

Validity of NPV Rule and IRR Criterion for Capital Budgeting Decisions

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Abstract: Net present value rule and interest return rate criterion are two important tools when making capital budgeting decisions. This paper would concentrate on the evaluation of the two criteria in order to judge the use of them under different conditions in making investment in the market. A number of real-life examples were researched to find out the distinct features, advantages and disadvantages of the two rules. They were compared in various of aspects to find out the validity of the two objects in different situations. With the analysis, circumstances that are suitable for the application of both net present value rule and interest return rate criterion are discovered separately, and they also have defects that they may not be valid to calculate the profits earned in some situations. To use the two tools in an appropriate way, it is required to make full evaluation to the relevant factors in the environment of the market.

1. Introduction

When analyzing capital budgeting projects, researchers have to make decision on which project should be accepted as a good investment. Whether the NPV calculation or the IRR calculation is more preferred to make investment decisions triggers heated discussion and NPV is generally supported by more academics.

Net present value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of time, which is used in capital budgeting and investment planning to analyze the profitability of a projected investment. NPV is the measurement of value of future cash flows in terms of used today's value. And if the result is larger than zero, it suggested that the discounted present value of all future cash flows related to that project or investment will be earning the profit. The larger the result is, the more attractive the project is. Additionally, IRR method is a discount rate that makes the net present value (NPV) of all cash flows equal to zero in a discounted cash flow analysis. It is a measurement of annual rate of growth that an investment is expected to generate. And the higher the IRR is, the more favorable the investment project is.[1]

For this paper, the purpose is to identify under which conditions, we should use IRR/NPV to analyze the project and the validity of them. Several contents shown below are going to be covered: what can researchers do when analyzing capital budgeting projects, the usage of NPV during the analyzing process & advantages & disadvantages, the usage of IRR during the analyzing process & advantages & disadvantages, making a comparison between the 2 methods & under what circumstances should they be used.

In this paper, there are mainly five parts involved. The first two sections would separately discuss the usage of NPV and IRR rule in real capital budgeting decision and analyse their advantages and disadvantages. After that, a comparison is made between the two objects. Then, evaluation is made between them under different conditions. A conclusion of the paper is made at last.

2. Applying NPV to a capital budgeting decision

The net present value is the present value of current and future benefit subtract the present value of current and future costs of a project. The value that is calculated enables investors to have an assessment on the projects they may invest and is helpful for them to select the most profitable ones. It can offer a long-term view of different investment projects to investors and provides the optimal choice. The following part would be about the application of NPV rule and its advantages and disadvantages.

2.1 Usage of NPV

The net present value rule is an approach that is frequently used to consider the difference of the value of the fund due to the variation of time in an investment project judgement.

The net present value rule is closely and directly linked to the influence of an investment project to the profits made by a certain company. The benefits of a project are shown in the net present value that the decision-making process of investment is in line with the targets of the shareholders of a company which is earn as more profits as they can.

There are a number of cases of investment decisions for many firms in real life in the following contents.

1. The decision of renewing the fixed assets in a firm, with reference to Li Jing (2005) [2]. It is a quite common but significant long-term decision-making problem in companies. Apparently, there two simple answers to this problem: continue to use the old assets or purchase new ones. In this situation, the net present value rule can be applied to discover which programme to select in order to reach the maximum economic efficiency and gain more benefits for the company. Obviously, there are some conditions that limit the use of this rule in this situation. The renewing of the fixed assets should be sure to ascent the productivity of the firm and bring more earnings in the future. Moreover, the time period that the new and old fixed assets will be used ought to be the same.

2. Investment decisions in the situation that the life of the projects which are mutually exclusive are unequal, according to Wang Juan and Jiao Liyan (2005) [3]. With concern to the life of each project, the net present value per year (The sum of the net present value divided by the yearly net present value index) can be calculated to make comparisons between distinct projects.

3. The decision of whether or not to start a new investment project, proposed by Wang Juan and Jiao Liyan (2005) [3]. Usually, the money-investing to a long-term project is divided into several stages. The net present value rule can be useful under this situation that the funds invested to the projects at different periods have different value.

4. Decision-making under limit amount of capital, as suggested by Wang Juan and Jiao Liyan (2005) [3]. Because of this problem, in reality, no firms can invest every project that has a positive net present value. To maintain a sustainable development and reasonable structure of capital, the companies are aim to find the optimal projects under strict limitations. The net present value of numerous projects could be calculated and decide which ones to accept or reject.

