The influence of risk on the equity share of build-operate-transfer projects

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1. Introduction

In a Build-Operate-Transfer (BOT) delivery system, a Special Purpose Vehicle (SPV) designs, funds, builds, and operates a public infrastructure for a specified concession period at the end of which the facility is transferred back to the public authority (Malini, 1999). Under a BOT contract, the required capital expenditure is typically financed with equity and debt sources of private funding, and sometimes also with an injection of a share of initial public funds. The capital structure is designed in order to satisfy both the investor's expected return on investment and the lender's cover ratios. To repay the investment and operational services, the SPV is typically allowed to collect the users' fees or a shadow toll during the concession period. It is claimed that such a BOT scheme facilitates the development of capital projects by governments with funds from outside the public budget allocation, while transferring most of the risks to the private sector (Kang *et al.*, 2011).

One of the success factors of a BOT project is the design of an optimized capital structure that assures an adequate level of return on investment for the shareholders and sufficient debt capacity to reimburse the debt incurred (Zhang, 2005). A related key point is that risk factors play a crucial role in the definition of the capital structure because they affect both the Weighted Average Cost of Capital (WACC) and the targets imposed on lenders' covenants, such as the target Debt Service Coverage Ratios (DSCR).

Several studies have actually investigated the association between risk factors and the capital structure, but little research has so far studied the possible effects of the most important sources of risk on the determination of the Equity Share (ES) of capital injected into a BOT initiative as an integrating and additional understanding of the standard practices used in capital structuring.

With the aim of bridging this research gap, this paper presents an empirical analysis on the capital structure of an international sample of BOT projects so that several relevant risk factors that might have significant relationships with the ES are identified and analyzed. The sample includes 52 projects, financed by World Bank and mainly delivered in developing countries, to build and operate a variety of power and transportation infrastructures as well as social facilities. The effect of risk on the capital structure of BOT projects has been noted to be quite an important issue especially in developing countries, due to limited competition, inadequate skills in implementing and managing BOT long-term contracts, political instability, complex negotiation processes, and, in turn, expensive and limited capital markets (Kwak *et al.*, 2009; Chen and Doloi, 2008; Chen, 2009; Yang *et al.*, 2010).

The results of the present study offer project stakeholders a better understanding of the risk factors that might facilitate higher debt leverages and help refine the capital structures of BOT projects.

The paper is organized as follows. Section 2 provides an overview of current pertinent literature on capital structure of BOT projects, then in the research methodology the main risks related to the capital structure are identified, and the proposed risk model is given in order to establish the relationship with the equity investment. The project dataset and a Multiple Linear Regression (MLR) analysis are presented in Section 4, together with the empirical results. Section 5 provides the interpretation of the research results while Section 6 discusses the implications of the study in order to envisage potential applications for the establishment of an enhanced capital structure. Finally, the research conclusions are drawn up, recommendations are made, and future research directions are outlined.

2. Pertinent Literature

A BOT delivery system is a type of Public-Private Partnership (PPP) in which a legal entity, often known as SPV or project company, is allowed, by a public granting authority to design, finance, build and operate a public infrastructure for a predetermined concession period, at the end of which ownership, operations and maintenance (O&M) duties are transferred back to the public institution (Malini, 1999; Kumaraswamy and Morris, 2002). These contracts rely on the idea of partnership in which two or more stakeholders operate for their mutual benefits and improvements (Villalba-Romero and Liyanage, 2016). Revenues are obtained either from the end users or from a single offtake purchaser, such as a utility company or a government, that purchases the project output (World Bank, 2015), while the initial investment is privately financed with both equity and debt sources of funding.

BOT delivery systems have been recognized as an effective mechanism to mobilize private finance in public investments and to obtain value for money from the efficiencies of the private sector in managing public services and new technology (Bao *et al.*, 2015). The BOT contract is widely used to develop a discrete asset and is generally entirely new or green field in nature (World Bank, 2015). Many projects in a broad range of sectors have been successfully developed using BOT, with significantly increased output value. These include roads, bridge, ports, airports, railways, power, water supply, waste systems, telecommunication, schools, prisons and hospitals (Gupta et al., 2013).This delivery system facilitates the development of capital-intensive infrastructure projects with funds coming from outside the public budget allocation field (Kang *et al.*, 2011). Thus, the attractiveness of BOT initiatives stems from the opportunity of limiting government public spending by shifting investment costs to the private sector (Auriol and Picard, 2013).

Moreover, the BOT scheme underlines the benefits that can be obtained by transferring most of the project risks from the public to the private sector. Since a project consists of dealing with several risks, borne either by one or both parties (De Marco and Mangano, 2013), BOT and other similar types of PPP schemes require a proper and careful risk analysis and risk allocation between the public authority and the SPV (Zou *et al.*, 2014). This analysis is usually deemed more complex than in traditional construction contracts (Pellegrino et al., 2013). In other words, risk is an important component in determining the most appropriate levels of equity and debt sources necessary to finance project investment. In fact, the amount of debt the project can raise is a function of the expected capacity of its cash flows to service debt obligations and its creditworthiness, which depends on such aspects as the inherent value of its assets, its expected profitability, the amount of risk borne by the SPV, and the risk profile of the projected cash flows (Finnerty, 2013).

Also, risk factors affect the cost of capital and, in turn via the debt leverage, the WACC, which is a key determinant of investment decision by the project company's shareholders. However, since lenders raise the equity amount in an attempt to protect against risk exposure, targets imposed by the lending institutions on DSCRs are increased due to risk factors and, consequently, the debt capacity is reduced. This usually conflicts with the need of investors to minimize the equity level (Yun et al., 2009; Chang and Chen, 2001). Therefore, the determination of an appropriate debt-to-equity ratio is difficult because the capital structure of a BOT project varies according to the risk borne by the equity sponsors and the debt lenders. On the one hand, in order to obtain an attractive Rate of Return to Equity (RRE) through a minimized equity investment and the associated risk, equity holders usually seek to maximize the debt leverage as much as the project cash flow can justify. On the other hand, the lending institutions tend to size the debt level on the basis of the estimated risk profile of the project: the greater the risk, the lower the debt amount.

