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Original
Risk factors influencing the debt leverage of project financing initiatives in the energy industry / DE MARCO, Alberto; Mangano, Giulio. - In: INTERNATIONAL JOURNAL OF ENERGY SECTOR MANAGEMENT. - ISSN 1750-6220. - ELETTRONICO. - 11:3(2017), pp. -444. [10.1108/IJESM-02-2017-0006]

Availability:
This version is available at: 11583/2684231 since: 2017-10-03T14:00:00Z

Publisher:
Emerald

Published
DOI:10.1108/IJESM-02-2017-0006

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(Article begins on next page)

27 April 2024

Emerald International Journal of Energy Sector Management

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Journal:	*International Journal of Energy Sector Management*
Manuscript ID	Draft
Manuscript Type:	Research Papers
Subject Area:	Energy sector, Project management, Public Private Partnership, Project financing
Methods/ Tools / Analytical Frameworks:	Regression, Risk Analysis

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International Journal of Energy Sector Management

Risk factors influencing the debt leverage of Project Financing initiatives in the energy industry

Purpose –This paper contributes to understanding the crucial influence of risks on the capital structure of Project Financing (PF) initiatives in the energy sector.

Design/methodology/approach – The debt leverage of a capital investment is selected as the response variable and its relation with select identified risk factors is examined using a regression analysis on a dataset of 72 projects carried out all over the world in the energy industry.

Findings – Results have highlighted that the debt leverage is significantly influenced by several sources of risk. Country, Project, and Special Purpose Vehicle related risks have been shown to have an impact on the debt leverage of a PF scheme.

Research limitations/ Implications – The results could support both investors and lenders to better define the financial leverage of projects delivered under a PF mechanism. In particular, the study could help to have a better understanding of the main factors that influence the debt leverage in PF initiatives.

Originality/value – This paper contributes to filling the lack of works addressing the relationship between risk factors and capital structure in PF projects. In this way, this research leads to a better understanding of the risk factors that influence the capital structure of a PF initiative and they have therefore been proposed as a basis for the establishment of improved methods to design refined capital structures.

Keywords – Public Private Partnership, Build Operate Transfer, Regression Analysis, Risk Analysis

Introduction:

Project Financing (PF) is referred to as a mechanism to privately fund design, building and operations of a public facility for a predetermined concession period (Iossa et al., 2007). At the end of the concession period, the ownership is transferred back to the public authority (Malini, 1999). In return for its services, a project company can collect revenues directly from the final users or charge a shadow tool paid by the government on the behalf of the users. This financing system facilitates the development of capital projects with funds from outside the public budget allocation, while transferring risks to the private sector (Kang et al., 2011).

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PF is largely used to develop public infrastructures, utilities and social facilities in various sectors. In particular, for capital projects in the energy sector, PF can be considered as a suitable solution as power projects often require financial and operational capabilities by experienced private operators. With this regard, PF initiatives are seen by many public organizations as a suitable way to leverage limited public funding with private finance and procure expanded power capacity required by an increasing demand especially in some areas of the world (Algarni et al., 2007; Painuly, 2009).

However, capital projects in the energy sector are exposed to a high level of risk that impacts on project performance, profitability and financing (Thillairajan and Behera, 2016). In particular, risk seems to play a key role in determining the financial leverage of a PF scheme as a result of assessing the capacity of the predicted project cash flows to repay its debt obligations (De Marco and Mangano, 2013). In other words, the definition of an optimal capital structure for a PF initiative becomes a difficult issue as the lenders would tend to minimize debt according to risk profile, while equity investors would seek for greater debt in order to reduce their capital injection and obtain a greater return on equity and minimize their risk. Some studies have investigated the association between risk and some factors of a PF initiative, such as the concession duration or risk allocation between the private and the public sector (Jin, 2010; Zhang, 2005). However, little research has been carried out to demonstrate the relationship that may exist between risk and capital structure and, in particular, to study the effects of the most important sources of risk on determining the debt leverage of a PF initiative for energy sector projects.