2.2 Advantages and disadvantages

The net present value rule is a method that can give the dynamic value of an investment project comparing some other approaches that are relatively more static, for example, the payback period rule. The net present value rule could be a more preferable way for investors since the process of it involves consideration of the changes in the factors that can affect the profit of an investment, for example, the discount rate in the consequent years. The net present value rule can be widely adapted into various kinds of circumstances, the value of money in different time period that can influence the investment decisions are included in this. In comparison, the payback period rule requires investors to calculate the expected payback period and compare it with the payback period that is needed for the investors or companies to judge which investment project is more profitable. Although such a rule can be easily applied and understood by people, it tends to be just an assist in verdicting the profits that could be made because of ignoring the value of time, which exactly is the aspect that

the net present value rule has an advantage on. When a simple example is taken, the difference between these two methods of calculating the value of a specific project are quite obvious. The example, as suggested by A Siyu (2018) [4], is shown in the following table.

Table 1. Cost and payback of two projects in a certain period of time

Year	0	1	2	3
Project A	-100	+20	+80	+20
Project B	-100	+80	+10	+30

If the method of determining the payback period is used, it is obvious that project A is a more profitable one since it can earn profits as much as the original cost in the second year earlier than project B, which requires 3 years to achieve this target.

In comparison, when the net present value rule is introducing, the result is different. If it is assumed that in the future there will be a discount rate of 10%, the net present value of project A would be -0.68 while the net present value of project B has a value of 3.531. From this method, it is apparent that actually project B is the project that investors ought to choose. It can bring larger profits to investors though project A seems to be a more profitable one. From this example, the special feature of net present value rule is clearly shown, which is the consideration of the time. It makes it advantageous in deciding which project to select for investors.

The main disadvantage is established under the condition of perfect and complete capital market, suggested by Brealey Myers Allen in *Principles of Corporate Finance* [5]. So, the realistic occasions may bias the results and cannot be used in reality. And this could be explained from following ways.

The first assumption is that consumers share same and equal information, which isn't possible because there may the existence of information failure, which is the condition that consumers and sellers do not share the equal information. In this case, the result will be biased because of the possibility of "bad money drives out good, which means that some consumers may actually have the low utility of investment choices.

The condition of no transaction costs also needs to be applied. But as we know we have the duty to pay individual income tax. Considering this, we may have to value the return also by measuring the tax rate. The actual return on equity will be uncertain on the occasion. Additionally, there will also be the separation of second-hand profit.

Thirdly, unlimited relatively fixed loan must be able to give out in a relatively short period of time. But it's established that capital market is an unstable trade platform and the borrow or lend rate is changing all the time by consumers actions or social news. In addition, there are now many online platforms for debit and credit for young but poor students, and the interest rate of them are usually very high. For example, the HUABEI in China is now very popular among young adults. Bank is not the only subject and way that controls the rate. And the credit system would not allow swift and unlimited loan, so some consumers don't have enough money to invest in optimal projects.

In addition to that, perfect and complete capital market offers the condition of unlimited assets separation, which means that assets can be divided into tiny units. But each investment projects must have a minimum limit of investment amount. So, in this circumstance, part of consumers may be unable to invest in the project.

Moreover, the fact of perfect competition also brings problem. In order to help the healthy growth of economy, governments may have some policy like protectionism or trade restrictions. Subsidies, transfer payments could be offered. As a result, some special industry like sunrise, sunset and strategic ones could have the aid of subsidy and may be able to give better offer.

The limitation of public trade is needed to be out into considerations, too. In my view this limitation is quite similar to the first one. Some information or trade may be hidden like black market. So, the private trade causes the fact that profits of consumers may be narrowed down.

Last but not the least, the return rate may be constantly changing because of the unstable complexation of trade market. NPV may only estimate the value of present time overlook.

