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Analysis of the Shortcomings of the Investment Decision Method and its Improvement

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ABSTRACT

Investment decisions are an important part of the pre-investment process. The correct method of decision making for investment projects directly affects the investment benefit of the project. However, various investment decision methods and theoretical analyses have deficiencies. These deficiencies will affect the actual valuation results leading to poor decisions, losses to the business or missed investment opportunities for the benefit of the business. Therefore, there is a strong need to analyze and improve on the shortcomings in the investment decision-making methodology. This paper mainly analyses the problems in the current financial evaluation for investment decisions and the shortcomings of the evaluation methods. It then proposes corresponding improvement and refinement strategies in light of these shortcomings.

Keywords: *investment decision method, Net Present Value, Internal Rate of Return, real options.*

1. INTRODUCTION

The essence of investment decision-making is to maximize the benefits of investment by choosing the best decision method and, at the same time, to optimize the allocation of resources. In today's rapidly developing economy, sound investment decisions are essential to improve an enterprise's profitability and promote its expansion and reproduction. If the enterprise makes a major investment decision mistake, it will likely lead to the enterprise-facing economic decision failure. Even if business management is very advanced, it is difficult to recover the huge operational difficulties of investment decision failure. The final result is likely to lead the enterprise to bankruptcy and even develop national economic construction. Therefore, investors have to think about how to invest in making more effective use of their capital.

Chen mentioned that the main disadvantage of the NPV approach is that it lacks flexibility, and the firm needs to make the decision today despite the uncertain factors the project faces in the future [1]. Zhang and Tao summarized the shortcomings of the NPV rule: firstly, it is difficult to forecast future cash flows. Secondly, the discount rate is difficult to determine. Finally, although it is a dynamic indicator, it cannot estimate possible future market changes [2, 3]. Zhang, in the article "The choice of NPV and NPV rate in investment decision making" uses an example of a calculation to demonstrate that the NPVR and NPV evaluation of mutually exclusive solutions is a contradiction in terms of conclusions [4]. In Wang Xindong's article "Improvement of Techno-Economic Evaluation Indicators", he proposes to build a model using the idea of optimal investment size in managerial economics, and uses the idea of maximization to compare and analyze NPV and NPVR indicators, and concludes that NPV indicators are better than NPVR indicators [5]. Another research refers to the binomial tree model, which introduces real options as an NPV improvement, calculating the expected mean based on the value of the investment project in good and bad market times to overcome its limited flexibility [6].

Firstly, the paper introduces the significance and background of the study and the article's main ideas. Secondly, it introduces the existing investment decision-making methods and evaluation indicators. Thirdly, it provides an in-depth analysis of the shortcomings of the evaluation indicators and the evaluation methods of mutually exclusive solutions. Finally, it concludes the content of the article.

2. THEORIES RELATED TO INVESTMENT DECISIONS

2.1. Types of investment programs

With the development of the economy, multiple options for investment decision-making have become mainstream, the relationship between options is intricate and complex, and more and more comprehensive influencing factors are considered [7, 8]. First of all, it is necessary to clarify the relationship and type between programs, which is the key decision for selecting programs for investment.

2.1.1. Independent Program

This refers to programs that do not disturb each other and do not have any economic relevance. That is, these options exist independently of each other. The continuation or abandonment of any of them does not affect the choice of other options again.

2.1.2. Mutually Exclusive Investments

Mutually exclusive investments are the same as exclusive solutions, i.e., among many solutions, each solution cannot be substituted for the other, and choosing any one of them means giving up the others, which are incompatible with each other [9, 10]. For example, Project A is to build an apartment building on a plot of land you own, while Project B decides to build a cinema on the same plot of land. Project A and Project B are mutually exclusive projects.

2.1.3. Related Plan

Related options are a number of options that interact with each other in terms of techno-economic, cash flow, and use of funds. When choosing between options again, if one option is accepted (or rejected), then the cash flow of this option will change significantly. At the same time, it differs from mutually exclusive options in that the choice of one of the options will affect the choice of the other options.

The correlation type is divided into positive correlation and negative correlation. The positive correlation is the solution that will significantly increase the cash flow if it is on simultaneously, while the negative correlation is the opposite. They will weaken each other's power if they are on simultaneously, and only one of them can be on, so the solution comparison is made according to the criterion of mutual exclusion.

