STRUCTURING EQUITY INVESTMENT IN PPP PROJECTS

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ABSTRACT

Earlier studies have established guidelines to optimize the capital structure of a privatized project. However, in the US, many Public-Private Partnership (PPP) projects may not be fully self-financed through toll or other operating revenues due to insufficient revenue streams. With the limited debt capacity secured by toll revenues, most PPP projects must be backed by both private equity investment and public funds. The equity structure is of essence in a PPP deal because it implies risk and profit sharing. Therefore it provides a mechanism of private incentive and public interest protection. After identifying the limited upfront analysis of the financing structure, the Government Accountability Office has called for academic research and application of solid tools to protect public interest in PPP projects. This paper presents a structured approach for determining equity investment in PPP projects. Scenarios are generated using a linear programming model to reach the optimal equity structure under risk and uncertainty. The model divides equity investments into private equity and public funds and reaches the optimal equity allocation by maximizing the benefits from PPP financing. The I-10 Connector project is used as a case study to illustrate how equity investment is structured, given the limited bonding capacity from toll revenues.

KEYWORDS: Public Private Partnerships, Equity Financing, Optimization.

INTRODUCTION

Although the US government has impressively managed to provide essential transportation infrastructure for economic development and national security, the country still needs to increase infrastructure facilities to meet the demands from its people. Typically, the development of transportation infrastructure needs a significant upfront investment, which used to be funded by gasoline tax revenues. Due to the shrinkage of tax revenues and the recent financial crisis, the Federal and State governments find themselves in a distressed condition and cannot fund enough projects for the maintenance and upkeep of the existing infrastructure. Moreover, transportation infrastructure projects are more complex and involve many entities. As a result, management of infrastructural projects have become more challenging for public agencies. Since the early 1990s an increasing trend that has been observed is that many projects were being delivered through Public Private Partnerships (PPPs) to address the funding shortage and to improve project performance.

A Public-Private Partnership can be broadly defined as a long term agreement between public and private sectors for mutual benefit (HM Treasury, 2000). This agreement seeks to involve the private sector in the nontraditional areas of a project with the risks and rewards being shared in new ways (USDOT 2004). For example, a public agency may provide right-of-way and the right to collect user fees, while a private firm provides financing, technological innovation, and on-going service. Researchers and practitioners identify many contractual arrangements as

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PPPs, such as: fee-based contract services; Design-Build (DB); Design-Build-Operate-Maintain (DBOM); Design-Build-Finance-Operate (DBFO); Build-Own-Operate (BOO), and long-term leases (Mallet, 2008; USDOT, 2007; Abdel, 2007). In the United States, most partnerships require the private sector to be responsible for acquiring the majority of the necessary financing (FHWA 2009).

United Kingdom and Australia are widely recognized as forerunners in PPPs which have been used in various sectors of facility development since the 1980s (Abdel, 2007). As reported by the Public Private Infrastructure Advisor Facility (PPIAF) and the World Bank, PPP programs in the UK and Australia have been very successful and few PPP projects performed inefficiently or failed to meet their objectives (Sanghi 2007).

Early studies indicate that the successful delivery of PPP projects depend upon a properly formulated PPP agreement that both attracts private capital as well as and preserves public interests (Zhang et al 2001, FHWA 2009). However, PPPs are still new in the US. Many state transportation agencies have not established best practices and guidelines for PPP projects, causing strong public resistance due to serious concerns regarding the protection of public interests in PPP deals. In 2008 the Government Accountability Office (GAO) conducted a study to evaluate PPP projects in terms of protecting public interests. As GAO has pointed out, since the public sector gives up control over a future stream of toll revenues in exchange for upfront payment concession, PPPs might not be warranted due to the uncertainties of traffic on these toll roads. It may happen that the net present worth of the exchanged future stream of toll revenues will become much larger than the up-front concession received (GAO, 2008). GAO recommended that transportation agencies develop and conduct upfront financial analysis to determine the benefits and costs of PPP agreements and to better deliver transportation infrastructure projects.

LITERATURE REVIEW

PPPs still relatively new in the transportation sector, are believed to bring maximum benefits compared to other project delivery systems (Pakkala, 2002, Koppinen 2007, Abdel 2007). In the US, PPPs originated from educational programs and became increasingly used in urban renewal projects in the 1960s (Yescombe, 2007). Since the 1990s, an increasing trend of PPP application to the transportation sector has been observed due to the funding shortage in many states. Without strong political and public support, the use of PPPs is limited in the US transportation sector as compared to such forerunners such as the UK and Australia. Lack of well established procedures, guidelines, and analysis tools for PPP projects hinder transportation agencies from delivering transportation infrastructure with PPP contracts. Recently, the Texas legislature paused private investments for toll roads (Linderberger 2009).