As a consequence, it is crucial for both lenders and SPV shareholders to define an appropriate capital structure that is able to optimize the capital structure. Therefore, a successful PF initiative is based on an evaluation of all risks that a project faces during its life cycle (Nikolìc et al., 2011).

To this end, some previous studies attempted to investigate the relationship between risks and capital structure (Xenidis and Angelides, 2005; Zhang, 2005; Jin, 2010), but little research has been conducted to study the effects of risk on the level of equity of BOT initiatives. As a consequence, the relationship between the risk and the equity contribution in BOT projects is still unexplored and questions have arisen among practitioners and scholars regarding how to balance the proper level of equity.

3. Methodology and Model

3.1. Methodology design

The research was conducted through the following steps. First, after conducting a literature analysis, the main risk factors that were deemed to influence the equity participation in BOT initiatives were identified. To this end, each risk source was listed together with a proxy indicator, which was measured by a parameter. Second, data were collected from public web sources and an exploratory data analysis was carried out. Finally, after assuming that the ES was the response variable and the risk parameters were the independent factors, a MLR analysis was conducted using the MiniTab® software package in order to capture the relationship between the risk profile of the project and its capital structure.

As suggested by the literature review on research in BOT projects, many studies with different methodologies contributed to the field. However, as revealed by comparative studies (Kwak *et al*., 2009; Tang *et al*., 2010), no study has attempted to apply the MLR approach to determine the crucial influence of various risks on the ES of BOT projects. The appropriateness of the MLR lies in its ability to test the existing impact of independent variables (the BOT risk factors) on the dependent variable (the ES). To understand such influence, the MLR proves to be a superior and reliable method (De Marco *et al*., 2012a). Moreover, the MLR quantifies the strength of relationship between a dependent variable and independent variables (Tukey 1977). In this respect, the MLR methodology is more appropriate and reliable compared to other methodologies (*e.g.*, case method, factor analysis, or questionnaire survey) described in Tang *et al*. (2010).

3.2. The BOT risk model

Table 1 reports a classification of the risk sources with the associated indicators and parameters that are likely to affect the ES in BOT projects. The identification of risks is usually considered as the first step in managing BOT projects properly. All the risks were grouped into areas of origin, namely: Country, Financial, Revenue, Project and SPV-related risks. Each category of risk is identified with reference to literature studies. The country and the financial risks are related to the political risk; the revenue risks refers to the market areas; the project risks are inherent to the construction and the operations of the initiative, and finally SPV risks are associated with concessionaire risks.

Insert Table 1

3.2.1. Country risk

The country risks come from the context of political events and government policies that could influence the profitability of a project, affect approval processes and execution delays (Song *et al.*, 2013), and create barriers to the development of the project (Janssen et al., 2016). These kinds of risk are associated with governmental corruption (Maslyukivska and Sohail, 2007) and poor governmental decision-making processes (Li *et al.*, 2005). Country risk was here described by means of two indicators, namely Country Attractiveness and Political Environments. Country Attractiveness refers to the capability of a country to attract private capital for investments and is measured via Government Effectiveness (GE) and Regulatory Quality (RQ) indices (*i.e.*, parameters in the proposed

BOT risk model). GE indicates the perception of the quality of public services and the quality of policy implantation, while RQ refers to the ability of a government to formulate regulations that promote private sector development (World Bank, 2013). GE and RQ both range from -2.5 to 2.5, with 2.5 indicating high quality.

The political environment was measured by means of the Political Stability (PS) index, which has the aim of capturing the perceptions of the likelihood of political instability and political violence (World Bank, 2013). PS ranges from -2.5, which indicates scarce/poor quality, to +2.5, which indicates high quality. This indicator is very important since it can be associated with the public authority's role to create the necessary conditions for the establishment of a collaborative environment (Badi and Pryke 2015)

The parameters associated with the country risk were expected to have a negative impact on the ES, in the sense that low risk environments invite/encourage the lending institution to maximize the debt leverage, and the equity contribution can thus decrease.

3.2.2. Financial Risk

Financial risks appear to be crucial since they may have a heavy impact on a project's cash flows and in turn affect its profitability (Xenidis and Angelides, 2005). One of the main elements associated with financial risk is the inflation rate (Estache at al., 2007), since it can negatively influence the purchasing power and the return on investment. The higher the inflation, the more the/a project costs. Consequently, equity participation tends to decrease. Inflation is measured through the inflation rate (INFL), paying regard to historical monthly values, as reported by Rateinflation (2013).

Another key factor related to financial risk is the cost of equity capital, which is associated with the amount of debt and the internal rate of return (Schaufelberger and Widapasut, 2003) and, in turn, with the feasibility of a project (Ling and Lim, 2007). This indicator can be estimated by using the Capital Asset Pricing Model, considering that the return on equity is related to the firms' equity Beta. For this reason, the parameter selected as a proxy of the cost of equity is the Beta of Partners (BETA_PART) (Bloomberg, 2014). A low BETA_PART parameter stands for low risks and low expected returns. On the contrary, high betas indicate high risks and high associated returns. This could make lending institutions unwilling to provide bulk debt services in such situations, so that higher equity shares are required.

3.2.3. Revenue Risk

Revenue risk is associated with the commercial success of a BOT project and the potential changes on the revenue streams that may have an impact on the project cash flow (Sing and Kalidindi, 2006). The cash flows are typically used by private investors to evaluate projects (Olson et al., 2010). An example of revenue risk is the traffic risk in pay-toll road projects. Revenue risk largely depends on the economic environment, wherein a project is developed as an indicator of the ability of the end users, or offtake purchasers, to pay for the BOT project services. This indicator is measured via the GDP Growth Rate (GDP) in order to represent either positive or negative commercial spending environments. A high level of GDP Growth Rate stands for a less risky environment so that, in turn, the level of requested ES of the investment can be reduced.

