METHODS FOR ACCOUNTING FOR RISKS IN LONG-TERM PROJECTS

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Risks represent a large portion of a project’s success. This is especially important in long-term projects such as public-private partnerships (PPPs) due to their complicated nature and long duration. Risks manifest in these projects throughout the project phases and can have severe effects on them. Previous literature has studied and reported on various methods for incorporating risks long-term projects; however, there is no universal method used. Hence, this paper identifies and reviews the most commonly used methods. Four methods were identified, which are risk adjusted discount rate, uncertain parameters method, certainty equivalent method, and decoupled net present value (NPV) method. These methods were discussed and contrasted in order to show their uses for long-term projects such as PPPs. The first method was found to incorporate both risk and time in a combined method while the other methods relied on decoupling of the risk and time due to their different natures.

Keywords: Discount rate, Public-private partnership (PPP), Future cash flow, Net present value (NPV).

1 INTRODUCTION

Measuring and monitoring risks and uncertainties are key factors for a successful long-term construction project (Attarzadeh \textit{et al.} 2011). Projects pursued under a public-private partnership (PPP) face many uncertainties and inconveniences dealing with the high risk generated through this long-term cooperation of the parties (Attarzadeh \textit{et al.} 2011, Liang and Hu 2017). Thus, conducting a careful initial investment analysis is necessary to guarantee the desired results from such projects and prevent catastrophic failures (Shimbar and Ebrahimi 2017). In order to achieve reliable and definite results during the project’s financial valuation stage, a suitable approach should be considered to reflect the risks accompanying the project’s future cash flow (Shimbar and Ebrahimi 2017). Accounting or measuring risk techniques plays a vital role in deciding whether or not to invest in these type of projects due to their longevity and ensuing issues (Attarzadeh \textit{et al.} 2011, Shimbar and Ebrahimi 2017).

Several methods exist in literature to account for risks in long-term projects such as PPPs. Net present value (NPV) is considered the simplest and most commonly used technique in the financial valuation of projects (Shimbar and Ebrahimi 2017). However, in the existing literature, there are some modifications applied to the NPV method to achieve more accurate and realistic analysis (Miyauchi \textit{et al.} 2020). These modified techniques consider different ways to introduce risks and uncertainties during project valuation and directly affects the decision-making process. Thus, this
Risk's each parameter is uncertain parameters affected by this risk are determined (Attarzadeh As opposed to Managing risk in long term projects that each type of risk has a different nature that affects the types of risk from one determining the risk premium is based on the engineering economist free discount rate is same does not reflect the true impact of risk for the high future cash flow. Another reason that results for the individual cases (Shimbar and Ebrahimi 2017, Espinoza 2019) can be negatively affected RADR assumes a constant value for all the risk parameters without adjusting the discount rate. However, this assumption has some drawbacks and was criticized by a considerable number of researchers (Attarzadeh et al. 2011, Shimbar and Ebrahimi 2017, Espinoza et al. 2023). While RADR assumes a constant value for all the risks associated with the project, PPP project valuation can be negatively affected by this assumption and can lead to unreliable decisions due to their long-term nature. The value of risks usually increases with time in most cases (Shimbar and Ebrahimi 2017), therefore using a constant value throughout the lifetime of the project can reflect unreliable results for the investors (Shimbar and Ebrahimi 2017, Wibowo 2022, Espinoza et al. 2023). Another reason that highlights the unreliability of using a single adjusted rate to account for both time and risk is underestimating the long-term cash flow values and overestimating the short term ones (Shimbar and Ebrahimi 2017, Espinoza et al. 2023). For instance, in discounting the future cash flow of high-risk projects, practitioners tend to increase the risk premium in order to account for the high future risks. However, this approach causes an excessive discounting of such risks and underestimates its real value. In other words, assuming that risk and time value of money are the same does not reflect the true impact of risk. Also, adding a risk premium to the original or risk-free discount rate is considered a subjective matter (Shimbar and Ebrahimi 2017). In practice, determining the risk premium is based on the engineering economist’s judgement which could vary from one person to another. Finally, using a single risk adjusted discount rate that accounts for all types of risks in a project does not simulate the real case scenario. Moreover, it neglects the fact that each type of risk has a different nature that affects the cash flow in a different manner.

