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Government guarantees and risk sharing in public–private partnerships

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ABSTRACT

We study the interaction between a private firm and a government when they time an investment decision while in a public–private partnership. We use a real options framework and consider the degree of sharing in the cost of the investment and the risk in the operation of the project. The degree of sharing influences the investment timing and the project value. When the guarantee of the government is large and/or the cost sharing rate for the private firm is low, then the private firm-maximizing policy exercises the investment option earlier than the project value-maximizing policy.

1. Introduction

Since the first systematic program of the private finance initiative (PFI) was introduced in the United Kingdom in 1992, governments, worldwide, have sought to encourage the participation of private capital in public infrastructure projects. Their main motivation is the increased efficiency derived from market principles and entrepreneurship. The government is also motivated by the need to channel private capital into the public sector, in which it suffers from severe financial burdens. In Levy (1996), we find historical accounts of the global move toward public–private partnerships (PPP) as well as examples of projects.

Project financing principles have been applied to public infrastructure through PPPs or, in the UK, PFI transactions. In project financing, the project is “a distinct legal entity” and the financing is tailored to the cash flow characteristics of the project asset. Generally, a special purpose entity is created for a project thereby shielding other assets owned by a project sponsor from project failures. A project financing structure involves a number of equity investors and, often, a syndicate of banks, which provide loans for the investment and its operation. The loans are most commonly non-recourse loans that are paid entirely from project cash flow rather than from the general assets or the creditworthiness of the project investors. Finnerty (1996), in a comprehensive study, explores the contractual designs for sharing risks and returns among the investors.

In the infrastructure project under PPP, capital investment is made by the private sector on the strength of a contract with the government to provide agreed upon services. However, because of the sheer scale of the investment, long payback periods and maturity, and the various unforeseen risks involved, a project is often not feasible from the perspective of private risk capital. Therefore, the government provides some supports to mitigate risk. Since the return on the large scale of irreversible capital depends solely upon uncertain future cash flows, risk identification and allocation among partners are a key component of PPP. Government support in PPP contracts can take on many forms, from providing a capital subsidy in the form of a one-time grant, to jointly sharing some portion of the capital investment. In some other cases, the government might support the project by providing revenue subsidies that include tax breaks or provide guaranteed annual revenues for a fixed period of time.

Rose (1998) demonstrates, in the Trans-urban City Link project in Melbourne, Australia, that the contractual agreement, in which the private partner was allowed to defer concession fees, provided a substantial incentive to the equity investors to participate. The cost to the government of these guarantees was not in the form of immediate cash outlays but rather in the form of contingent liabilities. By offering guarantees for infrastructure projects, the government becomes responsible for all future liabilities that these supports might cause. Thus, a sound framework for a contract requires that the government assumes a level of guarantee that is high enough for the project to be economically feasible, but low enough not to burden the government and society.

Brandao and Saraiva (2007) present a real options framework allowing the government to analyze the cost–benefit and exposure of government supports and apply it to the BR-163 Toll Road infrastructure that links the Brazilian Midwest to the Amazon River. Ng and Bjornsson (2004) also argue in favor of the use of a real options framework to analyze a toll road concession project.

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This study applies a real options framework such as Dixit and Pindyck (1994) and Trigeorgis (1996), and capital structure models such as Leland (1994) to the project that is analyzed in this paper. Recently, there is a growing body of literature that analyzes the relation between investment and financing decisions of the firms in a real options framework, such as Lyandres and Zhdanov (2006), Mauer and Ott (2000), Mauer and Sarkar (2005), and Sundaresan and Wang (2007). In this paper we use the framework in these studies to model the risk sharing between a private firm and a government.

In this paper, we investigate how contractual arrangements effect the positions of the main partners in a project: the private investors and the government. We aim at formulating a model to facilitate the design of a contract that is attractive to private investors with an equitable cost for government guarantees.

The remainder of this paper is organized as follows. Section 2 presents our model for the project finance investment that takes into account cost and risk sharing between the private firm and the government. In Section 3, we derive two investment policies. Section 4 provides the numerical analysis of the investment threshold and the project value. Finally, Section 5 concludes the paper.

