Comparative Study on Financial Calculation Indicators of PPP Project

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Abstract. Financial calculation is an important part in the PPP project investment decision. In PPP practice, the selection of financial calculation indicators is quite arbitrary, which is prone to unfairness imbalance between PPP projects to a certain extent and even affects project decision-making. Financial calculation indicators usually used in the PPP scheme design include financial internal rate of return, return on investment, reasonable profit rate, annual interest rate, etc. Based on the economic meanings of the four types of indicators and combined with specific cases, the study analyzes the quantitative relation and applicability between different indicators. When the PPP project involves as long a period as 20 to 30 years, it is recommended to use dynamic indicators (financial internal rate of return) rather than static indicators (return on investment, reasonable profit rate, annual interest rate) in the project investment decision. When dynamic indicators are selected, it is more suitable for the public sector to adopt the internal rate of return on investment without considering the financing cost and debt repayment. For private sector, the internal rate of return of the project capital reflects the profit after the financial leverage using equity fund, with more realistic reference significance.

1. Introduction

Since 2014, with strong national support and promotion, the PPP market is under rapid development. By the end of March 2018, there are a total of 7,420 projects in the project management database of the PPP integrated information platform of the Ministry of Finance, including projects at stages of preparation, procurement, execution and hand-over, with an amount of investment of 11.5 trillion Yuan. In addition, there are 5,721 projects at the identification stage which are included in the reserve list, with an amount of investment of 6.1 trillion Yuan [1]. Before making investment decisions on PPP projects, financial evaluation is required. At present, there is a lack of financial calculation indicators designed for PPP projects. The Construction Project Economic Evaluation Methods and Parameters (Third Edition) [2] released by the National Development and Reform Commission in 2006 are applicable to the financial evaluation of projects at the stage of feasibility study, but not fully applicable to the current PPP practice. Financial calculation is an important step to determine whether a PPP project is feasible or financially acceptable. Most of the participants, including public and private sector, have no clear understanding of the meaning of financial calculation indicators, thus affecting the project decision. In practice, due to differences in understanding or other factors, different indicators of rate of return are used for similar PPP projects under the jurisdiction of the same government or similar PPP projects served by different PPP consulting institutions, which is unfair to some extent. At present, the existing researches on PPP financial calculation are mostly carried out from the perspectives of significance of financial calculation, basic steps, key calculation points and whole-process financial management [3-9]. There are also some researches conducting comparative analysis on the internal rate of return indicators.
of PPP projects \cite{10}. In this study, there is a comparison of the economics meaning of the indicators commonly used in current PPP projects, such as internal rate of return, return on investment, reasonable profit rate and annual interest rate. Combined with case studies, the applicability of different indicators is analyzed, so as to provide reference for the reasonable selection of financial calculation indicators in the PPP scheme design.

2. Categories and Meaning of Financial Calculation Indicators of PPP

2.1. Financial Internal Rate of Return

Financial internal rate of return (IRR) is a discount rate that makes the cumulative net cash flow of each year in the calculation period of the project equal to zero, that is, IRR is used as the discount rate to make the following formula right:

\[
FNPV(IRR) = \sum_{t=1}^{n} (CI - CO)(1 + IRR)^{-t} = 0 \tag{1-1}
\]

Where, \(FNPV\) - cumulative financial net present value;
\(CI\) - cash inflow;
\(CO\) - cash outflow;
\((CI - CO)\) - net cash flows for each time period \(t\);
\(n\) - cooperation period of project.