2.2 Uncertain Parameters

Managing risk in long term projects requires accounting for uncertainties (Attarzadeh et al. 2011). As opposed to the RADR method, this method incorporates the projects’ risks through the use of probabilistic parameters without adjusting the discount rate. First, the risk is identified, then the uncertain parameters affected by this risk are determined (Attarzadeh et al. 2011). Furthermore, each parameter is represented by a distribution curve to account for the risk factor as well as the risk’s stochastic nature (Attarzadeh et al. 2011, Shimbar and Ebrahimi 2017). Therefore, the
resultant NPV of the project is presented as a probabilistic value (Cruz and Marques 2012). Hence, introducing risk as a part of the future cash flow results in more realistic results (Attarzadeh et al. 2011, Shimbar and Ebrahimi 2017, Liang and Hu 2017, Kumar et al. 2018). @RISK and Crystal Ball are two of the powerful software tools that are widely used in the simulation process to account for the uncertain factors.

A growing number of scholars in literature have considered using uncertain parameters in representing the future cash flow. For instance, infrastructure investments or projects usually need a long time to develop and even more time to show return on investment (Espinoza and Rojo 2015). Thus, infrastructure projects require an accurate and a thorough study of risk and its impact on the future cash flow (Espinoza and Rojo 2015). In that view, Kumar et al. (2018) utilized Monte-Carlo simulations with NPV at risk to help investors in estimating highway projects’ profitability during the bidding phase. For a better valuation, it is important to identify the key uncertain factors in the study (Kagne and Vyas 2020, Wibowo 2022). Kagne and Vyas (2020) introduced a model that investigates the critical uncertain factors in a Build Operate Transfer (BOT) road project. The model ranked the most critical six uncertain parameters based on their influence on the project. Cruz and Marques (2012) introduced a stochastic model using Monte Carlo (MC) and Bayesian Networks (BN). Both methods focused on calculating a probabilistic public sector comparator (PSC) cost rather than a determinate value. The model used predefined probability distribution curves (log normal distribution curve) for the stochastic variables used in calculating the PSC cost. Therefore, the model’s results are expressed in probabilistic total PSC cost not as a certain value.

One valuable review represented by Hanafiizadeh and Latif (2011), illustrated the different forms to account for uncertain factors using simulations and covariance. Moreover, they introduced a model that considers the value of the uncertain parameters to be enclosed in a convex region named the uncertainty region. The size of this region depends on the investor’s willingness to take risks. This means that the riskier an investor is, the larger the uncertainty region. However, Wibowo (2022) argued that valuating projects using deterministic values in the future cash flow does not capture the stochastic nature of risk. Furthermore, using such traditional techniques affects the robustness of the measured value-for-money of projects.

Despite the wide use of Monte Carlo simulations in predicting the probability distribution of the resultant NPV of an investment, there are some drawbacks that should be considered while using this approach. These disadvantages can be summarized as: (1) difficulty in simulating the real future cash flow; (2) possibility of double counting of risks; (3) lack of consistency in representing different kinds of risks; and (4) the outcomes are difficult and complex to be easily understood (Espinoza and Morris 2013, Shimbar and Ebrahimi 2017, Espinoza et al. 2023).

