

The impact of socio-political and economic environments on private sector participation in energy infrastructure delivery in Ghana

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Abstract

Purpose – Investment in power and electricity generation for replacing aging infrastructure with new represents a major challenge for developing countries. This paper therefore aims to examine infrastructure projects' characteristics and how socio-political and economic investment environments interplay to influence the degree of private sector participation (PPP) in infrastructure delivery in Ghana.

Design/methodology/approach – Using World Bank Public-private infrastructure advisory facility (PPIAF) and private participation in infrastructure (PPI) project database data from 1994 to 2013, binary logistic regression was used to: determine the probability of a higher or lower degree of PPP; and examine the significance of factors that are determinants of private investments.

Findings – The findings reveal that the private sector is more likely to invest in a higher degree of PPP infrastructure projects through greenfield and concession vehicles as opposed to management and leasing contracts. From the extant literature, drivers of PPP included infrastructure project characteristics and the social–economic–political health of the host country. However, the significance, direction and magnitude of these drivers vary.

Originality/value – This paper identifies investment drivers to PPP advisors and project managers and seeks to engender discussion among government policymakers responsible for promoting and managing PPP



projects. Direction for future work seeks to explore competitive routes to infrastructure debt and equity finance options that finance energy projects.

Keywords Public–private partnership, Private sector participation, Energy infrastructure projects, PPP contracts

Paper type Research paper

Introduction

Global demand for electricity is almost double that of the total energy consumption, and this challenging situation is exacerbated by the investment needed to replace ageing power sector infrastructure [EC (European Commission), 2011]. In developing countries, an estimated \$5tn of investment is needed to meet the expected demands for electricity by 2030, with more than \$2tn needed for new generation capacity alone (Woodhouse, 2005; Tohmatsu, 2003). This investment shortfall has created a deficit in energy and consequently, lethargic economic growth across the African continent [UNECA (United Nations Economic Commission for Africa), 2011]. Traditionally, public funds (mainly taxes and rates) and donor support have provided major sources of finance for infrastructure development in middle-income and low-income developing countries [Owusu-Manu *et al.*, 2008; PSIRU (Public Services International Research Unit), 2012]. However, such funds are inadequate and have failed to resolve the energy infrastructure deficit because this complex problem encapsulates both structural and political attributes. The extant literature reports that *structural attributes* include inappropriate policy framework regulations (including tariff setting and procurement), while *political attributes* include inefficient public institutions for the management of infrastructure, limited political will to prioritize energy development and prevailing political instability [UNECA (United Nations Economic Commission for Africa), 2011; OECD (Organization for Economic and Cooperation Development), 2012].

The electricity market's weak financial condition stems from under-pricing of electricity tariffs and inefficiencies in revenue collection, which, in combination, have made power projects unattractive to private investors (World Bank, 2011). In Ghana, the underdeveloped and shallow nature of the capital market affords limited alternatives for investors to obtain long-term “affordable” finance for infrastructure projects [Irving and Manroth, 2009; UNECA (United Nations Economic Commission for Africa), 2011]. Independent power producers have hitherto sought international investment even though accompanying foreign exchange rates represent a significant risk. These systemic issues have reduced private participation in energy infrastructure development and have accounted for high electricity tariffs. The conundrum for many developing countries is how to create a safe investment environment that generates affordable electricity [UNECA (United Nations Economic Commission for Africa), 2011].

Innovative financing approaches represent a possible solution for both current and future infrastructure needs (Badu *et al.*, 2012). Public–private partnership(s) [PPP(s)] represents one such approach and provide alternative sources of capital; a vehicle for improving the efficiencies in public project investment delivery; and an opportunity to enhance project management expertise (Moszoro and Krzyzanowska, 2007). By combining public needs with private capability and resources, PPPs represent a more politically palatable option than privatization [UNECA (United Nations Economic Commission for Africa), 2011]. To date, empirical research has focused on the risk factors (i.e. political, legal and economic) at a national level as individual determinants of PPPs (Basilio, 2010; Albalade *et al.*, 2012; Hammami *et al.*, 2006; Ismail, 2013) and the critical success factors for the implementation of PPPs in infrastructure projects (Ogunsanmi, 2014; Zagodzdon, 2013). Limited research has been undertaken to explore how characteristics of infrastructure projects and the

socio-political and economic investment environments interact at a holistic level to influence the degree of private sector participation (PPP). This research therefore seeks to investigate these interrelationships within Ghana's energy infrastructure market as a means of generating greater understanding of them. Emergent new knowledge generated will afford crucial information for PPP advisors, project managers and government officials who strive to reform the energy markets and concomitant infrastructure development.

Legal forms and degree of private participation in infrastructure delivery

PPPs have provided a catalyst for stimulating greater PPP in the provision of public services (Demirag *et al.*, 2010). PPPs legally bind public and private sector entities, and this arrangement facilitates a conduit, or point of entry, for private investors to participate in infrastructure delivery (Peirson and McBride, 1996 in Grimsey and Lewis, 2002). Contractual arrangements for PPPs are classified into five thematic groupings, namely: *management contracts*, *leasing contracts*, *concessions*, *greenfield projects* and *divestiture/privatization*. Each variant contains sub-types according to the level of PPP and the degree of risk associated with the contract [UNECA (United Nations Economic Commission for Africa), 2011].