In order to bridge this research gap, an empirical analysis on the capital structure of a sample of 72 international PF energy projects is carried out in order to identify the relevant risk factors that might have significant relationship with the debt to equity ratio. This is expected to contribute to a better definition of the capital structure with expected benefits for both lenders and equity investors.

To this end, the paper is structured as follows. First, an overview of the current literature is presented. Second, the main risks related to the capital structure are identified in the research methodology section and the risk model is proposed in order to assume the relationship with the

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debt to equity ratio. After that, the dataset and the linear regression analysis are shown. Then, discussions and implications of results are addressed to envisage potential applications for enhancing the capital structure. Finally, conclusions are drawn together with future research directions.

Literature Review

Risk in PF

PF projects are often complex in nature with burdening risk and highly leveraged capital structures. Lenders, who provide the greatest portion of financing in the form of nonrecourse or limited-recourse debt, are typically concerned about the risks inherent with financing, developing and operating PF initiatives (Boeing Singh and Kalindi, 2009). Therefore, PF schemes require a proper and careful risk analysis and risk allocation between the public party and the Special Purpose Vehicle (SPV) or project company (De Marco and Mangano 2013). This analysis is often more complex than in traditional construction contracts (Pellegrino et al., 2013). Furthermore, the stakeholders involved in a PF scheme may have diverging interests and objectives (Demirag et al. 2011). Also, risk is an important element in the definition of the most appropriate level of equity and debt sources of financing required as highlighted by Ng et al. (2010). In fact, the amount of debt the project can raise is a function of the expected capacity of its cash flows to serve any debt obligations and its creditworthiness, which depends on aspects such 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).

The bankability of a project is often evaluated via the Debt Service Coverage Ratio (DSCR). This ratio assesses the capacity of project's cash flow to repay the debt service during the lifecycle of the project. It is defined as the ratio between the cash available before the debt repayment and the total amount of debt to be repaid in the same period (Borgonovo and Gatti, 2013). The minimum DSCR needs to be greater than one as to meet the debt capacity. However, most lending institutions

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usually require higher values based on projected cash flows and expected risk of the project (De Marco, et al., 2012b).

In this context, available literature offers studies aimed at analyzing the risks inherent with PF initiatives and providing linkages between risk and capital structure. The mix of funding sources for a PF project varies according to the nature and scale of the project (Wei and Gosling, 2013) and the task of designing the capital structure requires both private sponsors and lenders to decide how much should be provided in the form of equity financing and how much should be borrowed from the lenders, also based on the level of available public financing, if applicable. As typical risk-averse institutions, lenders are concerned with project risks and care about measures to mitigate risks that could influence the debt servicing capability (Boeing Singh and Kalidindi, 2009). Debt has advantages, such as tax shield, and disadvantages, such as the distress caused by debt obligations. Due to the attractiveness of borrowed fund, equity investors tend to include debt fund into PF projects as much as possible. It is typical for infrastructure PF projects to have from 15 to 20 years of loan repayment, depending on the nature of the project and its future cash flow (Choi et al., 2010). For long, PF projects were funded with up to 80% or even 90% of debt on total funding required, but the impact of recent financial crisis and credit crunch has increased the equity level (Demirag et al., 2011) up to 75% (Carbonara and Pellegrino, 2014). However, a typical debt to equity ratio is usually in the order of 70/30 (Cuttaree et al., 2011).

PF in energy projects

In periods of bad economy, the shortage of public finance and limits imposed on public budgets, have been forcing many countries to cut traditional investments in energy projects (De Marco et al., 2016). as a consequence, there is an increasing interest in the application of PF schemes in the energy sector. For example, just in Europe, approximately one trillion euros are expected to be spent in energy and power capital investments (Rehme et al., 2015). In developed countries the need for power plants is driven by revamping or replacing existing power stations capacity, while in emerging countries electricity consumption is tremendously growing. Another important driving

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factor is the transition to low-carbon form of generation (Blyth et al., 2015). Thus, new renewable energy plants are required (Shen-fa, and Xiao-ping 2009).