2.2. Net Present Value Method

The NPV method is a decision-making method that uses the net present value of a project as a reference object. According to the NPV formula, when the NPV is positive, i.e., the discounted cash inflow is greater than the discounted cash outflow, and the payoff rate of the investment project is greater than the predetermined discount rate, the program is feasible. Otherwise, the project is not feasible, and the NPV method is specifically calculated as follows:

$$NPV = \sum_{t=1}^{n}(CI - CO)_t(1+i)^{-t} \quad (1)$$

CI is current cash inflow, $C0$ is current cash outflow and i is the discount rate.

NPV indicates the increase or decrease in the value of an investment project to the business and is essentially the excess return that can be earned on an investment project over the expected payoff. The NPV method evaluates investment proposals by measuring the existence and size of such excess returns.

2.3. Internal Rate of Return Method

The internal rate of return has some of the characteristics of net present value and is most often used as a substitute for net present value in financial practice. It is based on the principle of finding a rate of return that reflects the intrinsic value of a project. It is not itself influenced by capital market benchmark interest rates but depends on the project's cash flows and is a fully endogenous variable. The IRR method is specifically calculated as follows:

$$\sum_{t=1}^{n}(CI - C0)_t(1+IRR)^{-t} \quad (2)$$

CI is current cash inflow, $C0$ is current cash outflow and i is the discount rate.

The determination is: if the IRR is greater than the discount rate, then the project is acceptable; if the IRR is less than the discount rate, then the project is not acceptable

2.4. Net Present Value Rate Method

NPV rate is a dynamic investment return indicator used to measure the profitability of different investment options. Its economic meaning is the size of the net present value achieved per unit of the present value of the investment. The NPVR is equal to $\frac{NPV}{I_P}$.

The determination is NPV greater than 0 means the project is ready for investment. The greater the NPV ratio, the more efficient the investment and the better the investment. Therefore, the NPV ratio identifies both the profitability and the investment efficiency of a solution.

3. ANALYSIS OF THE SHORTCOMINGS OF THE INVESTMENT DECISION METHOD AND IMPROVEMENT

3.1. Analysis of the shortcomings of NPVR when used for the comparison of mutually exclusive solutions

Both NPVR and NPV are dynamic indicators for evaluating economic solutions. Firstly, the two indicators are consistent for stand-alone solutions, i.e., NPV ≥ 0, there must be NPVR ≥ 0, and the solution is economically viable. Secondly, the conclusions are not necessarily the same for mutually exclusive schemes or independent combinations of schemes with varying investment amounts.

For example:

Table 1. different evaluations for projects A and B

	Project A	Project B
Investment amount	135	150
NPV	29	30
NPVR	21.48%	20%

If the NPVR is used to make investment decisions, investors will often make the wrong judgement and choose Project A with a higher NPVR. But $NPV_A < NPV_B$ and $NPVR_A > NPVR_B$, a point of conflict arises because NPV is an absolute indicator that reflects the excess return on the economic profitability of the project. At the same time, NPVR is a relative indicator, and the two indicators reflect different aspects of the investment project, creating a conflict of determination.

Therefore, NPVR as an efficiency indicator cannot be used as an indicator for judging mutually exclusive solutions, but rather the absolute indicator NPV should be used as the optimal indicator for judging mutually exclusive solutions.

3.2. Analysis of flaws in the definition of NPV and IRR indicators

NPV and IRR are the most commonly used methods of investment decision making. Still, NPV and IRR are applied with underlying economic assumptions that cause their definitions to be too idealistic. To examine these two indicators, it is important to start with their economic implications and present the flaws in applying NPV and IRR indicators.

3.2.1. Analysis of flaws in the definition of NPV indicators

From Equation (1), since NPV is discounted at the benchmark rate of return, it is implicitly assumed that all cash inflows to the project are reinvested at the benchmark rate of return until the investment matures. In other words, when evaluating an investment project using the NPV rule, it is implicitly assumed that intermediate cash flows exist at the benchmark rate of return. However, in practice, the benchmark rate of return, i.e., the reinvestment rate, is subject to change.