The IRR indicator contains three indicator models, i.e. internal rate of return on investment, internal rate of return on capital, and internal rate of return of investors. The above three indicators are dynamic indicators, which can be calculated by preparing the net cash flow statement with reference to Formula 1-1. When IRR is greater than or equal to benchmark yield (i.e., minimum acceptable IRR), the project scheme is financially acceptable.

a. Internal rate of return on investment

The indicator, internal rate of return on investment, is calculated on the basis of the total project investment, in order to examine the profitability of the whole project before the financing plan is determined, which belongs to the pre-financing indicator. This indicator is calculated on the basis of the cash flow statement of project investment, including two indicators before and after income tax. In addition, the indicator before income tax is not affected by changes in income tax policy, and only reflects the rationality of the project scheme itself. But the indicator after income tax might be affected by specific changes in income tax policy for the project, and is the standard for comparison and reference at the project company level. When the indicator is selected, the public sector assumes no responsibility for financing, guarantee and repayment of the debts of the project. Interest repayment has been reflected in the indicator.

b. Internal rate of return of project capital

The indicator, internal rate of return of project capital, is calculated on the basis of project capital in order to examine the level of investment income possibly obtained from the project capital, which is calculated according to the cash flow statement of project capital. Capital refers to the part of the total investment of construction project that is actually contributed by investors. For the project, it is non-debt funds and there is no interest or debt. When the indicator is used, the private sector generally bears the risk of changes in financing cost of PPP projects, and may also claim for compensation from the public sector due to the change of financing conditions.

c. Financial internal rate of return of project investors

The indicator, financial internal rate of return of project investors, is calculated on the basis of capital contribution of both parties to the project in order to examine the level of investment income possibly obtained by each project investor, which belongs to post-financing analysis indicator. This indicator is often applied to the calculation process where all shareholders of the project company implement asymmetric dividend distribution (same share with different rights), that is, it is applied to the calculation of financial internal rate of return of social capital under the circumstances where government investment entity does not participate in the project dividends. This indicator is calculated by using the cash flow statement of investors. In the table, cash inflow refers to various incomes actually derived
from social capital due to the implementation of the Project, mainly including cash inflows such as profits actually distributed and distribution of gains on disposal of ending assets. Cash outflow refers to the equity contribution actually made by private sector due to the implementation of the Project, mainly including contributed capital and so on.

2.2. Return on Investment

Return on investment is to consider the comprehensive earning capacity of a PPP project from a static point of view, involving two indicator modes – project return on investment (ROI) and rate of return on common stockholders’ equity (ROE), both of which take the cash flow in the normal year of operation after the project reaches the design capacity as a static object of study.

a. Project return on investment

Project return on investment represents the profitability of the total investment, which refers to the ratio of the annual earnings before interest and tax (EBIT) of a normal year or the annual average earnings before interest and tax for operation period to the total project investment (TI) after the project reaches the design capacity. The calculation formula is as follows:

$$\text{ROI} = \frac{\text{Annual EBIT}}{\text{TI}} \times 100\% \quad (1-2)$$

Where, EBIT = total profit+ all interests paid.

At the time of using the ROI indicator, since the loan part is included in the project investment, it is not necessary to calculate this part separately when calculating the government subsidy.

This indicator is applicable to PPP projects that don’t consider the capital structure of the project company, provided that the return from the public sector has covered all the project costs, and the public sector does not bear the responsibility for the change of financing costs. In general, the value is taken with reference to the benchmark interest rate for long-term loans and rises on the basis of the benchmark interest rate.

b. Rate of return on common stock holders’ equity (ROE)

ROE represents the profitability of project capital, which refers to the ratio of the annual net profit of a normal year or the annual average net profit for operation period to the total project capital after the project reaches the design capacity. The calculation formula is as follows:

$$\text{Rate of return on common stock holders’ equity (ROE)} = \frac{\text{Annual Profit Rate}}{\text{Project capital}} \times 100\% \quad (1-3)$$

The ROE indicator not only reflects the profitability of the capital invested in the project, but also measures the cost of project liabilities. Generally speaking, the higher the ROE becomes, the better the result is. If it is higher than the bank interest rate in the same period, moderate liabilities are beneficial to investors. This indicator is applicable to PPP projects that consider the capital structure of the project company and the repayment of the public sector according to the actual amount of loan interest. In this mode, the loan part is not considered in the capital, so for the amount of principal and interest repayments to be included in the financing part as a part of the government subsidy, the ROE is higher than the ROI in general.