However, only few PF initiatives in the energy sector reach their financial close (Kann, 2009) even if PF allows governments to secure an infrastructure without immediately raising taxes or public debt (Khmel and Zhao, 2016). Therefore, the success of PF is based, on the one hand, on an increasing demand for infrastructures (De Marco et al., 2012a) and, on the other hand, on public financial and budgetary constraints. Furthermore, a successful PF initiative is based on the consideration of all risks that a project faces during its life cycle (De Marco et al., 2017). In fact, unexpected changes related to project costs, debt servicing, dividend payments, construction delays, cash flow generated by the project can bring to heavy deficits (Nikolìc et al., 2011).

Research Methodology

The research is conducted through the following steps. First, based on the literature analysis the main risk factors that are likely to impact on the debt leverage in PF energy projects are identified. To this end, each risk source is listed in association with a proxy parameter, which is in turn measured by a numerical indicator. Second, data are gathered via public web sources and an exploratory data analysis is carried out. Finally, after assuming that the debt leverage is the response variable and the risk parameters are the independent factors, a linear regression analysis is completed using in order to capture the relationship between the project risk profile and the debt to equity ratio, which represents the capital structure of a PF investment.

Risk Model

Table 1 reports a classification of risk sources with associated parameters and indicators that are supposed to influence the debt leverage. All the risks are grouped into areas of origin namely: country, financial, revenue, project and SPV-related risks.

Table 1. Risks Identification

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Country Risk

The country sources of risk are related to the context of political events and government policies that could jeopardize the profitability of a project due to delayed authorizations and approvals (Song et al., 2013). These kinds of risks are typically associated with the governments' corruption (Maslyukivska and Sohail, 2007) and poor government decision making processes (Li et al., 2005). High corrupted countries and low levels of political stability can make investors less willing to finance their projects. This category also covers risks arising from unanticipated regulatory changes, such as changes in taxation or foreign investment laws (Hainz and Kleimeier, 2012).

The country risk is here described by means of two parameters, namely: the Country Attractiveness and the Political Environment. The Country Attractiveness refers to as the capability of a country to attract private capital and it is measured via the Government Effectiveness (GE) and the Regulatory Quality indexes. GE indicates the perception of the quality of public services and the quality of policy implantation, while the RQ refers to the ability of a government to formulate regulations that promote the private sector development (World Bank, 2015). GE and RQ both range from -2.5 to 2.5 with 2.5 indicating high quality.

The political environment is measured by the Country Stability Index (CSI) that is aimed at capturing the perceptions of the likelihood of political instability and political violence (World Bank, 2015). CSI ranges from -2.5 indicating scarce quality, up to +2.5 indicating high quality. The parameters associated with the country risk are expected to positively impact the equity share in the sense that low risk environments are able to attract more private capital to develop PF initiatives.

Financial Risk

Financial risks appear to be crucial since they may heavily impact on the project cash flows and, in turn, affect its profitability (Xenidis and Angelides, 2005). One of the main elements associated with the financial risk is the inflation rate (Estache at al., 2007) as it can negatively influence the purchasing power and the return on investment. The higher the inflation, the higher the project costs

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and consequently the debt leverage tends to increase since the required fund are greater. The inflation is measured through the inflation rate (INFL), with historical values as reported by Rate Inflation (2016).

Revenue Risk

Revenue risk is associated with the commercial success of a project and the potential changes on the revenue streams that may have an impact on the project cash flow (Boeng Sing and Kalidindi, 2006). The cash flow is typically used by private investors to evaluate projects (Olson et al., 2005). An example of revenue risk is possible fluctuation of electricity tariffs paid by the final users in power projects. Revenue risk largely depends on the economic environment, wherein a project is developed for measuring the ability of the end users, or offtake purchasers, to pay for the energy that is produced by the plant. This parameter 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 in the sense that positive GDP rates are associated with increased demands of enerergy. The higher are the expected revenues the more willing are the lending institutions to inject debt in a project. Thus, the debt leverage can be increased and more exploited.