### 2.3 Certainty Equivalent Method

Since time and risk are two different factors and cannot be combined in one factor as argued by (Attarzadeh et al. 2011, Espinoza and Rojo 2015, Shimbar and Ebrahimi 2017, Espinoza et al. 2023), many studies have attempted to separate them and recommend for them to be treated individually (Espinoza and Morris 2013, Haktanır and Kahraman 2023). One of the first methods to consider time and risk as separate factors in NPV calculations is the certainty equivalent method (CEM) (Shimbar and Ebrahimi 2017, Haktanır and Kahraman 2023). The smallest certain return that could be gained from an investment instead of an expected return over the same investment is the basic concept behind this method. In a simpler way, CEM helps investors in gaining guaranteed income on the investment rather than a riskier uncertain income. Similar to RADR, in CEM, the value of risk is subjected to the investor’s propensity to take risk. However, unlike RADR, CEM uses a risk-free discount rate in discounting future cash flow and includes risk as a separate coefficient ($\alpha$). This risk coefficient varies with time, which means that risk does not have the same
value throughout the lifetime of the project. α has a value that ranges from 0 to 1, and it accounts for all risk associated with the project (Shimbar and Ebrahim 2017, Haktanır and Kahraman 2023). Also, α is a reducing factor that is multiplied with the future cash flow. Therefore, when α is close to 1, it means that the risk is low and there are higher chances to get a high expected return.

However, there are two main drawbacks mentioned in literature regarding the CEM. Firstly, the subjectivity in measuring risk, as mentioned earlier, the tendency of the investor to take risks affects the result (Espinoza and Morris 2013, Shimbar and Ebrahim 2017, Haktanır and Kahraman 2023). Moreover, the value of the risk coefficient is highly affected by the historical data analysis. Nevertheless, studies in the financial literature addressed this shortcoming and suggested using fuzzy models with the CEM to lessen the interference of personal judgments in the decision-making process (Haktanır and Kahraman 2023). Secondly, several researchers have stressed that CEM has some practical limitations in calculating the risk coefficient and they argue that it does not simulate the nature of risk in long-term projects practically where the lifetime of these projects is long (Espinoza and Morris 2013, Shimbar and Ebrahim 2017).

2.4 Decoupled Net Present Value

In view of decoupling risk and time in the NPV calculations, a new method was developed to overcome the subjectivity in measuring risk as in the certainty equivalent method. This new method is referred to as the decoupled net present value (DNPV) method (Espinoza and Morris 2013, Espinoza and Rojo 2015, Shimbar and Ebrahim 2017). DNPV follows the same concept of CEM in separating the risk and time when discounting cash flows. However, there are differences in the methods of calculating risk (Espinoza and Morris 2013). In the DNPV method, risk is priced and treated as a cost that is either added to the expenditures and/or deducted from the revenues. In other words, the risk is incorporated in the calculations of NPV as a synthetic insurance product that protects the investor from potential losses in the expected cash flow. This expected loss could either be an increase in the expenses or a reduction in the expected revenues.

The idea of pricing risk stems from the well-known concept in the business field that recommends buying insurance packages or products to compensate for any risk (Espinoza and Morris 2013, Espinoza and Rojo 2015, Shimbar and Ebrahim 2017). The price of each risk is considered as a percentage (Ꞃ) of the expected value of the expenditures or revenues depending on the kind of risk. Therefore, DNPV reflects the impact of each risk individually in the future cash flow unlike other methods. Hence, allowing a better valuation of the project and providing the investor a clearer view to take the right decision. There are three methods to calculate the risk parameter Ꞃ. Firstly, is a heuristic method that relies on either the investor’s past experience in dealing with similar projects or the values found in literature for wide range of projects. The data in literature provides a wide range of the estimated value of Ꞃ (Espinoza and Morris 2013). Secondly, probabilistic methods can be used that provide a probability distribution function for the uncertain parameters in the project. Thus, eventually the loss or increase in cost and revenues are determined; and accordingly, the price of risk can be determined as well (Espinoza and Morris 2013, Espinoza and Rojo 2015, Shimbar and Ebrahim 2017). The third approach is much similar to the probability based method but is enhanced to account for the stochastic nature of risk. To this end, the DNPV method manages to solve the problem of coupling risk and time value of money by separating them (Nguyen et al. 2021). Moreover, it provides a more objective method for measuring or pricing risk.