3.2.4. Project Risk

Project risk can refer to development risks that may cause schedule delays and cost overruns, such as design and construction risks. Development risks generally increase with the size of the project investment, due to the number of involved stakeholders, execution tasks, coordination actions, and communications. Investment Size (INV) is the parameter that was used here to measure the project size.

In addition, project risks are related to complexity, in terms of construction site conditions, sophisticated design, the use of new construction technologies, etc. Therefore, it may be assumed that a long construction duration is a crucial aspect in a complex project

(Hoffmann *et al.*, 2007). For this reason, the Construction Duration (CDUR) parameter, expressed in years, was used here to represent project complexity.

Project risk is also related to the project's capability to generate a sufficient cash flow in order to repay the debt and ensure acceptable levels of profit. In the proposed model, the capability of creating this cash flow stream was measured by the Concession Period (CPER), defined as the length of the contract, expressed in years during which an SPV operates the project on behalf of the public party. This parameter is mainly related to the recovery of the investment. A long duration of concessions can bring much uncertainty to the BOT project (Sarmento and Rennegoo, 2016), but a longer concession period is more beneficial for the private investor, who can benefit from more profits (Carbonara *et al.*, 2014). The size of investment requested for a project is likely to call for greater apportionment of equity, in terms of total amount, but smaller in percent share because of the higher financial exposure. On the contrary, a long construction duration makes a project riskier, and lending institution are less willing to fund the debt portion of project finance. Thus, the SPV partners have to collect higher ES into the project investment (Logan, 2003). Finally, longer concession periods offer the opportunity of collecting money over a longer period of time. This entails a lower risk and, in turn, a lower level of ES is required.

3.2.5. SPV Risk

Finally, SPV related risks were described by the Solidity indicator, which refers to the financial strength of the consortium of partners of the SPV. It may be viewed as a measure of the durability of the concessionaire as an independent entity to raise fund, repay debt and make profit. Even though the SPV is supposed to be independent, its financial solidity is strongly related to the financial reliability of the partners (Parikh and Samson, 1999). Therefore, we may assume a significant relation between the financial Solidity of the SPV and the financial strategy for developing a project (Dixon et al., 2005). The

Solidity of the SPV is measured by the Average Size of Partners (PART_SIZE) parameter, which is defined as the average weighted value of the market capitalization of the main shareholders (De Marco et al, 2012a). Since it is easier to raise funds for a project for a more solid SPV, the associated level of risk decreases, and high debt leverages are acceptable because they are more likely to be reimbursed. This reflects on smaller shares of the equity contribution.

4. Project dataset and results

4.1. Dataset

Table 2, which refers to the proposed risk model, summarizes information on the dataset by presenting the independent risk parameters that are deemed significant in the determination of the ES of BOT initiatives. The columns report the minimum, mean, and maximum values, the low, average and upper quartiles, and the standard deviations, respectively.

Insert Table 2

The sample is composed of 52 BOT projects that have been selected from different areas around the world, and are especially related to energy initiatives. The initiatives show an approximate $490 MLN average investment and their ES ranges from 17% to 51% of the total capital expenditure while the financial close goes from 1995 up to 2013

4.2. Regression analysis and results

The goal of the regression analysis is to test whether the independent variables taken into account are significant factors and whether they have a positive or negative impact on the response variable (Newbold *et al.*, 2013; Tabanick and Fidell, 2001). A positive influence indicates that an increase (or decrease) in the independent variable determines an increase (or decrease) in the dependent variable, while a negative effect produces an opposite result between independent and response variable variations.

To achieve this goal, first, the presence of multicollinearity among the independent variables was investigated via the calculation of the Variance Inflation Factor (VIF). The VIF evaluates the relationship between an independent variable and all the other independent ones within the model, and it is calculated as $1/(1-R^2)$, where R^2 is the coefficient of determination of one predictor on all the others; it represents the proportion of variance in the independent variables under study that is associated with the other independent variables in the model. Variables with a VIF greater than 5 are subject to exclusion from the model (Tabanick and Fidell, 2001), as this would lead to erratic estimation of the regression coefficient (O'Brien, 2007). Table 3 shows that there was no multicollinearity in the risk model.

Insert Table 3

Secondly, after checking for multicollinearity, the study carried out the standardization of the values of risk parameters (Carrol Rovezzi and Carroll, 2002). This was needed due to the fact that the variables in the dataset had different orders of magnitude and measurement, so it was difficult to compare them with regard to the level of significance they had on the value of the ES. In order to generalize the results obtained from the test on the dataset of the 52 projects, it was deemed worthwhile to provide the following considerations. Given the size of the dataset, the paper carried out the observations of each parameter normally distributed with its respective mean and variance values. Moreover, the values of the population mean and variance of each risk parameter were unknown. To this end, the mean and standard error of each risk parameter were calculated and each observation was then standardized using the Student's *t*-test with Eq.(1). Finally, the proposed risk model was given in the form of a MLR, as in Eq.(2).

$$t-value=\frac{\bar{x}-\mu}{S/\sqrt{n}} \qquad (1)$$

$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k \qquad (2)$$

where $\bar{x}$ is the sample mean of the value of a risk parameter;

μ is the population mean of the value of a risk parameter;

$S/\sqrt{n}$ is the standard error – ratio of the sample standard deviation to the square root of the sample size of 52 projects;

Y is the level of the equity

α is the estimate of the constant coefficient;

β is the estimate of the parameter coefficient;

x is the value of a risk parameter;

k is the number of risk parameters, which here is 10.

The standardization results are set out in Table 4, in which the columns show the estimate of the parameter coefficient, the standard error, the value of the *t*-statistic and the *p*-value along with the associated level of significance.