Project Risk

Project risk can refer to development risks that may cause schedule delays and cost overruns, such as design and construction risks (Thuyet et al., 2007). . 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 (INV) is the indicator selected to measure the project size. The higher the investment, the higher the leverage because there is usually the opportunity of use more source of debt (Khmel and Zhao, 2016).

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 can be assumed that a long construction duration is a crucial aspect in a complex project (Hoffmann et al., 2007).

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For this reason, the Construction Duration (CDUR) indicator, expressed months is taken into account to represent the project complexity. Shorter construction periods allow to obtain cash flows earlier (Gupta et al., 2013) with positive effect on the riskiness of the project. Under these conditions a lending institution is more will to invest in a project. Therefore, there is a negative expected relationship with the debt leverage.

Project risk is also related to the project's ability to generate a sufficient cash flow for repayment of debt obligations and for ensuring acceptable levels of profit. In the proposed model, the capability of creating this cash flow stream is measured via the Concession Period (CP), defined as the length of the concession contract, expressed in years, when an SPV runs the project operations. This indicator is mainly related to the recovery of the investment. Shorter concession periods are usually associated with huge cash flows. However, short concession periods leads to a greater level of risk in case of delays or unexpected negative events. On the contrary, a long concession duration can bring much uncertainty to the 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).

SPV Risk

The main characteristics of the SPV are likely to influence the decisions of the investors. This is due to the fact that the very often the SPV does not own the physical assets, which cannot be used as guarantees against the loan repayment obligations. For this reason, there is a strong relationship between the SPV risks and the financial strategy (Dixon et al., 2005). SPV related risks are described by the Solidity parameter, which refers to the financial strength of the consortium of partners of the SPV. The Solidity of the SPV is measured by the Size of the Main Partner (PART_SIZE) numerical indicator, which is defined as revenues collected in the contract signature year. Since it is easier to raise funds for a project that has a reliable SPV, the associated level of risk decreases, and the debt leverage can increase. The other factor taken into account is the number of

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partners of the SPV (NPART). The greater the number of partners, the greater the capacity to inject equity capital into the project and, in turn, the lower the financial leverage.

Data analysis

Based on the proposed risk model, Table 2 summarizes the independent parameters that are supposed to have a significant impact on the debt to equity ratio of a PF project. Columns report the minimum, mean, and maximum value, the low, median and upper quartile and the standard deviation, respectively.

Table 2. Summary of the exploratory analysis on the dataset

Regression Analysis

The Normal Probability Plot shows the normality of the dependent variable records (Figure 1), thus a linear regression model is applicable. The goal of the regression analysis is to test if the independent variables considered are significant factors to the debt to equity ratio and whether they have positive or negative impact on such response variable (Tuckey, 1977). A positive influence indicates that an increase (or decrease) in the independent variable determines an increase (or decrease) of the dependent variable, while a negative effect produces opposite direction between independent and response variable variations.

Figure 1. Normal Probability Plot – Debt/Equity

First, the presence of multicollinearity among the independent variables is investigated via the calculation of the Variance Inflation Factor (VIF). VIF evaluates the relationship between an independent variable and all 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 and the it represents the proportion of variance in the independent variable under study, that is associated with the other independent variables in the model. Variables with VIF greater than 5 are discarded

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(Tabanick and Fidell, 2001), since the regression coefficient are poorly estimated (O'Brien, 2007). A suggestion that directly addresses the problem of reducing multicollinearity is to re-specify the model by eliminating one or more of the independent variables that are highly correlated with the other ones.

Table 3: Multicollinearity in the complete model

Table 3 shows that multicollinearity exists in our model because GE and RQ have very high VIFs. Therefore, these predictors are discarded as to avoid multicollinearity, as shown in Table 4.