2.3. Reasonable Profit Rate

Reasonable profit rate is a new term about the return on investment of the project company, which is put forward by the Ministry of Finance in the Guide for Demonstration of Financial Affordability of Public-Private Partnership Projects (C.J. [2015] No. 21) to calculate PPP operation subsidies, and it is a static financial analysis indicator. According to Article 16, the expenditure for operating subsidies shall be reasonably determined on the basis of project construction cost, operating cost and profitability, and calculated separately according to different payment modes. The calculation formula is as follows:

$$\text{Amount of operating subsidy expenditure in that year} = \frac{\text{Total construction cost} \times (1+\text{Reasonable Profit Rate}) \times (1+\text{Annual discount rate})^n}{\text{Financial operation subsidy cycle (Year)}} + \text{Annual operating cost} \times (1 + \text{Reasonable Profit Rate}) \quad (1-4)$$
Article 18 of the document C.J. [2015] No. 21 clarifies the value of reasonable profit rate. The reasonable profit rate shall be based on the profitability of medium- and long-term loans of commercial banks, and determined after fully considering different scenarios including availability payment, usage payment and pay-for-performance, as well as risk and other factors. This indicator is applicable to PPP projects that don’t consider the capital structure of the project company, provided that the return from the public sector has covered all the project costs, and the public sector does not bear the responsibility for the change of financing costs.

2.4. Annual Interest Rate
Annual interest rate is a static indicator, which is involved as PPP projects are paid by average capital plus interest method or average capital method.

Average capital plus interest method refers to the repayment method of bank loans. The public sector regards annual government subsidies for social capital during the construction period of a PPP project as a kind of financing loan, and the same amount of loans (including principal and interest) shall be repaid every year during the operation period, in which the principal is the total construction investment to be repaid, and the interest is the ROI of social investors, as shown in Formula 1-5. Average capital method is similar to average capital plus interest method, which is also a way of repayment of bank loans. The difference is that the total amount of loans is equally divided during the operation period, and the same amount of principal (total construction investment) and the interest (return on investment) on the remaining loans in that year are repaid annually, so that the amount of principal repayment is fixed, along with a decrease in interest, as shown in Formula 1-6.

\[
A = \frac{P * (1+i)^n}{(1+i)^n-1} \tag{1-5}
\]

\[
A = \frac{P + (P - B) \cdot i}{n} \tag{1-6}
\]

Where, A refers to annual government subsidy;
  i refers to annual interest rate;
  P refers to total construction investment;
  B refers to total amount of construction investment repaid.

The value of annual interest rate in a PPP project generally rises by 2-3 percentage points on the basis of the benchmark interest rate for medium- and long-term bank loans. The PPP project to be paid using average capital plus interest method or average capital method at an annual interest rate is also a project that does not consider the capital structure of the project company but considers the total construction and operation cost, provided that the public sector assumes no responsibility for the change of financing costs.

3. Quantitative Relation between Different Calculation Indicators

3.1. Quantitative Relation between Indicators
a. Quantitative relations between financial internal rate of return and return on investment, reasonable profit rate and annual interest rate

The financial internal rate of return is correlated with return on investment, reasonable profit rate and annual interest rate. After calculating the availability service fee and performance service fee of the PPP project company with return on investment, reasonable profit rate and annual interest rate, the financial internal rate of return is calculated on the basis of cash flow statement. As the construction and operation cost of the project is certain, the higher the return on investment, reasonable profit rate or annual interest rate is, the greater the project’s cash flow will be, and the higher the calculated value of financial internal rate of return will be.

b. Quantitative relation between internal rate of return on investment and internal rate of return on capital
Since the internal rate of return on investment belongs to “pre-financing” analysis, it has nothing to do with the financing structure and only depends on the cash flow of the project. The internal rate of return on capital depends on loan ratio and loan interest rate. Under financial leverage, the higher the loan ratio becomes, the lower the loan interest rate will be, and the higher the internal rate of return on capital will be. It is controversial as to which is bigger between internal rate of return on investment and internal rate of return on capital.

