

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

Original

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(Article begins on next page)

1 The Influence of Risk on the Equity Share of Build-Operate-Transfer Projects

3 1. Introduction

4 In a Build-Operate-Transfer (BOT) delivery system, a Special Purpose Vehicle (SPV)
5 designs, funds, builds, and operates a public infrastructure for a specified concession
6 period at the end of which the facility is transferred back to the public authority (Malini,
7 1999). Under a BOT contract, the required capital expenditure is typically financed with
8 equity and debt sources of private funding, and sometimes also with an injection of a
9 share of initial public funds. The capital structure is designed in order to satisfy both the
10 investor's expected return on investment and the lender's cover ratios. To repay the
11 investment and operational services, the SPV is typically allowed to collect the users'
12 fees or a shadow toll during the concession period. It is claimed that such a BOT scheme
13 facilitates the development of capital projects by governments with funds from outside
14 the public budget allocation, while transferring most of the risks to the private sector
15 (Kang *et al.*, 2011).

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

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

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

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

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

51 **2. Pertinent Literature**

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

63 BOT delivery systems have been recognized as an effective mechanism to mobilize
64 private finance in public investments and to obtain value for money from the efficiencies
65 of the private sector in managing public services and new technology (Bao *et al.*, 2015).
66 The BOT contract is widely used to develop a discrete asset and is generally entirely new
67 or green field in nature (World Bank, 2015). Many projects in a broad range of sectors
68 have been successfully developed using BOT, with significantly increased output value.
69 These include roads, bridge, ports, airports, railways, power, water supply, waste systems,
70 telecommunication, schools, prisons and hospitals (Gupta *et al.*, 2013). This delivery
71 system facilitates the development of capital-intensive infrastructure projects with funds
72 coming from outside the public budget allocation field (Kang *et al.*, 2011). Thus, the
73 attractiveness of BOT initiatives stems from the opportunity of limiting government
74 public spending by shifting investment costs to the private sector (Auriol and Picard,
75 2013).

76 Moreover, the BOT scheme underlines the benefits that can be obtained by transferring
77 most of the project risks from the public to the private sector. Since a project consists of
78 dealing with several risks, borne either by one or both parties (De Marco and Mangano,
79 2013), BOT and other similar types of PPP schemes require a proper and careful risk
80 analysis and risk allocation between the public authority and the SPV (Zou *et al.*, 2014).
81 This analysis is usually deemed more complex than in traditional construction contracts
82 (Pellegrino *et al.*, 2013). In other words, risk is an important component in determining
83 the most appropriate levels of equity and debt sources necessary to finance project
84 investment. In fact, the amount of debt the project can raise is a function of the expected
85 capacity of its cash flows to service debt obligations and its creditworthiness, which
86 depends on such aspects as the inherent value of its assets, its expected profitability, the
87 amount of risk borne by the SPV, and the risk profile of the projected cash flows
88 (Finnerty, 2013).

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

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

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

112 **3. Methodology and Model**

113 *3.1. Methodology design*

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

123 As suggested by the literature review on research in BOT projects, many studies with
124 different methodologies contributed to the field. However, as revealed by comparative
125 studies (Kwak *et al.*, 2009; Tang *et al.*, 2010), no study has attempted to apply the MLR
126 approach to determine the crucial influence of various risks on the ES of BOT projects.

127 The appropriateness of the MLR lies in its ability to test the existing impact of

128 independent variables (the BOT risk factors) on the dependent variable (the ES). To
129 understand such influence, the MLR proves to be a superior and reliable method (De
130 Marco *et al.*, 2012a). Moreover, the MLR quantifies the strength of relationship between
131 a dependent variable and independent variables (Tukey 1977). In this respect, the MLR
132 methodology is more appropriate and reliable compared to other methodologies (*e.g.*,
133 case method, factor analysis, or questionnaire survey) described in Tang *et al.* (2010).