In literature, DNPV was utilized in different types of projects such as infrastructure PPP projects, and in the energy sector including projects in oil and gas, electricity, and solar energy (Espinoza and Rojo 2015, Nguyen et al. 2021, Zhang et al. 2022). These projects are characterized by its long period; therefore, it is highly subjected to uncertainties and risk that could not be
foreseen (Espinoza and Morris 2013). In PPP infrastructure projects, Nguyen et al. (2021) introduced DNPV as a valuation method to optimally determine the concession period of a BOT Highway project in Vietnam. The model used the heuristic method in determining the risk parameter J in order to price the associated risk. Also, Espinoza and Morris (2013) demonstrated the benefits of using DNPV instead of the traditional NPV method in valuation investments and applied it to an infrastructure project in Colombia and the results were compared with the RADR method. The results revealed the ability of DNPV to accurately evaluate the risk transferred to the investor without the need for the heuristic assumptions of RADR.

3 DISCUSSION

This paper presents a review of the different methods used to account for risks during the financial valuation stage of an investment in PPP projects. The four methods found in literature are RADR, Uncertain Parameters, CEM, and DNPV. After studying and evaluating the four methods through the existing literature, it could be noted that most studies stressed on the fact that the RADR method does not reflect the true impact of risk in the future cash flow. Thus, this poor understanding of risk incorporation can result in over or underestimating of the discounting rate of return and eventually leads to incorrect investment decisions. Accordingly, many studies focused on how to overcome the main drawback in the RADR method which is coupling both time and risk in a single adjusted rate of return. As a result, probability-based methods were introduced powered by simulation software such as Crystal Ball and @Risk. Introducing uncertain factors to the future cash flow instead of determinate ones accounted for the risk associated with the project and also the stochastic nature of risk. Using stochastic parameters showed a wide range of acceptance in PPP projects. However, some studies mentioned the complexity of the results and that it is not easily interpreted. Other research has attempted to decouple time value for money and risk resulting in two methods, which are CEM and DNPV. Both methods share similar views for decoupling time and risk in discounting the future cash flow but differ in the methods adopted for measuring the risk value. CEM has some limitations in practice regarding projects with long durations. On the other hand, DNPV was derived from CEM but with some enhancement to better suit PPP projects and long-term projects in general. All four methods have different degrees of subjectivity in measuring risk. RADR and CEM are considered more subjective in their results than DNPV and probability methods. Finally, choosing the appropriate approach to incorporate risk depends on the nature of the project, the number of uncertainties and risk associated with the project and the investor’s tendency to take risks.

4 CONCLUSION

Valuating capital investment projects such as PPPs or other long-term projects faces several issues in the financial aspect. In real practice, risks associated with these types of projects play a vital role in the valuation process. Often, PPP projects take a long time to materialize and longer time to show revenue or return over investment. Thus, many political and market changes could occur as the project period increases. These changes and uncertainties are considered financial risks that may hinder the success of a project. Therefore, accounting for risks in valuating such capital investment projects is a major step. In that view, this paper identified and reviewed the most common and widely used approaches for incorporating risk in determining the NPV for PPP projects. A detailed review of the benefits and shortcomings of each method was introduced. Furthermore, the authors summarized the main concepts and ideas behind each method and its contribution to the field of study. Despite the criticism directed at RADR, it is still considered the easiest and simplest method to incorporate risk in calculating the NPV of a project or an investment.
In this paper, a review of the disadvantages of considering both risk and time value of money as interchangeable parameters was introduced. The literature showed many attempts to reflect the true impact of risk in the future cash flow through the decoupling of risk and time. Different applications for the mentioned methods were also introduced. These applications included PPP projects in different fields such as the infrastructure and energy sectors.

References