c. Relation between internal rate of return on capital and internal rate of return of investors

According to the cash flow statements of the project investors, the main cash inflows are actually distributed profits, and the remaining cash inflows are contingent income. The main cash outflows are contributed capital and operating costs, and the remaining cash outflows are contingent expenditures. In the event that preferred stock dividend distribution, statutory surplus reserve and discretionary surplus reserve are not taken into account, the annual net profit and residual cash flow can be allocated in time, and the internal rate of return of investors equals the internal rate of return on capital, following the equal shares enjoying equal rights rule. However, in practice, the cash flows of a project cannot be fully distributed in the current year, and the PPP project company needs to set aside retained earnings, so in general, the internal rate of return of investors is less than capital IRR. Besides, for the purpose of encouraging the participation of social capital or reducing the financial pressure, the public sector will give up dividends of some PPP projects. In the case where the same share enjoys different rights, the internal rate of return of investors may be higher than capital IRR.

3.2. Empirical Study

The investment of a PPP project totals 312.22 million Yuan (including the interest of 6.3 million Yuan during the construction period), and the cooperation period is 20 years (including 1-year construction period and 19-year operation period). 30% of the construction investment is capital, the proportion of investment by public and private sector is 1:9, and the balance of fixed assets recovered at the end of the period is 0. The operating cost is 5 million Yuan per year. The financing cost is calculated by 20% (5.88%) increase on the basis of the current bank interest rate for medium- and long-term loans. The repayment term is 15 years, and the repayment method is average capital method.

a. Relation between IRRs at different income levels.

When the reasonable profit rate is 6%, 8% and 10% respectively, the calculated results of each indicator are shown in Table 1.

| Name of Indicator | Reasonable Profit Rate |
|-------------------|------------------------|
|                   | 6% | 8%  | 10% |
| Average annual income of the project company (x 10^4 Yuan) | 3338 | 3791 | 4272 |
| Internal rate of return on investment (before tax) | 4.19% | 6.01% | 7.83% |
| Internal rate of return on investment (after tax) | 3.22% | 4.66% | 6.09% |
| Internal rate of return of project capital | 1.61% | 4.91% | 8.06% |
| Internal rate of return of investors (with equal shares enjoying equal rights) | 1.61% | 4.91% | 8.06% |
| Internal rate of return of the private sector (The public sector gives up all income distribution rights) | 28.24 | 32.6% | 36.47% |

According to the above calculations, when the reasonable profit rate rises from 6% to 8%, the average annual income of the project company increases from 33.38 million Yuan to 42.72 million Yuan. As the cash flow increases, the IRR indicator also increases. In this case, if all of the project’s remaining cash flows are considered to be allocated in the same year, then the calculated internal rate of return of investors is equal to capital IRR. However, in practice, it is very hard to allocate all own cash flows of the project. With equal rights for equal shares, the internal rate of return of investors generally cannot reach the level of the internal rate of return on capital. Given the public sector gives up all dividends and based on case assumptions, the calculated internal rate of return of private sector is much higher than the internal rate of return on capital.
In this case, the loan interest rate is calculated at 20% (5.88%) above the base rate. When the reasonable profit rate is 6%, the internal rate of return on investment is lower than the loan interest rate; under the effect of financial leverage, the internal rate of return on capital is lower than the internal rate of return on investment. When the reasonable profit rate is 10%, the internal rate of return on investment is higher than the loan interest rate; under the effect of financial leverage, the internal rate of return on capital is higher than the internal rate of return on investment. When the reasonable profit rate is 8%, the internal rate of return on capital is lower than the internal rate of return on investment before tax and higher than the internal rate of return on investment after tax.

b. Relation between IRRs under different financing structures. When the average annual income of the project company is 42.72 million Yuan and the financing structures are different, the calculated results of each indicator are shown in Table 2.