Table 4. Proof that the model has no multicollinearity among predictors

After the study of the multicollinearity, the regression analysis is completed. Since the variable of the dataset have different order of magnitude, thus the results are difficult to compare, the regression is carried out on standardized variables (Carrol Rovezzi and Carroll,2002). To this end, for each parameter, the mean and the standard deviation are calculated and each observation is then normalized using the Equation 1.

$$z = \frac{x - \mu}{\sigma} \qquad \text{Equation 1}$$

where $\boldsymbol{x}$ is the value to be standardized, $\boldsymbol{\mu}$ is the mean of the population, and $\boldsymbol{\sigma}$ is the standard deviation of the population.

Results are reported in Table 5 where columns report the estimate of the regression coefficient, the standard error, the value of t statistic and the p value with the associated level of significance.

Table 5. Results of the regression analysis

The level of significance is associated to the p-value, which ranges from 0 to 1, is obtained from the observed sample and represents the probability of incorrectly rejecting the null hypothesis. The smaller the p-value, the lower the probability that rejecting the null hypothesis is wrong. If it is less than a predetermined critical value, usually equal to 5%, the null hypothesis is rejected. In the

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regression analysis the null hypothesis states that the coefficient equals zero (Montgomery and Runger, 1999).

Discussion of results

The results show that four out of the eight risk factors taken into account have a significant relevance in describing the debt leverage of energy PF initiatives. Therefore, risks in different areas are important aspects that need to be considered by project stakeholders when assessing a PF contract and defining its capital structure.

In particular, the negative impact of the country stability shows that low-risk countries are associated with lower levels of debt and increased equity capital injections. This result goes against the model's hypothesis: this can be probably justified by the fact that high risk countries are associated with lower spreads on borrowed capital (Girardone and Snaith, 2011). Moreover, a well-structured regulation framework at the country level can increase the willingness of private investors to contribute their efforts in public infrastructure development.

Furthermore, the negative relationship with the construction duration suggests that financial institutions are more willing to inject debt capital in projects with shorter construction durations. As a matter of fact, these projects are likely to be less complex and risky and less subject to delays that can jeopardize their profitability. Similarly, shorter concession periods are associated with more debt apportions. This result points out that the lending institutions do not consider long concession periods as an advantage.

The SPV solidity, expressed here as the annual revenue of the main partner, also proves to be a significant risk factor. The positive influence demonstrates that more reliable companies are likely to borrow a larger amount of debt capital. This specific aspect is becoming crucial, since lending institutions are asking private investors for strong financial reliability and creditworthiness before undertaking an investment, and this is creating more and more entry barriers for small contractors, with a negative effect on the level of competition (Demirag *et al.*, 2011).

Implications

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The proposed analysis investigates the relationship between risk and the definition of the capital structure of a PF initiative in the energy sector.

This work originates both theoretical and practical implications. From a theoretical perspective, this work extends the literature on the topic, which usually explains the issue under study from a qualitative perspective mainly highlighting the aspects related to a proper risk allocation between the public authorities and the private investors involved in the project. In particular, it can be considered as a basis for a better understanding of the sources of risk that can affect the definition of the capital structure for a PF initiative. In this sense, previous works have been focused on the identification of risks and on their classification. This research proposes an empirical method for measuring the impacts of such risks in the definition of the capital structure and it can be considered as a foundation for establishing methods able to design refined debt leverages for PF investment.

From a practical point of view, this work can be used as a predictive method in refining decision criteria for determining the debt leverage in PF power projects. In fact, in a PF initiative, lending institutions typically require a large apportion of equity capitals as a tangible commitment by project promoters, evidence of SPV reliability and reduced risk of debt service. On the other hand, private promoters try to increase the debt level in order to relieve private risk and obtain an acceptable rate of return. In this sense, the proposed study can be considered as a support for private investors to define a more efficient debt leverage. It can also assist in better allocating risks among involved parties.