Zhang (2005a) investigated PPP practices in European and Asian counties and identified barriers to the successful implementation of PPPs in transportation infrastructure development. He recommended that the best value procurement should be used on PPP projects, which would improve the efficiency of project delivery. The best value approach requires public agencies to evaluate bids with a set of predetermined criteria in a two-stage procurement process. During the first stage, private partners are required to submit their application for pre-qualification. Then, select private firms send their bids. The sponsoring agency awards the work to the bid that offers the best value, leaving aside the bid with the lowest cost. This process ensures that the public agency gets the best value which covers cost, time, quality, safety, etc (FHWA 2007b). The best value procurement could also incorporate value for money analysis that is typically conducted in

Australia and UK. The value for money analysis compares the PPP procurement to alternative traditional procurement methods under uncertain conditions. Since projects would proceed through PPP projects only when PPP procurement provides the better value compared to a more traditional procurement method, the value for money analysis ensures that PPP procurement achieves the best value for public agencies (Akintoye et al 2003, Mythbusters 2007).

Researchers also investigated the financial aspects of PPP projects. Gross (2009) put forward an approach to structuring concession lengths and toll rates. Zhang (2005b) used an optimization model to facilitate private and public sector for conducting financial viability analysis in order to determine the optimal debt and equity structure. Chiara and Garvin (2008) used the Martingale variance model and the general variance model as alternative modeling tools for BOT risk evaluation. Brandao and Saraiva (2008) viewed the minimum traffic guarantee (MTG) as an option and developed a model to evaluate government outlays in PPPs. Similarly, Lui and Cheah (2009) used the real options theory to model the PPP structure in waste water treatment plants. Abdel (2007) described implementation principles in PPP projects based on the analysis of concession agreements and the successful experience in the UK and British Columbia. Zhang (2005c) reported the primary financial criteria for selecting the right private partners in PPP deals. These criteria include net present value, internal rate of return, and total investment schedule. Though a great number of studies have been conducted in other counties, no convincing work has been conducted in the US. The Government Accountability Office has called for the development of upfront analysis tools for PPP projects in order to better protect public interests (GAP 2008). This paper provides a prompt for the allocation of capital, particularly for equity investments between public and private partners.

FINANCING MECHANISM

PPP projects are financed based on expected revenues from project operations. If a project is expected to yield a large amount of revenues, sufficient debt financing from the financial market can be obtained. This is called debt financing. The Federal Government provides financial support for infrastructural development with credit assistance such as TIFIA, GARVEE, private activity bond, etc. Additionally, state governments may also use general revenues to secure general obligation bonds for infrastructural development. However, if the expected revenues fall short, debt financing may not cover total project costs which creates a financial gap. The financial gap needs to be closed with funds from either public or private sectors. While debts must be paid at a pre-determined rate and within a pre-determined period, project funds from public and private sectors, typically known as equity financing, take high risks and get repaid after debt service.

The equity component is of essence in PPP project financing and needs careful attention and a full evaluation. First, debt capacity is determined by the project revenue stream and evaluated by financial institutes. Second, private partners are willing to invest in PPP projects only when they anticipate a high rate of return, or a minimal internal rate of return (MIRR) from the investments. If the project is not profitable enough, no private partners will take the risk to invest. Therefore public agencies may have to give away a significant share from the total profit to attract private investments, even if equity investments may just be a small percentage of the financial gap. Third, public agencies must protect their interests and ensure that private partners do not abandon projects when private partners obtain enough profits from PPP projects earlier than expected. Earlier exit from PPP projects may benefit private partners because they could reduce their operational and maintenance costs. Private partners are thus required to guarantee a minimum amount of investment to reduce the risk to public agencies. Furthermore, strong public resistance to high private profit in PPP projects pushes many public agencies to limit the rate of return for private investments. Therefore, the amount of private equity, or the allocation of private equity and public funds in PPP deals, remain a major subject of PPP financing.