2. The model

2.1. The basic scheme

The basic scheme of the contract in our model is as follows. In a framework similar to the toll road project considered in Rose (1998) and Brandao and Saraiva (2007), the main risk factor is the revenue flow X upon the completion of the construction. The capital expenditure of I is shared by the private firm and the government in the ratio of α to $1-\alpha$. Out of the net operating revenue of $X-c$, the firm pays concession fees at rate k to the government, where c is the operating cost. Concession fees are prevalent in many PFI projects, as seen in Rose (1998). These fees constitute a fair return for the government investment of $(1-\alpha)I$, which is a kind of tax. Our model assumes that if the net operating revenue is less than k, then the government receives the $\min(X-c, k)$ amount, which implies that the government provides revenue subsidies if $X-c$ is negative. This arrangement gives private capital sufficient compensation for shouldering a greater share of the irreversible capital expenditure of αI. It is typical of many infrastructure projects that the cash flows are poor in the initial years of operation. The revenue subsidies, as discussed in Brandao and Saraiva (2007), also are important in making the investment attractive enough for the risk capital to participate in the joint venture. The revenue sharing scheme in our model entitles the private firm to a contingent claim, $\max(X-c-k, 0)$, which provides a limitless premium when the revenue is great. Another risk abatement support we examine is the guarantee that the firm can transfer its ownership to the government when the prospect of revenues diminishes below a certain level, and the firm receives a compensation of K in exchange for the transfer of the entitlements. This scheme is in contrast to the ownership transfer term in Rose (1998) in which the government has the right to terminate the concession period if the project turns profitable. Our premise reflects a recent trend in which the concern is primarily to make the partnership attractive to risk capital.

Although the government is not motivated solely by the monetary benefits accruing from the project, we assume that the government participates in the partnership only when the contingent liabilities ingrained in the contract, net of the return to its share of the initial investment, is within a certain limit.

2.2. The model setup

In this section, we construct a model for analyzing the investment project that is consigned to a private firm by the government.

Suppose the instantaneous profit from the infrastructure service, Xt, is given by a geometric Brownian motion:

$$dX_t = \mu X_t dt + \sigma X_t dW_t, \tag{1}$$

where μ and σ are the expected growth rate and the volatility of Xt, respectively, and Wt is a standard Brownian motion defined on a probability space $(\Omega, F, \mathbb{P})$.

The private firm, which operates the project, selects the time of the transfer, T_g, that maximizes the expected discount present value in the operation. The optimization problem of the private firm is given by:

$$F(x) = \max_{T_g} \mathbb{E}_t^x \left[\int_t^{T_g} e^{-\rho(s-t)} \max(X_s - c - k, 0) ds + e^{-\rho(T_g - t)} K \right], \tag{2}$$

where ρ is the discount rate, and x_g is the optimal transfer threshold. The optimal transfer time, T_g^*, is given by:

$$T_g^* = \inf\{T_g > 0 | X_{Tg} \le x_g\}. \tag{3}$$

Similarly, the value of the government can be formulated by:

$$G(x) = \mathbb{E}_t^x \left[\int_t^{T_g^*} e^{-\rho(s-t)} \min(X_s - c, k) ds - e^{-\rho(T_g^* - t)} K + \int_{T_g^*}^{\infty} e^{-\rho(s-t)} (X_s - c) ds \right]. \tag{4}$$

Following the standard arguments of (Dixit and Pindyck, 1994) the ordinary differential equations, which are satisfied by the values in Eqs. (2) and (4), are derived from the Bellman equation:

$$\frac{1}{2}\sigma^2 x^2 F'' + \mu x F' - \rho F + \max(x - c - k, 0) = 0, \tag{5}$$

and

$$\frac{1}{2}\sigma^2 x^2 G'' + \mu x G' - \rho G + \min(x - c, k) = 0. \tag{6}$$

The general solutions of Eqs. (5) and (6) are given by:

$$F(x) = \begin{cases} a_1 x^{\beta_2} + \dfrac{x}{\rho - \mu} - \dfrac{c + k}{\rho}, & x \ge c + k \\ a_2 x^{\beta_1} + a_3 x^{\beta_2,} & x < c + k, \end{cases} \tag{7}$$

and

$$G(x) = \begin{cases} b_1 x^{\beta_2} + \dfrac{k}{\rho}, & x \ge c + k \\ b_2 x^{\beta_1} + b_3 x^{\beta_2} + \dfrac{x}{\rho - \mu} - \dfrac{c}{\rho}, & x < c + k, \end{cases} \tag{8}$$

where $\beta_1 = \frac{1}{2} - \frac{\mu}{\sigma^2} + \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2\rho}{\sigma^2}} > 1$ and $\beta_2 = \frac{1}{2} - \frac{\mu}{\sigma^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu}{\sigma^2}\right)^2 + \frac{2\rho}{\sigma^2}} < 0$. $a_1, a_2, a_3, b_1, b_2, b_3$, and x_g are constants to be determined by using the conditions that each function in two regions must be continually differentiable across $c+k$ and the following conditions

$$F(x_g) = K, \tag{9}$$

$$F'(x_g) = 0, \tag{10}$$

and

$$G(x_g) = \frac{x_g}{\rho - \mu} - \frac{c}{\rho} - K. \tag{11}$$

Eq. (9) is the value matching condition that requires the value of the private firm at the transfer threshold to equal K. Eq. (10) is the smooth-pasting condition that ensures the optimality of the transfer