3.2.2. Analysis of flaws in the definition of IRR indicators

(1) From Equation (2), the formula discounts the cash flows using the IRR as the discount rate so that NPV = 0. This implicitly assumes that the cash flows received by the investor before project maturity are reinvested at a fixed IRR. This assumption is unrealistic because the initial investment that has been recovered and reinvested may be at a higher or lower rate of return than the project's IRR and may not be exactly equal to the IRR. This economic assumption is not justified.

(2) Difficult to determine the result of the IRR solution

The second drawback of IRR is the problem of multiple roots. The formula defining the IRR shows that the equation for solving the IRR is a higher-order equation. The number of solutions can be one of three things: no solution, multiple solutions, and a unique solution. In other words, there may be no IRR in a project, or there may be multiple IRRs, and if this is the case, it is difficult to choose which is the true IRR?

<u>*3.2.2.1. IRR does not exist*</u>

Table 2. Project A's cash flow

Cash flow	CF_0	CF_1	CF_2
Project A	-100	200	-200

Based on the formula for internal rate of return, the solution process is as follows:

$$\frac{200}{(1+IRR)} = \frac{200}{(1+IRR)^2} + 100$$

Simplify to get: $(1+IRR)^2 = -1$, Obviously, in this case, the IRR is not solved. There is no IRR for this project.

3.2.2.2. Two or more IRRs

Table 3. Project B's cash flow

Cash flow	CF_0	CF_1	CF_2
Project B	-100	230	-132

Based on the formula for the internal rate of return, the solution process is as follows.

$$100+\frac{132}{(1+IRR)^2}=\frac{230}{1+IRR}$$

The solution is that IRR = 10% or 20%. At this point, there are two IRRs, and the project is called an unconventional project. The net cash flow of an unconventional project is very unstable. Funds may suddenly increase in one of the years, for example, to raise funds, or funds may suddenly decrease again in one of the years, for example, to repay debt. As we know from Descartes' law of signs, the sign changes direction several times, so the phenomenon of multiple roots occurs.

3.2.2.3. Unique solution

The third case is the conventional project when the cash flow changes sign only once when it is possible to solve for an IRR that is a unique solution.

In fact, the first and third situations are basically rare, and the most common is actually the second case of unconventional projects. Then the investor is faced with the problem of defining whether the project can be invested in terms of IRR. Therefore, the IRR indicator is flawed.

3.2.3. Contradiction analysis and improvement of IRR and NPV for the comparison of mutually exclusive solutions

Assume there are two mutually exclusive options, A and B. The cash flow for both is shown below.

Table 4. Cash flow of options A and B

Project/CF	CF_0	CF_1	CF_2	CF_3	CF_4	IRR	NPV(i=10%)
A	-430	230	179	124	94	20.44%	84.39
B	-430	70	138	240	260	18.84%	105.59

The calculation results show that IRRA>IRRB>i and 0<NPVA<NPVB. Therefore, if project A and project B are both independent projects, then there is no doubt that both are investable. Still, if the two projects are preferred, B should be chosen according to the NPV method, but according to IRR, A should be chosen, at which point the evaluation conclusions of IRR and NPV will be contradictory.

Instead of IRR, we can use ΔIRR as a mutually exclusive solution evaluation. The difference IRR is the discount rate at which the net present value of the difference between two mutually exclusive scenarios is made equal to zero, rather than the difference between the IRRs of the two mutually exclusive scenarios, i.e., expressed by the equation:

$$\sum_{t=0}^{n}[(CI-CO)_S-(CI-CO)_B]_t(1+\Delta IRR)^{-t}=0 \tag{3}$$

$(CI-CO)_S$ represents the annual net cash flow from a smaller investment. $(CI-CO)_B$ represents a larger annual net cash flow from the investment. The ΔIRR is evaluated based on the following criteria: if ΔIRR >= i, the option with the larger investment is chosen, and vice versa, the option with the smaller investment is chosen.

3.3. Analysis of the shortcomings of the NPV rule

According to the previous analysis, the NPV should be chosen for the investment decision in the case of NPV and IRR for mutually exclusive solutions. In addition to the evaluation condition NPV>0 for independent project evaluation, the project is feasible. Therefore, the investor should optimally choose NPV when making an investment decision, and this argument has been proven correct for this reason. However, is the investor to choose a stand-alone solution in any case simply by virtue of NPV > 0? The answer is no. In this section, the shortcomings of NPV in the selection of stand-alone solutions are further discussed.