Insert Table 4

Thus, the regression model is given in Eq.(3):

Equity share = 0.367 – 0.0072Government Effectiveness – 0.061Regulatory Quality + 0.191Political Stability – 0.139Inflation Rate – 0.096Average Beta of Partners + 0.260GDP Growth Rate – 0.383 Investment Size + 0.394Construction Duration + 0.150 Concession Period + 0.327Average Size of Partners (3)

As far as the statistical background of the results given in Table 4 is concerned, it is worthwhile mentioning the following. The *p*-value, which ranges from 0 to 1, is obtained from the observed sample and represents the probability of rejecting the null hypothesis given below. The *p*-value of each risk parameter tests the null hypothesis that the estimate of the regression coefficient is equal to zero. This implies that, in the proposed risk model, the null hypothesis (H_0) represents "no influence" of a risk parameter on the ES, while the alternative hypothesis (H_1) implies that there is such an influence at a given significance level.

H_0: There is no significant influence (positive or negative) of a risk parameter on the level of equity.

H_1: There is significant influence (positive or negative) of a risk parameter on the level of equity.

As discussed in Section 2.2, the risk parameters can either positively or negatively impact on the ES, and this impact is represented by the estimate of the regression coefficient with its appropriate sign. The significance level, which is equal to the probability of either 0.05 or 0.01, represents a constant critical value at either 5% or 1%, respectively. If the *p*-value is smaller than the given critical value, the null hypothesis is rejected and it can be concluded that there is a significant relationship between a risk parameter and the ES at a given significant level. On the contrary, if the *p*-value is more than the predetermined critical value, the test fails to reject the null hypothesis, the result of which is that there is not enough evidence to prove the existence of a significant relationship between the independent and dependent variables. In other words, under the null hypothesis, the test implies that the estimate of the regression coefficient is equal to zero, so the *t*-value is therefore brought to zero and the *p*-value to 1 (Newbold *et al.*, 2013). This means that the risk parameters under consideration have no influence on the ES with a probability of 100% (the *p*-value of 1). The explanatory power of the model is measured by the multiple *R*-squared and the adjusted *R*-squared coefficients, which show the portion of the total variation in the dependent variable that is explained by variation in the independent variables (Newbold *et al.*, 2013; Tabanick and Fidell, 2001). A multiple *R*-squared value of 50.50% implies the portion of the variation in the level of equity due to the variation in all of the risk parameters taken together.

However, from a practical point of view, it was worth considering the adjusted *R*-squared value as it is/was an unbiased estimate of the portion of the total variation in the ES, which takes/took into account the sample size of 52 projects and all the variables in the constructed risk model. An appropriate *R*-squared value depends on the application field, and the values derived from the present research are acceptable for the management field and in a decisional context (Newbold *et al.*, 2013; Tabanick and Fidell, 2001).

As far as practical considerations of the results are concerned, after comparing the *p*-values of different risk parameters against the two given levels of significance in the regression test, the following was found: GE and INV had a negative impact on the level of equity, which means that more attractive business environments and huge initiatives require less equity participation. On the contrary, high rates of GDP, longer CDUR, and larger SPVs call for higher levels of ES. In terms of level of magnitude, CDUR, INV, and SIZE_PART impact more heavily on the ES, since the absolute values of their coefficients are the greatest ones. On the contrary, the influence of GE is lighter, with an absolute value of its coefficient equal to 0.072.

Finally, Fig. (2) presents the test results on the data residuals used to validate the consistency of the proposed model. The Normal probability plot shows that the residuals are normally distributed, and they follow a straight line without the existence of non-normality, skewness, or outliers in the project dataset. The Residuals versus fits indicate that there is no evidence of a systematic error in the residuals of the regression model and that they are randomly scattered around zero. The Histogram of the residuals resembles a normal curve, thus demonstrating normality of the dataset. Moreover, while the Residuals versus orders do not present any systematic trends caused by periodicity, the residuals correlate with one another or with the time series.

Insert Fig.1

5. Interpretation of the results

The results show that five out of the ten examined risk factors have a significant statistical relevance on describing equity participation in the capital structure of BOT projects, and the relevant drivers confirm the pre-assumed relationships. Thus, risks in different aspects are important factors to be considered by project stakeholders (Ng *et al.*, 2012) when assessing a BOT project and designing its capital structure.

In particular, the negative impact of GE demonstrates that low-risk countries are able to create an environment that facilitates the collection of higher debts in the capital structure of BOT projects, while, accordingly, private sponsors are called upon to contribute with less equity funding. Furthermore, a well-structured regulation framework at the country level can increase the willingness of private investors to participate in public infrastructure development efforts.

At the same time, the positive relationship with GDP growth shows that a low level of risk, associated with a higher capability of a project to generate revenue, is more likely to attract more equity funding. In fact, the rate of return is generally higher for equity capital than for debt, and this higher cash flow needs to be covered from sufficient streams of revenue. Coherently, the revenue risk has been identified as one of the most critical risk factors to have an impact on the success of a BOT initiative (Singh and Kalidindi, 2006), although sponsors rely not only on the balance sheet, but also on the revenue stream to finance a project.

The negative influence of the size of the investment underlines that a large project imposes a greater financial effort on project sponsors, who provide more equity to the total amount, but less in percent share. This aspect is related to the fact that as the size of a project increases, the inherent risk also increases due to high start-up costs, long-term investment time spans, slow rates of return and high degrees of asset specificity (Wibowo and Alfen, 2013). Moreover, construction projects often involve many contracting parties and one-of-a-kind development efforts (Halawa *et al.*, 2013). The positive influence of the construction duration means that long construction periods are related to high risks of delay and cost overrun. Therefore, lending institutions are hesitant to contribute with more debt leverage to the capital structure of a project. This higher level of risk is associated with an increased level of uncertainty and complexity related to larger projects with long construction durations (Rafindadi *et al.*, 2014).

