$

In this way, the IRR method can be used more widely than before as it can be applied to the investment with the cash flow which includes more than one change of sign.

4. Conclusions

The paper introduces two investment rules used to measure the value of a project or investment and provides some other strategies that aid in enhancing the computations of the conventional procedures depending on the shortcomings of the regulations. It contributes to the current knowledge on NPV and IRR methodologies and has some implications for investors.

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