| Name of Indicator                                         | Ratio of Capital |
|----------------------------------------------------------|------------------|
| Internal rate of return on investment (before tax)       | 20%  | 30%  | 40%  |
|                                                          | 7.83% | 7.83% | 7.83% |
| Internal rate of return on investment (after tax)        | 6.09% | 6.09% | 6.09% |
| Internal rate of return of project capital               | 8.86% | 8.06% | 7.52% |
| Internal rate of return of investors (with equal shares enjoying equal rights) | 8.86% | 8.06% | 7.52% |
| Internal rate of return of the private sector            | 55.9% | 36.47% | 26.65% |

It can be seen from Table 2 that since the internal rate of return on investment is not related to financing plan, the internal return on investment remains unchanged when the ratio of capital is increased from 20% to 40%. Since the internal rate of return on capital is related to financing plan, the capital IRRs are 4.91%, 4.86% and 4.81% in response to the ratios of capital of 20%, 30% and 40%, respectively. In this case, the internal rate of return on investment is higher than the loan interest rate which is 5.88%. When the ratios of capital are 20% and 30% respectively, the internal rate of return on investment is higher than the internal rate of return on capital. However, when the ratio of capital is raised to 40% and the internal rate of return on investment is still higher than the loan interest rate, the internal rate of return on investment before tax is higher than the internal rate of return on capital, and the internal rate of return on investment after tax is lower than the internal rate of return on capital. Combined with the calculated results in Table 4, it can be seen that internal rate of return on investment and internal rate of return on capital are not only related to interest rate but also influenced by investment and financing structure.

4. Selection and Comparison of Financial Measurement Indicators of PPP

4.1. Advantages & Disadvantages and Applicable Conditions of Financial Measurement Indicators of PPP

Advantages, disadvantages and applicable conditions of four indicators including financial internal rate of return, rate of return on investment, reasonable profit rate and annual interest rate are described in Table 3.
### Table 3 Comparative Analysis of Indicators

| Category                          | Financial Internal Rate of Return | Reasonable Profit Rate and Annual Interest Rate |
|----------------------------------|-----------------------------------|-----------------------------------------------|
|                                  | Description                      | Description                                  | Function                                      | Applicable Conditions                  |
|                                  | Function                          | Function                                      | Function                                      | Applicable Conditions                  |
|                                  | Applicable Conditions             | Applicable Conditions                         | Function                                      | Applicable Conditions                  |
| **Sub-item**                     |                                   |                                               |                                               |                                   |
| **Internal rate of return on investment** | Examine the level of return on investment | It is applicable to PPP projects that do not consider the capital structure of the project company, provided that the return from the public sector has covered all the project costs and the public sector assumes no responsibility for the change of financing costs. | Project return on investment | Examine the profitability of the total investment |
| **Internal rate of return of project capital** | Examine the level of return on capital | It is applicable to PPP projects that consider the capital structure of the project company and the repayment by the public sector according to the actual amount of loan interest. | Rate of return on common stock holders’ equity (ROE) | Examine the profitability of the capital |
| **Financial internal rate of return of investors** | Examine the level of return of investors | It is applicable to the situation in which all shareholders share asymmetric dividends (For example, it is agreed that the public sector will not share dividends for shares it holds.). | | |

| Nature of Indicator              | Dynamic Indicators | Static Indicators |
|----------------------------------|--------------------|-------------------|
| Advantages                       | With the time value of capital taken into consideration, the actual level of return on an investment project is directly reflected from a dynamic perspective. It refrains from the influence of external parameters and completely depends on project investment process and net cash flow amount during management, which is relatively objective. | Boasting clear and direct economic significance Easy to calculate | Boasting clear and direct economic significance Easy to calculate |
## Category

| Description       | Function                         | Applicable Conditions |
|-------------------|----------------------------------|-----------------------|
| Financial Internal Rate of Return | The calculation process is complex. In terms of projects with unconventional cash flows, for example, when there is a large amount of additional investment in the operation period, multiple IRRs may appear, which may be either too high or too low, lacking practical significance. | |
| Return on Investment | While considering the ROI statically, the time value of capital is not considered. Thus, the influence of construction period, different investment methods and recovery amount on the project cannot be correctly reflected. It fails to reflect the influence of construction period, different investment methods and recovery amount on the project. The calculation of indicators is too subjective and arbitrary, resulting in relatively bad comparability of the calculation scope of numerator and denominator. Net cash flow information cannot be used directly. | |
| Reasonable Profit Rate and Annual Interest Rate | While considering the ROI statically, the time value of capital is not considered. | |