Similarly, the positive impact of the average size of partners on the ES confirms the idea that a greater financial solidity allows more equity to be injected into the initial investment of a project. This specific aspect is becoming more and more important, because lending institutions are asking private investors for strong balance sheets before undertaking an investment, and this is creating entry barriers for small contractors, with a negative effect on the level of competition (Demirag *et al.*, 2011).

6. Implications

The proposed model addresses both theoretical and practical implications.

From a theoretical point of view, the results obtained from the regression analysis conducted lead to a better understanding of the risk factors that influence the capital structure of BOT projects, so they have been proposed as a foundation to establish improved methods in order to design refined capital structures in BOT projects.

As far the practical implications are concerned, the study carried out could help get a better understanding of the main factors that influence the ES of BOT investments, which thing in turn provides opportunities for private promoters to enhance the profitability associated with equity capital, and for lending agencies that fund international projects to better deal with risks related to the debts they grant.

In a BOT initiative, the lending institutions usually ask for a greater ES as proof of commitment of the project promoters, in order also to reduce the risk associated with the debt service burden on the project cash flow (Walker, and Smith 1995). On the contrary, project promoters have the aim of maximizing debt leverage in order to relieve the associated private risk and assure an acceptable and attractive rate of return. This model may be viewed as a support for private investors to achieve a more efficient level of equity in their BOT investments, and it could assist both shareholders and lenders to attain a more balanced risk allocation and a more efficient capital structure of BOT projects.

Moreover, this study may help international project sponsors and investors get a better understanding of the project conditions and regional environments that could facilitate high debt leverages and low equity contributions, with improved effects on the project selection and project portfolio management processes. Accordingly, future research will have to address translating the model put forward into a practical project assessment framework in order to assist sponsors and lending institutions in the process of determining a more accurate project risk rate, with a resultant improved design of the capital structure.

7. Summary

This study has been conducted to understand the way risks are related to the capital structure of a BOT project and to help design an efficient debt-to-equity ratio. In particular, hypothesizing that equity participation is affected by project risks, a model and its associated empirical analysis have been proposed with the aim of understanding the risk factors that could have an impact on the ES of a BOT initiative. Country, Financial, Revenue, Project and SPV-related risks have been defined, together with their indicators and associated parameters. The results show that four out of the five identified sources of risk have a significant influence on the equity portion of financing injected into a BOT project, namely: Country risk, connected to the efficiency of public services, Revenue risk, measured by the growth of the GDP rate of the region in which the project is developed, Project risk, in terms of the amount of total investment and the duration of the construction period, and the SPV-related risk, linked to the financial solidity of the partners involved in the project company.

The regression analysis has highlighted that government effectiveness, the rate of GDP growth, the size of investment, the construction duration, and the average financial size of the SPV partners have a significant impact on the percent share of equity that private sponsors inject as their initial financing /funds into a project. The proposed methodology leads to a better understanding of the main factors that affect the amount of equity injected into a BOT initiative.

8. References

Auriol, E. Picard, P. M. (2013), “A theory of BOT concession contracts”, *Journal of Behaviour & Organization*, Vol. 89, pp. 187-209.

Bao, H., Peng, Y., Ablanedo-Rosas. J.H. and Gao, H. (2015), “An alternative incomplete information bargaining model for identifying the reasonable concession period of a BOT project”, *International Journal of Project Management*, in press.

Bloomberg, (2014). “Library Documentation Room”, http://www.library.hbs.edu/go/datastream.html (accessed 16 November).

Carbonara, N., Costantino, N. and Pellegrino, R. (2014), “Concession period for PPPs: A win-win model for a fair risk sharing”, *International Journal of Project Management*, Vol. 32 No.7, pp 1223-1232.

Carroll Rovezzi, S., and Carroll, D. J. (2002), *Statistics Made Simple for School Leaders*. Rowman & Littlefield, Lanham, ML.

Chang, L., Chen, P. (2001), "BOT Financial Model: Taiwan High Speed Rail Case", Journal of Constrction Engineering and Management, Vol 127 No. 3, pp. 214- 222.

Chen, C., Doloi, H. (2008), “BOT application in China: driving and impeding factors”, *International Journal of Project Management*, Vol. 26 No.4, pp. 388-398.

Chen, C. (2009), “Can the pilot BOT Project provide a template for future projects? A case study of the Chengdu No. 6 Water Plant B Project”, *International Journal of Project Management,* Vol. 27 No. 6, pp. 573-583.

De Marco, A., Mangano, G. and Zou, X.Y. (2012a), “Factors influencing the equity share of build-operate-transfer projects”, *Built Environment Project and Asset Management*, Vol. 2 No.1, pp. 70-85.

De Marco, A., Mangano, G., Cagliano, A.C. and Grimaldi, S. (2012b), “Public Financing into Build-Operate-Transfer Hospital Projects in Italy” *Journal of Construction Engineering and Management.* Vol. 138 No. 11, pp. 1294-1302.

De Marco, A. and Mangano, G. (2013). “Risk and Value in Privately Financed Health care Projects”, *Journal of Construction Engineering and Management*, Vol. 139 No.8, pp. 918-926.

Demirag, I., Khadaroo, I., Stapleton, P. and Stevenson C. (2011), “Risks and the financing of PPP: Perspectives from the financiers”, *British Accademy Review,* Vol. 43 No. 4, pp. 294-310.

Dixon, T. Pottinger, G. and Jordam, A. (2005), “Lessons from the private finance initiative in the UK: Benefits, problems and critical success factors”, *Journal of Property Investment & Finance*, Vol.23 No. 5, pp. 412-423.

Estache, A., Juan, E. and Trujillo, L. (2007), “Public-Private Partnerships in Transport Policy”, *Research Woring Paper 4436*. The World Bank, Washinton DC.

