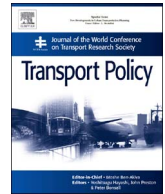




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Financial risk assessment and modelling of PPP based Indian highway infrastructure projects[☆]

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ABSTRACT

This paper investigates financial risk associated with highway infrastructure projects by identifying parameters such as traffic flow and project cost; and further models the risk by analysing real-world PPP based highway projects in India. It applies the Net Present Value (NPV)-at-risk model tool which uses Monte Carlo Simulation taking into account the probability distributions for different input parameters, and gives uncertainty associated with NPV. Further, the model is applied to 30 real-world BOT highway projects to identify critical risks and discuss mitigation strategies. The critical contribution of the paper is towards applying a standard risk-analysis model (NPV-at-risk tool supported by Monte Carlo Simulation) to the real-world PPP based highway infrastructure projects. The application of the developed model can be used as a decision tool to judge the profitability of a project and make investment decisions in the bidding phase by the private investors. It also helps in identifying which source of uncertainty has the most influence on the project's financial returns and what is the actual relationship between the critical influencing parameters and associated NPV; this will be helpful to government agencies and public authorities to identify the factors that have largest impacts and consider the corresponding mitigation strategies.

1. Introduction

India is one of the world's biggest markets for PPP with over 1300 major national level infrastructure projects as on 31st March 2014; moreover, half of them are road infrastructure projects and have been operated under various models such as BOT, BOT Annuity and Engineering Procurement and Construction (EPC). (PPP India Database, 2014). In India, National Highways Authority of India (NHAI) is a government agency responsible for the administration and maintenance of a network of over 70,000 km of national highways. Indian policy makers have realized that national highways form the economic backbone of the country; and a wide gap lies between the demand of the infrastructure and the supply available (Shetty, 2012). Therefore, it is crucial to make plausible efforts for substantial raise in infrastructure investment and improve the quality of infrastructure facilities. Some of the problems associated with transportation infrastructure development include financing, land acquisition and delays in construction.

Public-Private-Partnership (PPP) is a project delivery system that can address some of these issues. PPP involves a contract between a

public sector authority and a private party, in which the private party is responsible for providing and operating a public service or a project and collect revenues (Delmon, 2011). Because of this, a substantial part of the financial, technical and operational risk associated with the project is vested with the private party. The Government of India is looking forward to huge investments in infrastructure from private investors and has been focusing on the development of tools and activities to attract more investments through PPP format (Ernst and Young, 2012). The main advantages to government from PPP arrangements are in two folds. Firstly, they can use the private funds to finance their infrastructure projects. This is especially very important if the government is facing fiscal constraints. Secondly, through PPP, they may benefit from the expertise and experience of a private entity to build and operate a facility in a more cost-effective way (Delmon, 2011).

Build-Operate-Transfer (BOT) model is a form of PPP which has extensive applications in infrastructure projects. In a typical BOT highway project, a private entity is authorized to construct and operate a transportation infrastructure facility and in return, is allowed to collect tolls for a specified period of time to recover all the costs and

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earn a reasonable profit. PPP-BOT projects typically involve high financial risks because of their long-term nature and uncertainties associated with projected future cash flows, traffic forecast, delay in construction and cost overrun. One of the major unanswered questions is the risk assessment and modelling of these uncertainties for road transport infrastructure projects. In India, many of the past BOT projects have either been delayed or abandoned and had to be bailed out by the government due to inefficient financial risk management and strategy planning. For example, the 'Vadodara-Halol Toll project' in Gujarat state which has been operational since 2000 is currently under loss due to wrong traffic projections, thereby raising both policy and revenue risks for the involved parties (Raghuram, 2003).

This paper investigates the investment risk associated with a BOT highway infrastructure project with the help of 30 real-world highway projects. It applies Net Present Value (NPV)-at-risk model providing a cumulative probability distribution curve for NPV by considering a range of associated parameters and corresponding suitable distributions. The developed model after appropriate customizations can be used as a decision tool to judge the profitability of a project and make investment decisions in the bidding phase by the private investors. It also helps in identifying which source of uncertainty (e.g., traffic projections or construction delay) has the most influence on the project's financial returns and what is the actual relationship between the critical influencing parameter and associated NPV. Towards the end of the paper, various mitigation strategies and its applications have been discussed.