In addition, this study may help international investors to gain insights on the project conditions and investment environments that may facilitate high debt leverages with positive effects on project selection processes.

Still, the model suffers from some limitations. For instance, just several macro-finance factors are taken into account in the risk profile. However, the aim of the study is to investigate the inherent financing structure of PF initiatives in the energy arena, separately from the positive or negative conjuncture of surrounding financial markets. Future research will be oriented to involve more

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external factors, in order to understand how cyclical external sources of risk might impact on the financial leverage of PF investments.

Conclusion

An empirical analysis is proposed to explore the factors that can influence the level of debt capital injected into the capital structure of a PF initiative in the electrical power sector. The hypothesis is that the debt leverage is affected by a variety of project risks. Country, Financial, Revenue, Project and SPV risks have been defined together with their parameters and associate numerical indicators. The results show that three out of the five sources of risk have a significant influence on the debt leverage. In particular, the Political Stability, that is associated with the environment wherein the project is developed, the Construction Duration, the Concession Period, that are typical project risks, and the Average Size of Partners, that is related to the private sponsors, prove to be significant variables of the debt to equity ratio for a PF mechanism used to finance a power investment. In other words, a high-risk country, short construction and concession periods, and creditworthy shareholders are likely to determine a maximized debt leverage. The aim is to provide a support in design an efficient debt-to-equity ratio and provide some hints for both private investors and lending institutions to determine the level of debt and equity that should be injected into a PF investment.

This can be used to give opportunities for private sponsors to enhance their profitability and for lending agencies to better handle their risks.

References

Algarni,, A.M., Arditi, D., and Polat, G. (2007). "Build-operate-transfer in infrastructure projects in the United States", *Journal of Construction Engineering and Management, Vol.133 No.10, pp. 728-735.*

Blyth, W. McCarthy, R. and Gross, R. (2015). "Financing the UJK power sector: is the money available?" *Energy Policy*, Vol. 87, pp. 607-622.

International Journal of Energy Sector Management

Boeng Singh, L. 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.

Boeing Singh, L., and Kalidindi, S.T. (2009). "Criteria influencing debt financing of Indian PPP road projects: a case study", *Journal of Financial Management of Property and Construction,* Vol.14, No.1, pp. 34-60.

Borgonovo, E. and Gatti, S. (2013). "Risk analysis with contractual default. Does covenant breach better?", *European Journal of Operational Research*, Vol. 230 No.2, pp. 431-443.

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. 7 No. 7, pp. 1223-1232.

Carbonara, N., and Pellegrino, R. (2014). "PPP for public infrastructure in Italy: Opportunities and challenge", *Managerial Finance*, Vol 40, No.1, pp. 1078-1094.

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

Choi, J-H., Chung, J., and Lee, D-JK. (2010). "Risk perception analysis: Participation in China's water PPP market", *International Journal of Project Management*, Vol. 28, No.6, pp. 580-592.

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

Demirag, I, Stapleton, P., Stevenson, C. (2012). "The diffusion of risks in public private partnership contracts", *Accounting, Auditing & Accountability Journal*, Vol.25, No.8, pp. 1317,1339.

De Marco, A. and Mangano, G. (2013). "Risk and value in privately finance healthcare projects", *Journal of Construction Engineering and Management*, Vol. 139, pp. 918-926.

International Journal of Energy Sector Management

De Marco, A., Mangano, G., Cagliano, A.C., Grimaldi, S. (2012a). "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., Mangano G., Michelucci, F.V. and Zenezini, G. (2016), "Using the private finance initiative for energy efficiency projects at the urban scale", *International Journal of Energy Sector Management*, Vol. 10 No.1, pp. 99-117.

De Marco, A., Mangano, G., and Nabaev, T. (2017), "The influence of risk on the equity share of build-operate-transfer projects", *Built Environment Project and Asset Management*, Vol. 7 No.1, pp. 45-58.