3. Applying IRR to a capital budgeting decision

Another method that are frequently used in financial market is The Internal Rate of Return (IRR), which is a measurement of the expected growth rate and the potential profitability when analyzing capital budgeting projects. Estimating capitalization rate is especially important for investors, since it can give an approximate figure of how much return that are going to be earn in a given time. For example, an investor is going to rent out an official building for 5 years. Every year there will be interests earned by the investor, and gaining more interests anually. So, the estimation of the potential interests earned over the 5 years period would represents IRR. [6]

IRR shares the same calculation concept as net present value (NPV), one of the differences is that it measures the discount rate that makes NPV equals to zero. When calculating IRR, the initial investment must always be negative since it represents an outflow from investors. Cash flows in the future could be positive or negative, which depends on whether the project is earning the profit or demanding for new investments. IRR is often used when companies are making comparison between the amount of profit that can be generated by existing projects and new projects. Companies sometimes meet circumstances that they have to make decision between whether to expand an existing project or instead develop new operations. By finding the IRR, companies are able to find the one with a higher profitability and begin the investment process.[7] [8]

Based on IRR, it will be easier for a company to decide whether the project should be accepted or rejected. Companies are also able to make comparison between different investment choices. In order to know whether the IRR is acceptable, IRR rule take place to compare the value of IRR with the opportunity costs of capital of the company. Generally, If the IRR is greater than or equal to the costs of capital, the company would accept the project as a good investment. When the value is less than the cost of capital, for example, if an investment has an IRR of 15%, whereas the opportunity cost of capital is about 20%, then the investment should be rejected since it cannot benefit the company. IRR is also useful when ranking multiple potential investments on a relatively even basis. A company may use IRR to determine which project should be chose from multiple ones. While both projects can benefit the company, the company is more likely to choose the one with the higher IRR. Furthermore, IRR is also helpful for individuals, for instance, people who are willing to rent houses might consider IRR before they make their decisions. When individuals are making financial decisions, the one that has a higher IRR are much more desirable. [9]

IRR is a useful method to analyse projects and investments, but it does come with limitations. When a project has some negative cash flow between other positive cash flows, the equation of the IRR will get more than one value and both the two value make the $NPV=0$. The reason is that there is double change between positive and negative cash flows. The number of the IRR for a project can be as many as the changes in the sign of the cash flows. There are also cases in which no internal rate of return exists. For example, if a project has a positive NPV at all discount rates, then no discount rate will produce a zero NPV. Another limitation is that when finding the IRR of mutually exclusive projects (the other is unacceptable when one of them is accepted), the value can be misleading. This is mainly cause by two reasons. Firstly, the IRR rule ignores the size of the project. Small projects might be considered better when calculating the IRR. Most of the time a larger project brings more money back in the future, but it often shows a low IRR. Therefore, conflicts might occur between NPV and IRR since IRR often fails to provide a complete answer when dealing with projects that have large difference in investment requirements. The second reason is that IRR ignores unconventional cash flow patterns. When two projects have different pattern of cash inflows, for example, one of the projects shows an upward trend in the pattern of the cash flow while the other one shows a downward trend, IRR fails again to provide a complete answer. Moreover, IRR involves large assumptions, especially when investors are predicting future cash flows. Optimistic assumptions might include all the investments are available anytime in the future and all the money can be used efficiently. Market conditions might also change in the future so these predictions might be subjective and involve optimistic assumptions. By using these optimistic assumptions, it will often result in a very high IRR. In real life, few investments will be as expected and this might lead to inaccuracy

when measuring the potential benefit a project can bring in the future. Therefore, although the IRR shows companies the time value of the invested capital, it does not contain a complete accurate prediction of the future potential risk. This problem can be only solved when IRR is combined with other methods. [10] [11] [12]

4. Comparison between NPV and IRR

From the nature of these to criterion Net Present Value (NPV) is the value of all future cash flows (positive and negative) over the entire life of an investment discounted to the present. NPV analysis is a form of intrinsic valuation and is used extensively across finance and accounting for determining the value of a business, investment security, capital project, new venture, cost reduction program, and anything that involves cash flow, with reference to Corporate Finance Institute (2021) [13]. Internal Rate of Return (IRR) is a financial metric that considers the cash flows from an investment to evaluate its profitability. In other words, it evaluates investment returns by considering both positive and negative cash flows. It is called the internal rate of return as it doesn't consider external factors to evaluate a business opportunity. It is the discounting rate at which the total inflows from a project are equal to the total outflows, where Net Present Value (NPV) is equal to zero, suggested by Chaluvadi, S. (2021) [14]. Both methods show comparable results regarding "accept or reject" decisions where independent investment project proposals are concerned. In this case, these two methods don't compete, instead they give out similar outcome on whether accept or reject the project. They will only differ based on their minimum rate of return on the market.

