

The Analysis of Three Main Investment Criteria: NPV IRR and Payback Period

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ABSTRACT

Net Present Value is a simple, straightforward measurement when judging investment projects. It considers the time value during the calculation, which converts the money from the future to the present value. However, it can miss leading the investor at a certain case. In this paper, we will mainly be focusing on the NPV, by elaborate on how it works in the case, the calculation of it, the history, the numerical analysis. Additionally, we will compare NPV with other similar tools including Internal Rate of Return and Payback period that are used to measuring the value of the project, by illustrating their advantages and disadvantages.

Keywords: Net present value, Internal Rate of Return, Payback period

1. INTRODUCTION

When an investor decides to invest a project, he or she has lots of investment criteria to choose, such as NPV rule, IRR rule or payback period. As Lefley discuss the payback method and the disadvantages of this method [1]. Estrada talks about the importance of NPV and IRR, which means no toolbox would be complete without them[2]. Kavous said when the cash flow for the budgeting project is given, the application for the payback period and NPV rule should be different[3]. Beaves discussed the limitation of the conventional NPV formula[4]. Hajdasiński re-formulates payback period criterion and find the method to solve the problem that the traditional approach to the comparison of mutually exclusive projects by means of the Payback Period criterion has been inadequate[5]. Osborne even try to use a new way to find out whether NPV or IRR is the better investment criteria[6]. LOHMANN discussed the relative performance in the common capital budgeting decision procedures for dealing with the risk[7]. Agnes Cheng also said that both NPV and IRR have unique advantages and people should combine the advantages from both sides[8].

For the application of those criteria, Omotayo Brown told the application of NPV and IRR in analysis the

societal costs of tourism projects in developing countries [9]. San Ong use the NPV and payback period to find out the capital cost for installing a photovoltaic system in Malaysia [10]. So we can find that those three investment criteria have different advantages and drawbacks, and should be use in different situations.

1.1. Methodology

This paper analyzes NPV and IRR by researching and summarizing other related papers with specific examples and data from related books, describing their history, as well as their correlations and differences. We analyze and compare their respective algorithms and advantages by calculating NPV, IRR, and payback period. It also tries to analyze the advantages and disadvantages of each, and try to help individuals or companies can flexibly use NPV and IRR to make investment decisions.

2. INVESTMENT CRITERIA

2.1. The history of NPV (NET present value)

Net present value as a valuation method dates back at least to the 19th century. Karl Marx referred to NPV as virtual capital and computing as "capitalization," writing:

“The forming of a fictitious capital is called capitalizing. Every periodically repeated income is capitalised by calculating it on the average rate of interest, as an income which would be realised by a capital at this rate of interest.”. This is from: *Capital, Volume III, subtitled The Process of Capitalist Production as a Whole*, is the third volume of *Capital: Critique of Political Economy*. [11] It was prepared by Friedrich Engels from notes left by Karl Marx and published in 1894. Marx's literature is the earliest record of net present value.

Now, let's move a little closer to the present. In mainstream neoclassical economics, NPV was formalized and popularized by Irving Fisher in *The Rate of Interest in 1907*, and has been included in textbooks since The 1950s, starting with finance textbooks.

2.2. The calculation of each investment criteria

2.2.1. NPV rule

As we can see the well-known and often quoted maxim that due to the time value of the money, a dollar is worth more than a dollar tomorrow.[12]

So the money value now is called the present value, so we can obtain the present value of the future cash flow than decide whether it is a project worth for investing. [13] The rate of cost is called the discount rate. For instance, the discount rate is $D1=10\%$, so the 100 dollar in today equals to 110 dollar one year later, $100*(1+D1)=FV$. So 110 dollar in the one year future has the present value of 100 dollar. $110/(1+D1)=PV$. So from that, we can use P_n as the present value of the cash flow, D_n as the discount rate, and C_n as the n years' cash flow. And the formula for the present value equals to $P_n = C_n / (1+D)^n$. we can forecast the investment project has many different cash flow each year,so we need to get the net present value for the project. To value that project.

$$NPV = \sum_{t=0}^n C_t / (1 + D)^n \quad (1)$$

If the result of the NPV is positive, it shows that the project is worth investing, vice versa.