2. Literature review

Prior research endeavours have focused on the analysis of various options like NPV within a confidence interval, binomial lattice, government guarantees and fuzzy set theory to analyse the uncertainties with a BOT projects (Iyer and Sagheer, 2011; Attarzadeh et al., 2011; Ashuri et al., 2012; Ye et al., 2013). NPV-at-risk can be used for incorporating the risk profile by combining the Weighted Average Cost of Capital (WACC) and dual risk-return methods which gives NPV within a confidence interval using a Monte Carlo Simulation (MCS) technique (Ye and Tiong, 2000). Attarzadeh et al. (2011) used different techniques like Fuzzy set theory, probability modelling for decision making using insufficient data about parameters and complete information about their probability.

Wibowo et al. (2012) provided methods for quantifying payments of guarantees given to protect project sponsors from skyrocketing costs of acquiring land, delays in scheduled toll adjustment, and compensation payments in case of nationalization events. Nemuth (2008) implemented a two stage model, identifying and analysing the risks and then evaluating using MCS and discussed alternative actions. Further details of existing state-of-the-art research are illustrated in Table 1.

One of the major uncertainties involved in calculating NPV for a highway project is associated with estimating future traffic flow. Bagui and Ghosh (2011) proposed a method to determine lower and upper limits of traffic/revenue at risk. Iyer and Sagheer (2011) proposed a traffic band using binomial lattice method which was combination of both upper and lower limits of traffic which ensure certainty through an equitable risk and revenue sharing mechanism. Pathan and Pimplikar (2013) represented the risk of financing during the post construction period due to fluctuation in prime lending rate (PLR) through a case study and provided a reasonable agreement to change concession period corresponding to the change in prime lending rate.

The risk associated with a project is the probability of investment's actual return being different from the estimated return (Krishnamurthi, 2008). Risk includes the possibility of losing some or all of the original investment. Different versions of risk are usually measured by calculating the standard deviation of historical returns or average returns of a specific investment. Various valuation methods have been used to estimate the profitability and risk of a project which

can be broadly categorized into two categories – Discounted cash flow (DCF) models and Non-Discounted cash flow models. Former gives importance to the time value of money and calculates the present value of future and past cash flows using a discount rate. It includes tools like NPV, internal rate of return (IRR) and modified IRR. On the other hand, the latter focuses on the time required to recover the initial cost of investment without accounting for the time value of money and includes methods like payback period and accounting rate of return. (Atrill and McLaney, 2014).

Time value of money is an important aspect of every investment as all projects deal with cash flows over a long period of time; thus DCF models are a better valuation method (IFAC report, 2012). Among different DCF models, NPV is the most commonly used valuation method which is calculated as the "difference amount" between the sums of discounted cash inflows and outflows. It compares the amount invested today to the present value of the future cash receipts from the investment, taking inflation and rate of return into account. The decision rule to be followed is that a project is acceptable if the NPV is positive. However, this decision rule fails to provide decision-makers with a confidence level. Therefore, the concept of NPV-at-risk is developed which computes NPV at some specific confidence levels. It mathematically and objectively computes the risk associated with different possible future scenarios and keeps a track of these results.

Extensive research has been done for the success and improvement of BOT projects like including risks associated with future traffic flow, lending rate and project cost, but in individualistic approaches. A wide gap still persists when it comes to combining uncertainties associated with different parameters in one model while estimating future cash flows. Further application of such models for real-world PPP based highway projects in India is yet to explore. This paper aims to narrow down the gap by outlining a standard NPV-at-risk tool (supported by Monte Carlo Simulation) to analyse PPP highway projects and apply such powerful tools for 30 real-world projects. In this paper, probability distributions have been assigned to different parameters which affect the NPV of the project; and Monte Carlo Simulation is applied which incorporates uncertainties associated with different parameters to give NPV within a certain confidence interval. Also, the critical influencing parameter (parameter which affects output the most) is determined and appropriate risk mitigation efforts are discussed.

3. Methodology

A highway BOT project is influenced by a number of parameters; and uncertainties associated with those parameters are one of the major complications with the investors. In this paper, various risk categories influencing a BOT highway project and the associated parameters are first identified. Then, a corresponding probability distribution is assigned to each parameter to forecast the actual value of parameter. Then data is fed into a model developed in @Risk after which the results have been interpreted and analysed. The steps shown in Fig. 1 summarize the whole methodology used in this paper for developing the NPV-at-risk model.

3.1. Risk identification and assigning probability distribution

A highway BOT project is influenced by various types of risks and each risk is associated with a different parameter as shown in Table 2.

Uncertainties associated with these parameters become a major difficulty for the investors while analysing profitability of these projects. Probability distributions are thus assigned to each parameter as it gives a probability to various values of a parameter and is very helpful in forecasting the actual value of parameter. Some of those uncertain parameters which have been incorporated in the model developed in this paper are stated below along with their distributions:

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