Finnerty, J.D. (2013), Project Financing: Asset-Based Financial Engineering. third ed. Wiley Financial Series, the USA.

Gupta, A., Gupta, M.C. and Agrawal, R. (2013). “Identification and ranking of critical success factors for BOT projects in India”, Management Research Review, Vol. 36 No. 11, pp. 1040-1060

Halawa, W.S., Abdelalim, A.M.K. and Elrashed, I.A. (2013), “Financial evaluation for construction projects at the pre-investment phase in developing countries: A case study*” International Journal of Project Management,* Vol. 31, 912-923.

Hoffman, G. J., Thal, J.A. E., Webb, T. S. and Weir, J. D. (2007), “Estimating performance time for construction projects” *Journal of Management Engineering,* Vol. 23 No. 4, pp. 193-199.

Janssen, R., De Graaf, R., Smit, M. and Voordijk, H. (2016), "Why local governments rarely use PPPs in their road development projects: Understanding the barriers", *International Journal of Managing Projects in Business*, Vol. 9 No. 1, pp. 33 – 52.

Jin, X. H., (2010), “Determinants of efficient risk allocation in privately financed public infrastructure projects in Australia” *Journal of Construction Engineering and Management,* Vol. 136 No. 2, pp. 138-150.

Kang, C.C., Feng, C.M., Kuo, C.Y. (2011), “A royalty negotiation model for BOT (build-operate-transfer) projects: The operational revenue-based model” *Mathematical and Computational Models,* Vol. 54 No. 9/10, pp. 2338-2347.

Kwak, Y.H., Chin, Y.Y. and Ibbs, C.W. (2009), “Towards a comprehensive understanding of Public-private partnerships for infrastructure development”, *California Management. Review*, Vol 51 No. 2, pp. 51-78.

Kumaraswamy, M. M., and Morris, D. A. (2002), “Build-operate-transfer type procurement in Asian Mega projects”, *Journal of Construction. Engineering and. Management,* Vol. 1282, 93–102.

Li, B., Akintoye, A., Edwards, P.J. and Hardcastle, C. (2005), “The allocation of risk in PPP/PFI construction projects in UK” *International Journal of Project Management.,* Vol. 23 No. 1, pp. 25-35.

Ling, F. and Lim, H. L. (2007), "Foreign firms' financial and economic risk in China", *Engineering Construction and Architectural Management*, Vol. 14 No. 4, pp. 346-362.

Logan, T. M. (2003), "Optimal debt capacity for BOT projects in emerging economies*"*, *Journal of Structured Finance.,* Vol. 9 No. 3, pp. 71-79.

Malini, E. (1999). "Build Operate Transfer Municipal Bridge Projects in India". *Journal of Management Engineering*, Vol. 15 No. 4, pp. 51-58.

Maslyukivska, O. and Sohail., M. (2007), "European infrastructure procurement through PPP". *Proceeding of ICE Management Procurement and Law*. Vol. 160 No. 4, pp. 159-167.

Newbold, P., Carlson, W., and Thorne, B. (2013), *Statistics for Business and Economics*, 8th edition. London, Prentice-Hall.

Ng, S.T., Wong, Y.M.W. and Wong, J.M.W. (2012), "Factors influencing the success of PPP at feasibility stage – A tripartite comparison study in Hong Kong", *Habitat International*, Vol. 36, pp. 423-4323.

Nikolìc, D.M., Jednak, S., Benkovic, S., and Poznanic, V. (2011). "Project Finance risk evaluation of the electric power industry of Serbia", *Energy Policy*, Vol. 39 No. 10, pp. 6168-6177.

O'Brien, R.M. (2007), "A caution regarding rules of thumb for Variance Inflation Factors." *Quality and Quantity,* Vol. 41 No. 5, pp. 673-690.

Olsson, N. O. E., Frydenberg, S., Jakobsen, E. W. and Jessen, S. A. (2010), "In search of project substance: how do private investors evaluate projects?", *International Journal of Managing Projects in Business*, Vol. 3 No. 2, pp. 257 – 274.

Parikh, N. C. and Samson, R. (1999), “BOT road infrastructure projects: The process, problems and suggestions”, *Vikalpa: The Journal for Decision Makers*, Vol. 24 No.1, pp. 3-12.

Pellegrino, R. Vajdic, N. and Carbonara, N. (2013). “Real option theory for risk mitigation in transport PPPs”, *Built Environment Project and Asset Management*, Vol.3 No.2, pp. 199-213.

Rafindadi, A.D., Mikic, Kovacic, I. and Cekic, Z. (2014), “Global perception of sustainable construction projects.” *Procedia- Social and Behavioral Sciences* Vol. 119, pp. 456-465.

Rate Inflation. (2013). http://rateinflation.com/inflation-rate/uk-historical-inflation490rate.php=?form=ukir (Accessed 3 December 2015).

Sarmento, J.M. and Renneboog, L. (2016), “Anatomy of public-private partnerships: their creation, financing and renegotiations”, *International Journal of Managing Projects in Business*, Vol. 9 No. 1, pp. 94 – 122.

Schaufelberger, J. E. and Wipadapisut, I. (2003), ”Alternate financing strategies for build-operate-transfer projects”, *Journal of Construction Engineering and Management*, Vol. 29 No. 2, pp. 205-213.

Sing, L.B. and Kalidindi, S.N. (2006), “Traffic revenue risk management through Annuity model of PPP road projects in India” *International Journal of Project Management*, Vol. 24 No. 7, pp. 605-613.

Song, J., Song, D., Zhang, X. and Sun, Y. (2013), “Risk identification for PPP waste-to energy incineration projects in China”, *Energy Policy*, Vol. 61, pp. 953-962.

Tabanick, B.G., Fidell, L.S. (2001), *Using Multivariate Statistics. 3rd Ed*. HarperCollins, New York, NY.