2.2.2. IRR rule

When we consider about the IRR, it is the discount rate that can make the NPV for the project equals to 0. Because that for a worth-investing project,the rate of return must be higher than the opportunity cost of the capital. The IRR is the maximum opportunity cost of the capital that can be accepted by the investor. If the discount rate higher than IRR, the NPV would be negative, which means the project is not worth for investing. For example, the IRR is 28%, if the discount rate is 30%, higher than the IRR, the NPV would be negative.

$$NPV = \sum_{t=0}^n C_t / (1 + IRR)^n = 0 \quad (2)$$

2.2.3. Payback rule

The payback rule is mainly measuring about how long investor need to wait until they cover the initial cost of this investment. However, when the firm decide to use this rule, they must decide a appropriate cutoff date, as the rule will ignore the cash flow after that date. For example, project A, if the cutoff period is 2 years than the project cannot payback the cost.

The payback has a further brunch, which is the discount payback period, by discounting the future cash flow to get NPV and then compare the NPV whether it is positive before the cutoff date, if so, the project is worth investing.

3. NUMERICAL ANALYSIS

Although NPV has a wide range of applications, we still need to pay attention to the cases in which NPV is appropriate to make better investment decisions.

- (1)the direction of cash flow changes twice or more
- (2)The initial investment of mutually exclusive projects is different
- (3)The time series of cash flows of mutually exclusive projects are different.

When NPV is greater than 0, the project profit can be judged. When IRR is greater than or equal to the capital cost or target return investment rate of the project, the project profit can be judged. Comparing the two projects, the one with higher internal rate of return is selected.

We give an example: suppose JKL Media Company wants to buy a small publishing company. JKL determines that the future cash flows generated by the publisher, when discounted at a 12 percent annual rate, yields a present value of \$23.5 million. If the publishing company's owner is willing to sell for \$20 million, then the NPV of the project would be \$3.5 million ($\$23.5 - \$20 = \3.5). The NPV of \$3.5 million represents the intrinsic value that will be added to JKL Media if it undertakes this acquisition.

(4)The net present value method applies to the comparative decision-making of several mutually exclusive schemes with the same project lifetime and the same initial investment (the same money input).

(5)Internal rate of return and present value index are relative numbers (i.e. relative ratios) When evaluating programs, it should be noted that the absolute number of high proportion programs is not necessarily large, and vice versa If the two indicators are independent of each other, the internal rate of return should be used and the corresponding indicators should be given Give priority to projects with high internal rate of return.

The internal rate of return index is not influenced by the discount rate and may reflect the return on investment that the scheme itself can achieve. The indices in the NPV and NPV indices are influenced by the discount rate and cannot reflect the return that the project itself can achieve. So when we try to find out the return, we should not use NPV instead of using internal rate of return.

The net present value method describes the total gain and loss of the investment project, but does not explain the benefit of the investment, the actual return on capital of the investment project itself. Therefore, we should not use it if we need the return on capital.

The Bottom Line

Both IRR and NPV can be used to determine how desirable a project will be and whether it will add value to the company. While one uses a percentage, the other is expressed as a dollar figure. While some prefer using IRR as a measure of capital budgeting, it does come with problems because it doesn't take into account changing factors such as different discount rates. In these cases, using the net present value would be more beneficial. [14]

Unlike NPV, IRR is a ratio that cannot be used alone. In order to use the IRR method for investment analysis, the cost of capital of the company must be included and the cost of capital calculated.

If the calculated IRR is higher than the capital cost of the company, it shows that the investment project is feasible, on the contrary, the investment project should be abandoned.

NPV reflects the cash value of the net income of a project calculated according to cash flow. This is an absolute amount which has great limitations on comparing projects with different investment amounts.

This method is to subtract cash inflows from cash outflow to see how much money you can make. It is an absolute number, not a ratio. As long as the net present value is greater than zero, it shows that the project is feasible and should be invested.

4. THE PROS&CONS FOR NPV

4.1. *The pros&cons for NPV*

NPV is one of the basic finance tools that help investors to clarify whether they should invest in the project. How does it work? Due to the fact that the money in the future is not worth as the money in the present, it uses factors for instance discount rates and cash flows to calculate the money that you will gain in the future. The advantage of NPV is very obvious, it includes the majority of the risks and costs inside and directly gives the investors some basic idea of how much money they can gain in total. As it used in the first question, the managers in the company can using the method of NPV to see which

year they should execute in order to make the highest profit, and the answer is pretty clear, the third year has the highest. In this case, we can tell that NPV is a simple way to determine if a project delivers value because cash flows and discount rates were labeled, and the simplest way to determine the payback would be NPV.