### Disadvantages

- The calculation process is complex. In terms of projects with unconventional cash flows, for example, when there is a large amount of additional investment in the operation period, multiple IRRs may appear, which may be either too high or too low, lacking practical significance.

### 4.2. Applicability of Various Indicators on Participants in PPP

Under the PPP model, all participants have a certain tendency to choose indicators. When the public sector gains advantage in negotiations, the participants are inclined to adopt static indicators that do not consider the time cost of capital, namely return on investment, reasonable profit rate or annual interest rate. In this case, the public sector will assume more risks. Correspondingly, when the private sector gains advantage in negotiations, the participants are inclined to adopt dynamic indicators, namely financial internal rate of return.

In practice, if the public sector adopts static indicators including return on investment, reasonable profit rate or annual interest rate to design PPP schemes, generally, the private sector will also conduct cash flow analysis according to the value of static indicators, calculate the financial internal rate of return, and thereby determine whether the project is worth investing or not. Even if IRR is used in the PPP scheme design, there are differences in the selection of the three sub-item indicators between public and private sector.

For the public sector, if the project’s financing risk and interest rate risk are undertaken by the private sector, it is suitable to select the internal rate of return on investment, which only focuses on the profitability of the project itself. The public sector assumes no responsibilities for financing, guarantee and repayment of the debts of the project, so as to give full play to the capital operation ability of the private sector and freely determine the project financing scheme and capital arrangement, etc.

As for the private sector, the PPP’s financial scheme should consider the financing needs, capital arrangement and income distribution of the project apart from profit estimate. The internal rate of return on capital reflects the profitability after leveraging the financing with own funds, which is more valuable for investors. According to the quantitative relation studies described above, the relative sizes internal rate of return on investment and internal rate of return on capital are related to loan interest rate, financing structure and other factors. When the internal rate of return on capital is adopted, investors with strong financing ability are more likely to make cooperation with the public sector under the same conditions. In the case that the public sector gives up all dividends, the internal rate of return on capital fails to correctly reflect the return level of investors, and the investors may calculate their return level according to the internal rate of return of the private sector. However, the calculated result of this indicator is generally higher than that calculated depending on the actual profit and dividend of the project, and it may mislead investment decisions simply by depending on the value of the indicator.

### 5. Conclusion

a. Four indicators including financial internal rate of return, return on investment, reasonable profit rate and annual interest rate are all applied to the financial measurement of PPPs. Among them, the financial internal rate of return is a dynamic indicator, and the rest three indicators are static indicators without considering the time cost of capital. When the PPP project involves as long a period as 20 to 30 years,
it is recommended to use dynamic indicators rather than static indicators in the project investment decision.

b. The financial internal rate of return includes the internal rate of return on investment, the internal rate of return on capital and the financial internal rate of return of investors. The internal rate of return on investment belongs to pre-financing indicator, independent of the financing plan. The internal rate of return on capital belongs to post-financing indicator, which shows a difference with the proportion of financing. With equal share enjoying equal rights, the internal rate of return of investors is in line with the internal rate of return on capital, and the public sector will give up dividends of some PPP projects. In this case, the internal rate of return of the private sector is higher than the internal rate of return on capital.

c. In a PPP project, it is more appropriate, from the perspective of the public sector, to adopt the internal rate of return on investment without considering the financing cost and debt repayment. However, from the perspective of the private sector, the internal rate of return on capital considers the profitability after leveraging the financing with own funds, which has greater practical reference significance.

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