MODELING FOR EQUITY FINANCING

Division of equity financing between private partners and public agencies determines the sharing of project profit streams and affects the successful delivery of PPP projects. A Linear Programming (LP) model is developed to help public agencies accomplish their objectives while remaining attractive to private investments. It is assumed that a PPP project spans T years. Funding is secured and project starts at time point t=0. The following notations are used throughout the paper.

C = Construction cost	*R_t = Revenue at time t*
D = Debt	*DS_t = Debt Service at time t*
E_1 = Private Equity	*OM_t = Operation & Maintenance costs at t*
E_2 = Public Funds	*DSR_t = Debt Service Reserve payment at t*
i_A =Rate of return for public agency	*$P_{1(t)}$ = Profit Sharing for public partner at t*
i_B =Rate of return for debt holders	*$P_{2(t)}$ = NPW of Profit for public agency at t*
i_P =Rate of return for private partner	*DSCR = Debt Service Coverage Ratio*
γ = Public Opportunity Loss Coefficent	

$$\text{Objective Function: Max} \quad \left(D - \sum_{t=0}^{T} \frac{DS_{(t)}}{(1+i_A)^t}\right) + \left(E_1 - \sum_{t=0}^{T} \frac{P_{1(t)}}{(1+i_A)^t}\right) - \gamma * E_2$$

$$\text{s.t.} \quad D*DSCR - \sum_{t=0}^{T} \frac{DS_t}{(1+i_B)^t} <= 0$$

$$DS_t * DSCR - (R_t + DSR_t - OM_t) <= 0$$

$$C - (D + E_1 + E_2) <= 0$$

$$E_1 - \sum_{t=0}^{T} \frac{P_{1(t)}}{(1+i_{P(\min)})^t} <= 0 \qquad (ELP)$$

$$\sum_{t=0}^{T} \frac{P_{1(t)}}{(1+i_{P(\max)})^t} - E_1 <= 0$$

$$P_{1(t)} <= R_t - OM_t - DS_t$$

$$D, DS, E_1, E_2, P_1, P_2, >= 0$$

The objective of the optimization is to maximize the benefits for the public agency from PPP financing. The three benefits and costs components included in the objective function are debt financing benefits (costs), private equity financing benefits (costs), and opportunity costs associated with public funds. The model must satisfy several constraints. First, the debt capacity constraint defines the maximal amount of debt that a PPP project could support. Financial rating companies, like Fitch and S&P rate the project in accordance to the profitability. The project rating determines the Debt Service Coverage Ratio (DSCR), which, along with the project revenue stream, is used to calculate the debt capacity. Second, the debt holders require the debt service is secured with higher net revenue during the project operation phase. A reserve fund could also be used to pay debt service. The reserve fund is either from initial public or private investments, or operation profits reserves from earlier years. Third, PPP financing must be able to cover project costs. Fourth, the rate of return for private partners must be larger enough to attract private investments, yet small enough to protect public interests. $i_{P(\min)}$ and $i_{P((\max)}$ indicate the low and high boundaries of the rate of return for private partners. Furthermore, profits to private partners must be paid after debt services are paid.

In most cases, the proposed model ELP involves a great amount of variables and equations. To simplify the calculation, an alternative model SLP is developed and presented below. The objective function is changed to minimize costs so that the results will be on the positive side. In the SLP model, all values are discounted back to time 0. R, DS, P_1, and OM are the present worth of cash flows R_t, DS_t, $P_{1(t)}$, and OM_t. The two coefficients α and β are used to convert values at the discount rate i_D to i_B and i_{PI} . These constants are easily obtained by dividing the present worth of cash flows at i_D by the present worth of the same cash flows at $i_{B\ or}$ $i_{P.}$. D, DS, E_1, P_1 *and* E_2 remains as the decision variables in the SLP model.

$$
\begin{aligned}
&Min\quad (DS - D) + (P_1 - E_1) + \gamma * E_2\\
&s.t.\\
&\qquad D * DSCR - R <= 0\\
&\qquad DS = \alpha * D\\
&\qquad D + E_1 + E_2 = C\\
&\qquad P_1 >= \beta_{min} * E_1\\
&\qquad P_1 <= \beta_{max} * E_1 \qquad\qquad (SLP)\\
&\qquad P_1 <= R - OM - DS\\
&\qquad DS, D, P1, E1 \text{ and } E2 >= 0\\
&\qquad D, E1, E2 <= C
\end{aligned}
$$