Tang, L.Y., Shen, Q., and Cheng, E.W.L. (2010), “A review of studies on Public–Private Partnership projects in the construction industry”, *International Journal of Project Management*, Vol. 28 No. 7, pp. 683-694.

Tukey, J.W. (1977), *Exploratory data analysis*. Addinson-Wesley, Reading, MA.Yun, S., Han, S.H:, Kim, H., Ock, J.H. (2009), “ Capita structure optimization for build-operate-transfer (BOT) projects using a stochastic and multi-objective approach”, *Canadian Journal of Civil Engineering*, Vol. 36, pp. 770-790.Villalba-Romero, F. and Liyanage, C. (2016), "Implications of the use of different payment models: The context of PPP Road Projects in the UK", *International Journal of Managing Projects in Business*, Vol. 9 No. 1, pp. 11 – 32.

Walker, C. and Smith, A.J. (1995), *Privatized Infrastructure.* Thomas Telford, London

Wibowo, A. and Alfen, H.W. (2013), ” Fine-tuning the value and cost of capital of risky PPP infrastructure project”, *Engineering Construction and Architectural Management*, Vol. 20 No. 4, pp. 406-419.

World Bank, (2013). “Worldwide governance Indicators”. http://info.worldbank.org/governance/wgi/index.aspx#faq (accessed 13 November 2015).

World Bank, 2015. “Concessions, Build-Operate-Transfer (BOT) and Design-Build-Operate (DBO) Projects.” http://ppp.worldbank.org/public-private-partnership/agreements/concessions-bots-dbos#BOT_Projects (accessed 10 October 2015).

Xenidis, Y. and Angelides, D. (2005), “The financial risks in build-operate-transfer projects*”*, *Construction and Management Economics,* Vol. 23 No.4, pp. 431-441.

Yang, J.B., Yang, C.C. and Kao, C.K. (2010), "Evaluating schedule delay causes for private participating public construction works under the Build-Operate-Transfer model", *International Journal of Project Management,* Vol. 28 No. 6, pp. 569-579.

Zhang, X. (2005), "Financial viability analysis and capital structure optimization in privatized public infrastructure projects", *Journal of Construction Engineering and Management,* Vol. 131 No. 6, pp. 656-668.

Zou, W., Kumaraswamy, M., Ching, J. and Wong, J. (2014), "Identifying the critical success factors for relationship management in PPP projects", *International Journal of Project Management*, Vol. 32, 264-274. Appendix: List of the Projects

Appendix: List of the Projects

Project Name	**Country**	**Year of Financial Close**	**Equity Share**	**Goverment Effectiveness**	**Regulatory Quality**	**Political Stability**	**Constr. Duration**	**Conc. Period**	**Inv. Size**	**Beta of Partners**	**Avg. Size of Partners**	**Inflation Rate**	**GDP Growth**
Sual Pangasinan Coal-Fired Power Plant	Philippines	1995	0.23	-0.18	0.26	-0.48	3	25	1350	0.8244	12,500	0.067	0.047
PT Energi Sengkang	Indonesia	1996	0.20	-0.42	0.19	-1.18	4	20	225	1.83	665	0.08	0.076
Zhangzhou Houshi Power Plant	China	1999	0.20	-0.27	-0.33	-0.27	3	23	3200	1	5,450	-0.014	0.078
Ilijan Power Plant (Kepco Ilijan Corporation)	Philippines	2000	0.28	-0.14	0.16	-1.41	3.25	20	710	1.18	26,680	0.04	0.044
Bangalore International Airport Limited	India	2005	0.25	-0.08	-0.24	-0.99	2.7	30	324	1.7	338	0.042	0.093
Nam Chien 2 Hydropower Plant	Vietnam	2007	0.43	-0.22	-0.53	0.21	4	20	33.5	0.8	9,980	0.083	0.071
Yazd Solar/CCNG Plant	Iran	2007	0.43	-1.59	-1.59	-0.99	2.5	35	158	0.75	2,600	0.172	0.078
Magtaa Desalination Plant	Algeria	2009	0.30	-0.58	-1.07	-1.22	2.5	25	468	1.1	6,000	0.057	0.016
Suoi Lum 1 Hydropower Plant	Vietnam	2010	0.27	-0.25	0.17	0.24	1.7	20	22.7	1.3	980	0.071	0.054
Thuong Kon Tum Hydropower Plant	Vietnam	2010	0.30	-0.26	-0.62	0.11	2.7	30	267	0.32	1,200	0.089	0.064
Cirebon Coal-fired Power Plant	Indonesia	2010	0.32	-0.2	-0.39	-0.85	4	30	877	1.69	343	0.051	0.062
Bao Loc Hydropower Plant	Vietnam	2010	0.30	-0.26	-0.62	0.11	3	30	31.3	0.32	2,366	0.089	0.064
Vinh Son 3 Hydropower Plant	Vietnam	2010	0.30	-0.26	-0.62	0.11	3	30	41.6	1.12	2,500	0.089	0.064
Chu Linh and Coc San Hydropower Plants	Vietnam	2010	0.25	-0.86	-0.74	-1.6	3	35	38.6	1.32	7,350	0.093	0.048
Sanima Mai Hydropower Project (MHP)	Nepal	2010	0.30	-0.01	-0.33	-1.29	2.5	29	163	1	4,750	0.089	0.066
Bhubaneswar Expressways Private Limited	India	2011	0.23	0.31	0.29	-0.68	2.5	25	420	1.105	19,040	0.034	0.04
Norte II Combined Cycle Power Plant	Mexico	2011	0.30	0.36	0.38	-0.95	6	34	260	0.6953	4,000	0.065	0.088
Enerjisa Kavsakbendi HPP	Turkey	2011	0.32	0.36	0.38	-0.95	4	30	1350	0.96	9,700	0.065	0.088
Enerjisa Tufanbeyli Coal Plant	Turkey	2011	0.30	-0.64	-0.42	0.47	3	25	230	1.32	4,000	0.064	0.068