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

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., Trujillo, L. (2007). "Public-Private Partnerships in Transport Policy", *Research Working Paper 4436*. The World Bank, Washinton DC.

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

Girardone, C, and Snaith, S. (2011). "Project Finance loan spreads and disaggregated political risk", *Applied Financial Economics,* Vol.21 No.23, pp. 1725-1734.

International Journal of Energy Sector Management

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.

Hainz, C. and Kleimeier, S. (2012). "Political risk, project finance and the participation of development banks in syndicated lendings", *Journal of Financial Intermediation*, Vol. 21 No.2, pp. 287-314.

Hoffmann, 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.

Iossa, E., Spagnolo, G. and Vellez, M. (2007), "Contract design in public private partnerships", Report for the World Bank.

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, 138-150.

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

Kann, S. (2009). "Overcoming barriers to wind project finance in Australia", *Energy Policy*, Vol. 37, pp. 3139-3148.

Khmel, V. and Zhao, S. (2016). "Arrangement of financing for highway infrastructure projects under the conditions of Public-Private Partnership , *IATSS Research*, Vol. 30 No.2, pp. 138-145

Li, B., Akintoye, A., Edwards, P.J., 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.

International Journal of Energy Sector Management

Malini, E. (1999), “Build Operate Transfer Municipal Bridge Projects in India*”, Journal of Management in 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.

Montgomery, D.C and Runger, G.C. (1999). “Applied Statistics and Probability for Engineers”, John Wiley&Sons, New York.

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 & Quantity*, Vol. 41 No.5, pp. 673-690.

Olson, E.M., Slater, S.F., and Hult, G.T.M. (200%). “The performance implications of fit among business strategy, marketing organization structure and strategic behavior”, *Journal of Marketing*, Vol. 69 No.3, pp. 49-65.

Painuly, J.P. (2009). “ Financing energy efficiency: lessons from experiences in India and China”, *International Journal of Energy Sector Management*, Vol. 3 No. 3, pp. 293-307.

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.

Rate Inflation, (2016). <http://rateinflation.com/inflation-rate/uk-historical-inflation490rate.php=?form=ukir > (Dec. 6 2016).

Rehme, J. Nordigarden, D. and Cicksand, D. (2015). “Public policy and electrical-grid sector innovation”, *International Journal of Energy Sector Management*, Vol. 9, No.4, pp. 565-592.

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

International Journal of Energy Sector Management

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. , and Fidell, L.S: (2001), “Using Multivariate Statistics, 3rd Ed. HarperCollins, New York, NY.

Thillairajan, A. and Behera, M. (2016). “Private equity investment in power generation projects: Evidence from India ”, *International Journal f Energy Sector Management*, Vol 10 No.4, pp. 617-641.

Tuckey, J.W. (1977), *Exploratory data analysis*, Addison-Wesley, Reading, MA.

Van Thuyet, N. Ogunlana, S. O. and Kumar Day, P. (2007). “ Risk management in oil and gas construction projects in Vietnam”, *International Journal of Energy Sector Management*, Vol. 1, No. 2, pp.175-194.

Wei, W. and Gosling, G.D. (2013). “Strategies for collaborative funding of intermodal airport ground access projects”, *Journal of Air Transport Management*, Vol.32, pp. 78-86.

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

Xenidis, Y. and Angelides, D. (2005). “The financial risks in build-operate-512 transfer projects”,

513 *Construction Management and Economics*, Vol. 23 No. 4, pp. 431-441.

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.