134 3.2. The BOT risk model

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

143 **Insert Table 1**

144 3.2.1. Country risk

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

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

158 The political environment was measured by means of the Political Stability (PS) index,
159 which has the aim of capturing the perceptions of the likelihood of political instability
160 and political violence (World Bank, 2013). PS ranges from -2.5, which indicates
161 scarce/poor quality, to +2.5, which indicates high quality. This indicator is very important
162 since it can be associated with the public authority's role to create the necessary
163 conditions for the establishment of a collaborative environment (Badi and Pryke 2015)
164 The parameters associated with the country risk were expected to have a negative impact
165 on the ES, in the sense that low risk environments invite/encourage the lending institution
166 to maximize the debt leverage, and the equity contribution can thus decrease.

167 3.2.2. *Financial Risk*

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

175 Another key factor related to financial risk is the cost of equity capital, which is associated
176 with the amount of debt and the internal rate of return (Schaufelberger and Widapasut,
177 2003) and, in turn, with the feasibility of a project (Ling and Lim, 2007). This indicator
178 can be estimated by using the Capital Asset Pricing Model, considering that the return on
179 equity is related to the firms' equity Beta. For this reason, the parameter selected as a

180 proxy of the cost of equity is the Beta of Partners (BETA_PART) (Bloomberg, 2014). A
181 low BETA_PART parameter stands for low risks and low expected returns. On the
182 contrary, high betas indicate high risks and high associated returns. This could make
183 lending institutions unwilling to provide bulk debt services in such situations, so that
184 higher equity shares are required.

185 *3.2.3. Revenue Risk*

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

196 *3.2.4. Project Risk*

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

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

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

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

223 3.2.5. *SPV Risk*

224 Finally, SPV related risks were described by the Solidity indicator, which refers to the
225 financial strength of the consortium of partners of the SPV. It may be viewed as a measure
226 of the durability of the concessionaire as an independent entity to raise fund, repay debt
227 and make profit. Even though the SPV is supposed to be independent, its financial
228 solidity is strongly related to the financial reliability of the partners (Parikh and Samson,
229 1999). Therefore, we may assume a significant relation between the financial Solidity of
230 the SPV and the financial strategy for developing a project (Dixon *et al.*, 2005). The

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

237 **4. Project dataset and results**

238 *4.1. Dataset*

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

244 **Insert Table 2**

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

249 *4.2. Regression analysis and results*

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

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

266 **Insert Table 3**

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

279

280
$$t - value = \frac{\bar{x} - \mu}{S / \sqrt{n}} \quad (1)$$

281

282
$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k \quad (2)$$

283

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

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

286 S / \sqrt{n} is the standard error – ratio of the sample standard deviation to the square root of

287 the sample size of 52 projects;

288 Y is the level of the equity

289 α is the estimate of the constant coefficient;

290 β is the estimate of the parameter coefficient;

291 x is the value of a risk parameter;

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

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

296 **Insert Table 4**

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

298

299 Equity share = 0.367 – 0.0072Government Effectiveness – 0.061Regulatory Quality +
300 0.191Political Stability – 0.139Inflation Rate – 0.096Average Beta of Partners +
301 0.260GDP Growth Rate – 0.383 Investment Size + 0.394Construction Duration + 0.150
302 Concession Period + 0.327Average Size of Partners (3)

303

304 As far as the statistical background of the results given in Table 4 is concerned, it is
305 worthwhile mentioning the following. The p -value, which ranges from 0 to 1, is obtained
306 from the observed sample and represents the probability of rejecting the null hypothesis

307 given below. The p -value of each risk parameter tests the null hypothesis that the estimate
308 of the regression coefficient is equal to zero. This implies that, in the proposed risk model,
309 the null hypothesis (H_0) represents “no influence” of a risk parameter on the ES, while
310 the alternative hypothesis (H_1) implies that there is such an influence at a given
311 significance level.