The proponents of NPV rule argue that multiple or negative or the absence of IRR are universally regarded as a fatal flaw for the IRR method (see Hazen, 2003; Kierullf 2011; Osborne 2010; Brigham et al. 2012). According to Merlo (2012), for non-monotone NPV functions derived from non-normal NCF(NNCF), the NPV rule is used as if NPV is error-free and IRR is discarded incorrectly. In such cases, the NPV increases with an increasing discount rate that could lead to a wrong investment decision. In other words, no project would become more profitable if the cost of capital was higher. Meanwhile, the greatest conceptual difficulty for the practically important IRR criterion is its failure to generally provide a unique value, against which to compare the company's hurdle rate in order to arrive at a decision that is consistent with the NPV rule project, proposed by Weber, T. (2014) [15].

The internal rate of return (IRR) is used widely in practice, often because it is directly comparable to the rate of return on assets in financial markets. For example, it appears naturally as "yield to maturity" of a fixed-income security, i.e., the rate of return of an interest-bearing investment held to its maturity date at T. The well-known problems with the IRR resulting from its generic nonexistence or nonuniqueness disappear by using instead the selective IRR, which always exists and selects, for any external rate r , a unique element of the extended set $I(x)$ of possible IRRs (including $\pm\infty$) for a given cash-flow stream x . As suggested By Bhattacharyya (2021) [16].

Under the NPV approach, the present value can be calculated by discounting the future cash flows of a project at a predefined interest rate, known as the cut-off rate. However, under the IRR approach, cash flow is discounted at appropriate rates using a trial-and-error method that equates to a present value. The present value is calculated to an amount equal to the investment made. If IRR is the preferred method, the discount rate is often not predetermined as would be the case with NPV. NPV takes cognizance of the value of capital cost or the market rate of interest. It obtains the amount that should be invested in a project in order to recover projected earnings at current market rates from the amount invested.

The IRR method, on the other hand, does not take into account the prevailing interest rate in the market, and its aim is to find the maximum interest rate that will encourage a return on the amount invested. NPV presume that intermediate cash flow is reinvested at cutoff rate while under the IRR approach, an intermediate cash flow is invested at the prevailing internal rate of return. The results of NPV are similar to those obtained from IRR under similar conditions, while both methods offer contradicting results in cases where the circumstances are different.

When it comes to ranking more than two project proposals, NPV's predefined cutoff rates are fairly reliable compared to IRR.

5. How to decide whether to use IRR or NPV

When analyzing capital budgets for short-term projects, both IRR and NPV are suitable methods of evaluating the potential profitability of a proposed investment. If you have to choose one of several projects, you'll likely use NPV since IRR can't analyze multiple discount rates.

IRR is best for projects with short lifespans. The reason for this is that the outcomes of IRR become confusing when a project receives multiple cash flows, which is usually the case with long-term projects. Conversely, the NPV is ideal for longer-term projects because it analyzes each cash flow separately, which makes it more effective for making investment decisions.

NPV is the preferred method when you know the discount rates for the capital cost of a proposed project. IRR relies on trial and error and does not require a discount rate to generate an outcome.

6. Conclusion

The net present value rule is a practical and useful method in comparing the values of distinct investment projects. It enables investors to assess different projects with more accuracy under complex conditions. However, due to the lack of consideration on all the factors that may influence the outcome of the approach, it requires further efforts to discover the environment of the market for investment which can make the process of calculation more complicated. The NPV rule can be used to select projects with different initial size or different life spans. If a firm has a limit on the number of funds it can invest in new projects, it may not be able to undertake all available positive NPV projects. IRR is a good way to budget capital and we give equal importance to all cash flows. We just set it up with different ratios and want to know where is the present value of the cash inflow equal to the present value of the cash outflow. When evaluating projects that have constant movements in cash flows, the NPV method can be used for the evaluation of projects/investment plans even when there is a constant movement in cash flows. However, IRR method cannot be taken into use for the evaluation of projects when there is a constant movement in cash flows. If the discount rate changes, NPV produces different results for the same project whereas IRR produces the same results even if the discount rate changes for the same project.

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