Risk sources	Parameters	Indicators
Country	Country Attractiveness	Government Effectiveness Regulatory Quality
	Political Environment	Country Stability Index
Financial	Inflation	Inflation Rate
Revenue	Economic Environment	GDP growth rate
Project	Size Complexity Profitability	Investment size Construction duration Concession period
SPV	Solidity	Main Partner Revenues Number of Partners in the SPV

Table 1. Risks Identification

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	Acronym	Min	Mean	Max	Low quartile	Median quartile	Upper quartile	Standard deviation
Dependent variable								
Debt/Equity [%]	D/E	1	2.897	5.623	2.333	3	3.348	0.879
Independent variables								
Country Stability Index	CSI	-1.600	-0.433	1.210	-1.032	-0.460	0.027	0.645
Regulatory Quality	RQ	-1.310	-0.123	1.770	-0.420	-0.130	0.220	0.556
Government Effectiveness	GE	-1.260	-0.158	2.180	-0.522	-0.125	0.070	0.554
Inflation Rate [%]	INFL	0.040	6.166	20.820	3.777	5.110	8.078	0.409
GDP Growth [%]	GDP	0.700	6.076	0.140	4.200	6.000	7.900	0.026
Investment Size [MLN €]	INV	24.000	7.700	4,200.000	213.000	435.000	904.000	849.000
Construction Duration [years]	CDUR	7.000	35.780	84.000	24.000	33.000	47.250	17.100
Concession Period [years]	CPER	11.000	23.640	49.000	20.000	25.000	25.750	5.319
Average Size of Partners [MLN €]	PART_SIZE	22.000	17,512	103,439	701	5,702	17,274	27,399
Number of Partners in the SPV	PART	1	2.847	7	2	3	4	1.37

Table 2. Summary of the exploratory analysis on the dataset

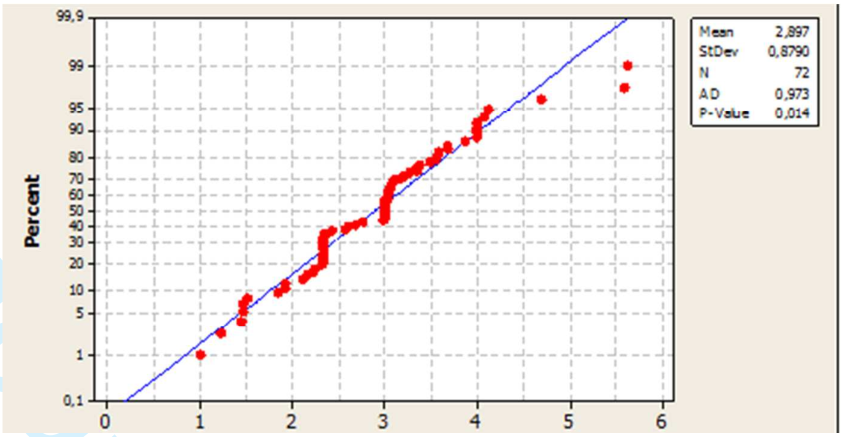

Figure 1. Normal Probability Plot – Debt/Equity

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	CSI	GE	RQ	INF	GDP GROWTH	INV	INV	CDUR	CPER	PART_SIZE	#PARTNERS
VIF	1.396	4.304	4.239	1.187	1.161	1.704	1.441	2.455	1.184	1.22	1.192

Table 3: Multicollinearity in the complete model

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	CSI	INF	GDP GROWTH	INV	CDUR	CPER	PART_SIZE	#PARTNERS
VIF	1.161	1.163	1.546	1.699	2.418	1.138	1.202	1.08

Table 4. Proof that the model has no multicollinearity among predictors

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	Estimate	Std. Error	t-value	p-value
Country Stability Index	-0.284	0.098	-2.88	**0.005****
Inflation Rate	-0.190	0.098	-1.92	0.059
GDP Growth Rate	0.141	0.113	1.24	0.221
Investment Size	0.229	0.119	1.92	0.06
Construction Duration	-0.417	0.142	-2.93	**0.005****
Concession Period	-0.343	0.097	-3.52	**0.001****
Average Size of Partners	0.487	0.100	4.85	**0.000*****
Number of Partners in SPV	0.151	0.095	1.59	0.117
Multiple R-Squared	47.10%			
Adjusted R-Square	40.40%			
Constant	0.367			
Significance notation	0 ***	0.001**	0.01*	

Table 5. Results of the regression analysis

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