The objective function in the SLP model is defined as minimization of PPP financing costs to public agencies. The three types of financing mechanism in PPP projects are debt, private equity, and public funds. The difference between Debt Service and Debt represents the public costs through debt financing. If the expected revenue is less, then the debt available from banks and government agencies will decrease. This happens because the banks who give debt take Debt Service Coverage Ratio (DSCR) into consideration when calculating the amount of debt. The DSCR is calculated as Revenue/Debt. In such cases the finance gap is arranged through equity finance which is costlier than the debts. In return for equity investments, private partners take a large share of project profits which translates into high rates of return. Hence public agencies need to fill the financial gap with private capital in the meantime to ensure that the return to private partners is not unexpectedly high. $(P_1\text{-}E_1)$ represents the cost of private equity financing.

A reduction of upfront public investments may be beneficial to public agencies. These reduced upfront investments leave more money-in-hand to be used for other new or renovating jobs. By using public funds in a PPP project, the public agency essentially gives up the opportunity to build other infrastructure that could bring economic and social benefits to the public. In the ELP and SLP models, a public opportunity loss coefficient γ is used to calculate the opportunity loss due to the use of public funds in PPP projects. One must notice that profit sharing for the public agency should also be incorporated into the coefficient γ. When γ=1, amount of benefit from PPP project operation derived from funds invested in the PPP project by the public will equal the cost of opportunity loss from alternative infrastructure development. $\gamma<1$ indicates that opportunity cost is less than the benefits from the PPP projects. The opposite is true when $\gamma>1$. The higher the γ, the larger the opportunity loss. In both models, $\gamma * E_2$ represents the total opportunity cost of public funds in a PPP project.

CASE STUDY

The Alabama Department of Transportation (ALDOT) received an unsolicited proposal to build a 23 mile highway named US 231/I-10 Connector which will run between Alabama border to Dothan. This highway was proposed to provide a safer and a more efficient road network to relieve traffic congestion. Dothan, also known as “Hub of the Wiregrass”, is located at a distance of about 100 miles from Montgomery and at about 200 miles from Birmingham and Mobile. This proposed highway will connect Dothan with these major population centers, which are currently served by network of Interstate System. The preliminary Traffic and Revenue Study report estimated the cost of construction of the connector highway to be $100 million (the numbers are adjusted within reasonable limits to maintain the secrecy of actual numbers associated with the project). It also estimated the expected revenue streams which were obtained from two different traffic growth cases a Base Case and an External-External (EE) Boosted Trip Table case.

Three scenarios were developed from the Base Case. The worst case scenario assumes that the toll revenue growth (which incorporates traffic growth and toll growth with inflation) would be 4.6% for 30 years. Under the average scenario, the toll revenue growth rate is expected to be 4.6% for the first ten years, 8% for the next ten years, and 4.6% for the last ten years. Under the best case scenario, the toll revenue will grow at 4.6% for the first ten years and 8% for the next twenty years. Three more scenarios were similarly developed using EE Boosted revenue streams. Under some of these scenarios, however, the toll revenue could not secure enough debt to cover all project costs. Therefore, equity financing must be used in this project. A reasonable distribution of private equity and public funds remains the major concern to the state agency because the equity allocation balances attracting the private sector and protecting public interests.

Based on the SLP model, an excel optimization model was developed to determine the optimal allocation of equity investment for the I-10 Connector project. Beta distribution was used to calculate the present worth of expected revenue under each scenario. Furthermore, sensitivity analysis was conducted using risk analysis tool @Risk 4.0 to evaluate the impact of uncertainty in the toll revenue and the opportunity loss coefficient. Data sets used on the base run are listed in Table 1. The optimal private equity investments under base case and EE boosted case are $9.55 and $11.76 million, respectively.

Table 1 Data Used In LP Analysis and Results

	C ($M)	R ($M)	DSCR	α	β (min)	β (max)	γ	***Optimal Private Equity***
Base Case	100	65	1.50	1.20	1.36	2.10	2.00	***$ 9.55 million***
EE Boosted	100	80	1.50	1.20	1.36	2.10	2.00	***$ 11.76 million***

DSCR was selected at a value of 1.5. After getting the optimal results, sensitivity analysis was conducted to test the impact of various expected revenues which range from 0 to $180M. This enabled in getting a set of values of all the decision variables by varying the expected revenue from 0 to $180M. Similar sensitivity analysis was conducted by changing DSCR from 1.35 to 1.75 in the model. Figure 1 shows the impact of expected revenues on agency cost, debt capacity, private equity, profit sharing to private partner, and public funds when DSCR is 1.5.