Even though it sounds perfect to use NPV to help you to make a better judgment, it still has some drawbacks. The first one is the uncertain feature. There are two factors that play an important role in the calculation of NPV, which are cashflows and discounts rate. These two are usually fixed in the problem-sets, however, in the real situation, they are more likely to be predicted, which could be changed without awareness, no one could guarantee that they will remain the same in the future. As a result, there are more calculations are be needed to figure out which projects are suitable for the investors, in addition, the result is only approximately accurate, it's not 100% correct since it omits some hidden costs including opportunity costs and organizational costs. To be more specific, we can easily tell that in this case which year has the highest NPV because we knew that all these data are been fixed, and by using the formula to calculate the result. However, there could be more accidents in the real world, the maintenance cost has become twice higher as the last year, the machine has suddenly broken and can't be used again... These are all the things that we can't tell. It does have risky inside.

The second limitation of NPV is can 'trap' you. Before I elaborate on this problem, the first thing is to define the definition of NPV again: "Net present value is the present value of the cash flows at the required rate of return of your project compared to your initial investment," says Knight. In practical terms, it's a method of calculating your return on investment, or ROI, for a project or expenditure. By looking at all of the money you expect to make from the investment and translating those returns into today's dollars, you can decide whether the project is worthwhile." (Amy Gallo, A Refresher on Net Present Value).[15] The main purpose of NPV is to help you have a better understanding of how much money you will gain in total from the future, that converted into the money at present, to compared whether you should invest. But investor might been tricked by this illusion without awareness, due to the fact that NPV can't tell you how long you have to wait on average until you can make profit on your investment. In other words, over rely on NPV can cause information bias. How would this limitation affect people or companies to make their judgments? For instance, your company has many investment project proposals, but you only can choose one to invest in, what are you going to do? Use NPV as a standard to compare with each other and choose the highest one. However, only using the NPV can't make the best interest, because it didn't consider the time go waiting for the profit. To conclude: NPV is not useful for comparing projects of

different sizes, as the largest projects typically generate the highest returns.

4.2. Compared advantages and disadvantages between NPV and IRR

As we all knew, IRR (internal rate of return) is another useful tool for calculating the benefit you will gain from the project, but there are many differences between those two tools.

NPV is using your cash inflow, which is converting into the present value from different time periods, to minus the cash outflow. But IRR is likely to let the cash inflow that at present value equals to the cash outflow, when the NPV is equal to zero, to find the rate of return from the project. To clarify, NPV is focusing on the specific number of money you will get, while IRR is calculating the percentage of benefit you can get.

The advantage of using IRR instead of NPV is it doesn't require the discount rate to get the result. It just using the cash inflow and cash outflow to calculate. Similarly, another advantage for IRR is it takes to account the time value of the money from the future and considers all the cash flow that you invest in the project. In conclusion, there is a high similarity in advantage between NPV and IRR, they are all the standard for measuring the project.

However, nothing is perfect, so do the IRR, there are some limitations when using the IRR. The first one is that IRR usually ignores the size of the projects when doing the valuation. By that means, IRR will no longer be suitable to use during comparing the projects that are in different sizes, especially for the corporation company. When there are two different sizes of projects that are letting the investor choose, the result from IRR is more likely to tell you to choose the short-term project, even though the longer project is more profitable and brings you more cash inflow.

The second limitation for IRR is, there is a certain restrain in the calculation, which is, there is a need to be a cash outflow at first, then the remaining cash flow should all be positive, otherwise, the result for IRR will be negative. To be specific, "when there is a project that is defined by a mixture of positive and negative cash flows, the result from IRR will be ambiguous (Lin, S. A. (1976). The modified internal rate of return and investment criterion).[16]

5. CONCLUSION

Through the whole discussion, we discuss three main investment standards in detail with specific cases: net present value, internal rate of return and investment payback period analysis. By analyzing their specific, we can clearly recognize their important role in today's market. For example, net present value, we can use the net

present value algorithm to calculate the actual income that the company can directly use the project, eliminate other interference factors, and get the results faster.

At the same time, according to the front parts, we can also see some information. For example, when selecting a project, if there is a conflict between NPV and IRR, NPV shall prevail. In the process of our actual use, IRR and NPV will be calculated, but we will focus on NPV.

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