3.3.1. Presentation of the problem

As we all know, the NPV rule is a forecast of future cash flows, which in turn are influenced by the external environment, such as macro policies, interest rates and epidemics in many ways. Therefore cash flows can be more positive than expected or less negative than expected [11]. Therefore, should an investor abandon a standalone solution when the NPV is found to be <0 based on future cash flow calculations? Clearly, the mere assertion that an NPV>0 solution must be viable is worth analyzing.

3.3.2. Case study

Hilton Hotels Group plans to open a hotel with an initial investment of $12million. Annual revenue is expected to be $2 million. A benchmark rate of return of 20% is assumed. The cash flow of the hotel project is shown in the table below.

Table 5. Cash flow of hotel project

CF_0	CF_1	CF_2	CF_3	…………
-12	2	2	2	2

With this cash flow, we can calculate the formula based on perpetual annuities: $\frac{A}{i} - CF_0$, where A is the annuity and i is the base discount rate, the net present value of the hotel project is calculated as: $-12 + \frac{2}{0.2} = -2 < 0$. We know from the previous definition of the NPV rule that when the NPV is < 0, we should abandon the investment in the project.

But I think the future is unpredictable, and the reason we can predict future cash flows is that a future cash flow is an expected value which is made up of the net present value of the cash flow in the positive case and the cash flow in the negative case multiplied by the probability of their occurrence respectively. Let us assume that we have a 50% probability of getting a positive cash flow after one year, which means we will receive a return of $6 million after one year. At the same time, we have a 50% chance of getting a negative outcome after one year, meaning that the hotel loses US$2million after one year. It's clear that the average cash flow is equal to 2 million dollars.

So based on the above assumptions, we can calculate the NPV of the positive case as $-12 + \frac{6}{0.2} = 18$. The net present value of the negative case is $-12 - \frac{2}{0.2} = -22$. At this point, the investor makes an expectation in his mind that if positive cash flows are received after one year, the hotel project will continue to operate. If the opposite happens, the hotel project will be abandoned immediately to stop losses. So, if the project is abandoned after one year, the net present value of the project is $-12 - \frac{2}{1+20\%} = -13.67$. We can therefore calculate the expected net present value of the project as

$$50\% \times 18 - 50\% \times 13.67 = 2.165 > 0$$

In summary, the NPV approach assumes a set process and situation at the outset, both in terms of cash flows and discount rates, and does not take into account the potential for flexible adjustments during the course of the project, i.e., once the plan is made, there is no turning back. In fact, in most investment projects, managers have the flexibility to make adjustments to the operation of the project either now or in the future in response to changes in market conditions in the face of uncertain market conditions.

4. CONCLUSION

The article analyzes the economic evaluation indicators and methods for investment decisions, identifies the theoretical shortcomings of the evaluation indicators and methods, and makes improvements and refinements for the shortcomings in the selection of mutually exclusive projects. The article's main findings are as follows.

(1) An in-depth analysis of NPVR, NPV, IRR and the flawed problems of the current decision-making methods is presented. Firstly, it is analyzed that NPVR cannot be used to compare mutually exclusive solutions and that the NPV method should be used instead. Then, the economic implications of NPV and IRR indicators are started, and it is pointed out that the two indicators are used with unreasonable economic assumptions implied. The article then identifies the flaws in applying IRR and NPV to the selection of mutually exclusive solutions by analyzing case studies and combining them with existing theories, respectively.

(2) Based on the analysis of the proposition that IRR indicators are not used as indicators for evaluating mutually exclusive solutions, the article proposes the rationality of using ΔIRR instead of IRR, and finally gives the criteria for selecting indicators for the comparison of mutually exclusive solutions in the light of actual case studies.

(3) Combined with the above discussion, the NPV rule applies to both independent and mutually exclusive options, as long as the NPV is greater than 0, then the option is accepted, but this ignores the subjective initiative of the investor, therefore, citing the actual case, in the initial situation NPV is less than 0. Suppose the investor's cash flow forecast is divided into good and bad cases. In the case of continuing loss, the investor will stop in time. So, the calculated NPV expectation will then be greater than 0.

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