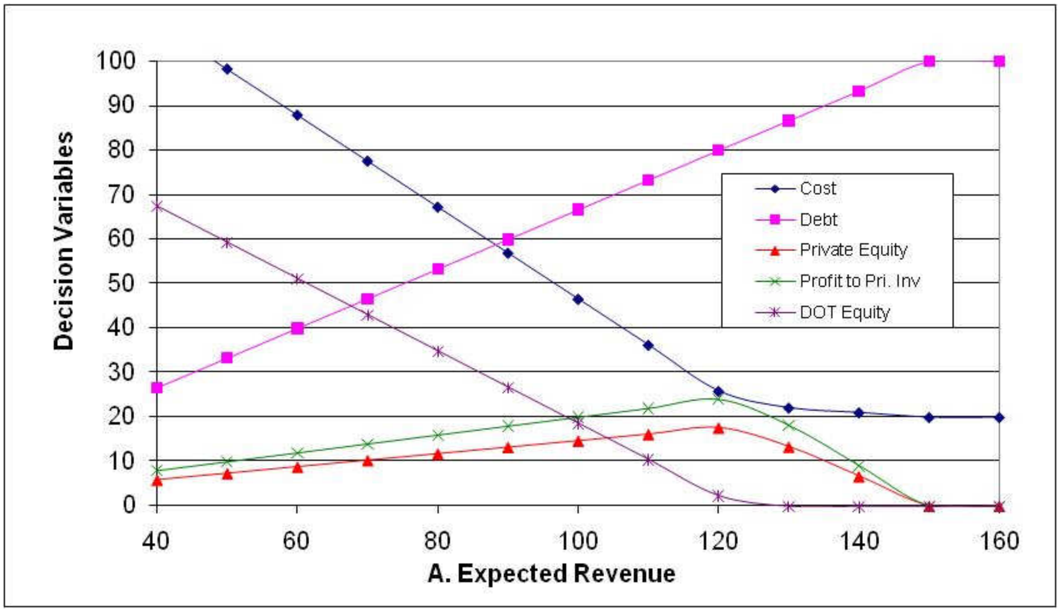

Figure 1 Impacts of Expected Revenue

It can be observed that as the expected revenue increases, total financing costs to the state agency will decrease. This can be explained by the increasing debt capacity due to high toll revenue. Debt financing is typically cheaper than equity financing. When high toll revenue is expected, net profit is expected to be high. Therefore, the project would be more attractive to the private sector, decreasing the need for public funds. This trend continues until the project is completely self-financed through debt. Equity financing becomes costly in the PPP project. The data obtained through solver sensitivity analysis was used to plot the graph between the expected revenue and the equity structure ratio of E2 and E1. Each point on this graph represents an optimal value obtained by sensitivity analysis. Revenue was selected to range from 0 to 180. The results are shown in figure 2. These curves, named as "Optimal Curves", were then used to obtain the values of E2 and E1 by projecting the values of expected revenue from the X axis to the optimal value curves and then projecting them to the Y axis. Given the DSCR, the optimal equity structure, described as public fund over private equity (E2/E1), can be selected. When the DSCR is uncertain and within a range, the public agency could define the optimal range of equity structure. This is called equity structure efficient space.

It should be noted here that a value of 0 for the ratio E2 and E1 indicates that the optimal solution should have no investment from DOT but it should not be misinterpreted that E1 should also be zero. We can not know about the amount of private equity investment from the graphs shown in figure 2. The information about private investment can be obtained using the sensitivity analysis report. In the I-10 Connector project, the optimal equity structure is 3.0 under base case, 5.8 under EE boosted case for an assumed value of DSCR 1.5 and E1+E2 should be equal to total equity requirement in both cases. With a DSCR range of 1.35-1.75, the equity structure ratio ranges from 3.74 to 10.3 under the base case scenario.