Project Name	Country	Year of Financial Close	Equity Share	Goverment Effectiveness	Regulatory Quality	Political Stability	Constr. Duration	Conc. Period	Inv. Size	Beta of Partners	Avg. Size of Partners	Inflation Rate	GDP Growth
TATA Itezhi-Tezhi HPP	Zambia	2011	0.23	-0.01	-0.33	-1.29	3	35	3640	1.63	25,035	0.089	0.066
L&T Hyderabad Metro Rail Private Limited	India	2011	0.27	-0.01	-0.33	-1.29	3	30	371	1.35	6,700	0.089	0.066
Navayuga Jahnavi Toll Bridge Private Limited	India	2011	0.29	0.55	0.65	-0.66	4	40	157	0.95	15,000	0.085	0.07
Darenhes Tatar HPP	Turkey	2011	0.31	0.36	0.38	-0.95	4.3	45	300	0.8	6,400	0.065	0.088
Blue Water Iron Ore Terminal Private Limited	India	2011	0.28	-0.01	-0.33	-1.29	3	30	119	1.81	2,868	0.089	0.066
SEW Bichom HPP	India	2011	0.30	-0.01	-0.33	-1.29	4	35	194	0.4988	107	0.089	0.066
Concepcion-Cabrero highway	Chile	2011	0.28	1.26	1.48	0.46	4	35	375	1.71	2,900	0.033	0.058
Greenko Dikchu HPP	India	2011	0.30	-0.01	-0.33	-1.29	4.5	35	159	0.5364	264	0.089	0.066
Song Bac HPP	Vietnam	2011	0.22	-0.23	-0.59	0.17	2	20	64	1.7	3,750	0.187	0.062
Nareva El Oued/Haouma/Akfhenir Wind Farm	Morocco	2011	0.25	-0.13	-0.11	-0.39	2	20	343	1.3	7,800	0.009	0.05
Santo Domingo de los Olleros TPP (Phase I)	Peru	2011	0.35	-0.15	0.48	-0.74	1.5	40	128	0.83	1,700	0.034	0.065
KOMIPO Wampu SHPP	Indonesia	2012	0.25	-0.29	0.17	-0.57	3	30	174	0.6	4,130	0.043	0.063
Green Ventures Likhu IV HPP	Nepal	2012	0.34	-0.99	0.17	-1.38	4.5	40	263	1.3	650	0.095	0.049
SAEMS Nyamwamba SHPP	Uganda	2012	0.33	-0.57	0.17	-0.89	2	20	36	0.6953	4,000	0.14	0.067
Bhopal Dhule Transmission Company Limited	India	2012	0.25	-0.18	0.17	-1.25	3	35	320	2.32	4,400	0.093	0.047
Jabalpur Transmission Company Limited	India	2012	0.25	-0.18	0.17	-1.25	3	35	219	2.32	4,400	0.093	0.047
ACP Tollways Private Limited	India	2012	0.18	-0.18	0.17	-1.25	1.2	20	352	1.87	135	0.093	0.047
Bali Nusa Dua Benoa Toll Road	Indonesia	2012	0.30	-0.29	0.17	-0.57	1.2	50	264	0.7977	3,686	0.043	0.063
Maharashtra Eastern Grid Power Transmission Com LTD	India	2012	0.30	-0.18	0.17	-1.25	3	35	882	1.58	9,300	0.093	0.047
Ruta 5 Norte/La Serena-Vallenar	Chile	2012	0.23	1.25	0.18	0.35	1.5	35	439	1.71	2,900	0.03	0.054

Project Name	Country	Year of Financial Close	Equity Share	Goverment Effectiveness	Regulatory Quality	Political Stability	Constr. Duration	Conc. Period	Inv. Size	Beta of Partners	Avg. Size of Partners	Inflation Rate	GDP Growth
Hangzhou Metro Line One	China	2012	0.51	-0.54	0.17	-0.54	5	25	720	0.59	23,938	0.027	0.077
Bosphorus (Eurasia) Tunnel	Turkey	2012	0.22	0.4	0.16	-1.19	5.5	30	1238	0.8	3,195	0.089	0.021
Santo Antonio do Jari Hydro Power Plant	Brazil	2012	0.26	0.007	0.17	0.07	3	57	512	0.81	4,304	0.054	0.01
Western UP Power Transmission Company Limited	India	2012	0.25	-0.18	0.17	-1.25	3.5	35	941	0.6242	5,300	0.093	0.047
K-Water Star Patrind HPP	Pakistan	2012	0.25	-0.79	0.17	-2.5	3.5	30	436	1	5,000	0.097	0.04
Sao Goncalo do Amarante Airport	Brazil	2012	0.18	-0.12	0.17	0.07	3	28	205	1.92	1,500	0.054	0.01
Alto Jahuel Transmisora de Energia	Chile	2013	0.17	1.25	0.18	0.35	2.5	35	249	0.2037	919	0.018	0.041
Dirang Energy Private Limited - Gongri HEP	India	2013	0.34	-0.18	0.17	-1.25	4	40	230	1.87	134	0.109	0.05
Cilacap Power Plant Phase II	Indonesia	2013	0.22	-0.29	0.17	-0.57	2.5	30	900	1.8	11,500	0.064	0.058
Empresa de Generacion Electrica de Junin	Peru	2013	0.30	-0.16	0.17	-0.86	2.5	20	89	0.5	347	0.028	0.058
Neusberg Hydro Electric Plant	South Africa	2013	0.24	0.33	0.17	0	1.75	20	56	0.91	5,200	0.057	0.019
Palmillas-Apaseo El Grande toll road	Mexico	2013	0.32	0.32	0.17	-0.67	5	30	741	1.74	990	0.038	0.011
Kalpataru Satpura Transco Private Limited	India	2013	0.21	-0.18	0.17	-1.25	3	35	58.2	1	180	0.109	0.05