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

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

316 As discussed in Section 2.2, the risk parameters can either positively or negatively impact
317 on the ES, and this impact is represented by the estimate of the regression coefficient with
318 its appropriate sign. The significance level, which is equal to the probability of either 0.05
319 or 0.01, represents a constant critical value at either 5% or 1%, respectively. If the p -value
320 is smaller than the given critical value, the null hypothesis is rejected and it can be
321 concluded that there is a significant relationship between a risk parameter and the ES at
322 a given significant level. On the contrary, if the p -value is more than the predetermined
323 critical value, the test fails to reject the null hypothesis, the result of which is that there is
324 not enough evidence to prove the existence of a significant relationship between the
325 independent and dependent variables. In other words, under the null hypothesis, the test
326 implies that the estimate of the regression coefficient is equal to zero, so the t -value is
327 therefore brought to zero and the p -value to 1 (Newbold *et al.*, 2013). This means that the
328 risk parameters under consideration have no influence on the ES with a probability of
329 100% (the p -value of 1). The explanatory power of the model is measured by the multiple
330 R -squared and the adjusted R -squared coefficients, which show the portion of the total
331 variation in the dependent variable that is explained by variation in the independent
332 variables (Newbold *et al.*, 2013; Tabanick and Fidell, 2001). A multiple R -squared value

333 of 50.50% implies the portion of the variation in the level of equity due to the variation
334 in all of the risk parameters taken together.

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

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

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

359 **Insert Fig.1**

360 **5. Interpretation of the results**

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

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

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

380 The negative influence of the size of the investment underlines that a large project
381 imposes a greater financial effort on project sponsors, who provide more equity to the
382 total amount, but less in percent share. This aspect is related to the fact that as the size of
383 a project increases, the inherent risk also increases due to high start-up costs, long-term
384 investment time spans, slow rates of return and high degrees of asset specificity (Wibowo

385 and Alfen, 2013). Moreover, construction projects often involve many contracting parties
386 and one-of-a-kind development efforts (Halawa *et al.*, 2013). The positive influence of
387 the construction duration means that long construction periods are related to high risks of
388 delay and cost overrun. Therefore, lending institutions are hesitant to contribute with
389 more debt leverage to the capital structure of a project. This higher level of risk is
390 associated with an increased level of uncertainty and complexity related to larger projects
391 with long construction durations (Rafindadi *et al.*, 2014).

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

398 **6. Implications**

399 The proposed model addresses both theoretical and practical implications.

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

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

409 In a BOT initiative, the lending institutions usually ask for a greater ES as proof of
410 commitment of the project promoters, in order also to reduce the risk associated with the

411 debt service burden on the project cash flow (Walker, and Smith 1995). On the contrary,
412 project promoters have the aim of maximizing debt leverage in order to relieve the
413 associated private risk and assure an acceptable and attractive rate of return. This model
414 may be viewed as a support for private investors to achieve a more efficient level of equity
415 in their BOT investments, and it could assist both shareholders and lenders to attain a
416 more balanced risk allocation and a more efficient capital structure of BOT projects.
417 Moreover, this study may help international project sponsors and investors get a better
418 understanding of the project conditions and regional environments that could facilitate
419 high debt leverages and low equity contributions, with improved effects on the project
420 selection and project portfolio management processes. Accordingly, future research will
421 have to address translating the model put forward into a practical project assessment
422 framework in order to assist sponsors and lending institutions in the process of
423 determining a more accurate project risk rate, with a resultant improved design of the
424 capital structure.

425 **7. Summary**

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

437 construction period, and the SPV-related risk, linked to the financial solidity of the
438 partners involved in the project company.

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

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Appendix: List of the Projects													
Project Name	Country	Year of Financial Close	Equity Share	Government 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	Government 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 Jahnvi 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

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
Project Name	Country	Year of Financial Close	Equity Share	Government Effectiveness	Regulatory Quality	Political Stability	Constr. Duration	Conc. Period	Inv. Size	Beta of Partners	Avg. Size of Partners	Inflation Rate	GDP Growth
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