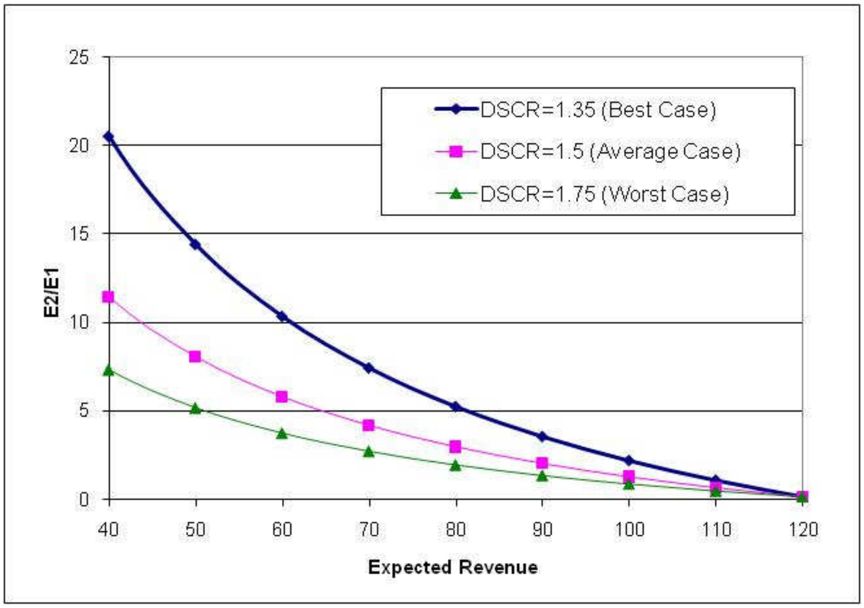

Figure 2 Equity Structure Using Curve Obtained By Optimal Solution

Sensitivity of the objective function was tested by varying the value of γ. The sensitivity report indicated that after a particular value of γ, the model reducing the public funds to 0 covered the equity requirement fully from private equity. This indicates that the value of γ helps to establish a cut off point for public funds in the project. Lastly, it may happen that information about the expected revenue is not available. In such a case the decisions of distribution of equity can be made by using the extreme corners of the area contained by the optimal curves and the expected range of the expected revenue. This is demonstrated in figure 3.

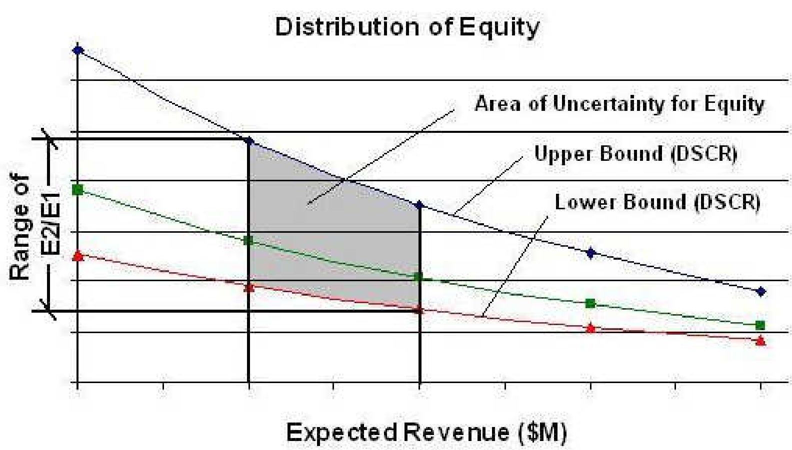

Figure 3 Decision for E1 and E2 During Higher Levels of Uncertainty

The area of uncertainty for equity in figure 3 is proportional to the uncertainty. If the uncertainty is less, the curves of optimal solutions will be much closer and the range of expected revenue can also be replaced by a point value of expected revenue. In any case, linear programming can be used for the distribution of equity for optimizing desired outcome. It is reasonable to say that the SLP model describes the PPP finance structure on a very primitive level. This model can be extended further to model multiple bank loans and multiple private equity investments at different rate of returns. The use of public opportunity loss coefficient γ enables the weighing of the social and external benefits of public funds, but the selection of γ requires a careful consideration.

CONCLUSION

Equity structure is of essence to PPP project financing. In an effort to successfully deliver PPP projects, transportation agencies must carefully design the equity structure to simultaneously attract private capital and protect public interests. This paper presents a model to help the agencies maximize the benefits from PPP financing. The model includes the benefits and costs from debt and equity financing and allows users to incorporate opportunity loss into the evaluation.

The case study discussed in this paper shows that optimal equity structure depends significantly upon three factors: expected toll revenue, debt service coverage ratio, and public opportunity loss coefficient. The research suggests that an optimal equity structure space could be defined under uncertainty. However, careful attention should be given to the selection of these important parameters in PPP financing design.

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