Under *management contracts*, the private company assumes responsibility for the operations and maintenance of the public enterprise for an agreed contract fee and over a specific period (normally 3-5 years) [ESCAP (Economic and Social Commission for Asia and The Pacific), 2011]. Ownership, investment decisions and financial responsibilities remain with the public sector (Pessoa, 2008). The Built-Lease and Operate (BLO) organization provides an example of a typical management contract used in the utilities sector (i.e. electricity, gas, water, transport and telecommunications) (Devapriya, 2006). For *leasing contracts*, a private company acquires temporary ownership of the asset over a specific period in return for revenues. Responsibility for operating the asset is assumed, including any associated commercial risks, typically over a period of 10-15 years (Ogunsanmi, 2014). Under *concession*, a public entity owns the assets but operations, maintenance and investment decisions are contracted out to a private company; ownership of the asset reverts back to the public sector after a specific 25-30 years' period of time [IBRD/World Bank (The International Bank for Reconstruction and Development / The World Bank), 2009]. This contractual arrangement may release efficiency gains in both operations and investment but it requires considerable commitment and regulatory capacity for its sustainability (Pessoa, 2008). Under the *greenfield* arrangement, the private investor finances, builds and operates a new project for a specific period, and this remains in private ownership (Albalate *et al.*, 2012). The private investor absorbs the commercial risk, while the political and exchange rate risks are shared with the public sector [UNECA (United Nations Economic Commission for Africa), 2011]. Such projects are myriad, but the most common is BOT where asset ownership is transferred to the government at the end of the concession period [UNECA (United Nations Economic Commission for Africa), 2011]. Because of the high initial investment and lengthy concession periods involved (15-30 years), an appropriate risk distribution strategy between parties is required. Other forms of greenfield projects include: Build-Own-Operate (BOO); Build-Own-Operate-Transfer (BOOT), Design-Build-Operate (DBO), Design-Build-Finance-Operate (DBFO) and Build-Lease-Transfer (BLT). *Divestiture*, otherwise known as *privatization*, is where a public enterprise (or part(s) thereof) is sold to a private entity in exchange for an equity stake (Devapriya, 2006). The private investor acquires ownership of the public assets and assumes all related risks (Albalate *et al.*, 2012). This contractual arrangement provides potential high efficiency gains but requires a solid regulatory environment and careful preparation to be successful (Pessoa, 2008). Divestiture

can be partial divestiture or joint venture, where part of an asset is sold to the private sector or the government and a private entity jointly fund a new asset [UNECA (United Nations Economic Commission for Africa), 2011; Devapriya, 2006]. The duration of this contract is usually indefinite, but it may be limited under license (Pessoa, 2008).

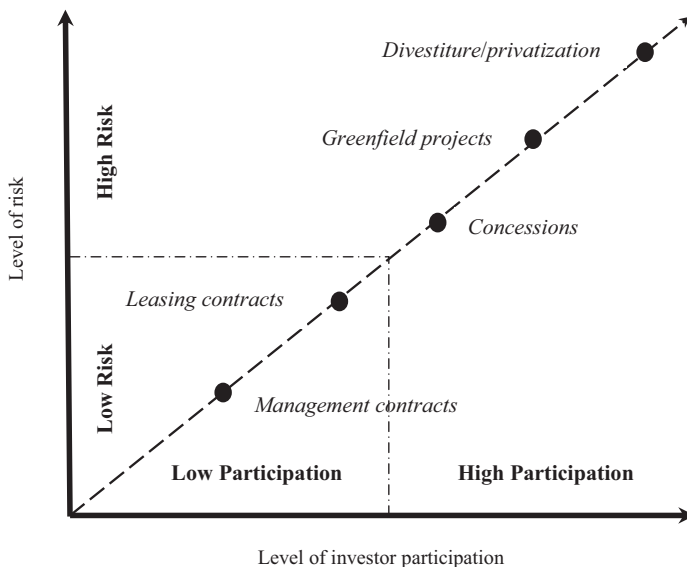
From this synthesis of literature, it is appropriate to hypothesize that:

H1. The degree of PPP in an energy infrastructure project delivery is significantly dependent on: (*H1a*) ownership level; (*H1b*) size of investment; (*H1c*) the power sector; (*H1d*) generation segment; and (*H1e*) revenue source.

The type of PPP arrangement entered into determines the degree of PPP; the extent of investments; sharing of risk; and other requirements needed to execute the project successfully. The degree of participation is theoretically classified (for the purposes of this research) as either “higher” or “lower”. The higher the risk that the private investor assumes, the higher the intensity of participation and the greater the anticipated profitability from such risk-taking (Figure 1). *Concessions, greenfield projects* and *divestiture* are classified as higher intensity forms of PPP contracts, while *management* and *leasing contracts* are regarded as lower intensity forms of PPP contracts.

Private sector investments and the socio-political and economic environments

Attracting private sector investors to PPP contracts and their successful implementation requires both a supportive policy/regulatory framework and a competitive investment climate (Alexander *et al.*, 1996; and Kirkpatrick and Parker, 2004). Robust economic regulations ensure that the interests of all parties involved (public, private and the end user) are protected (World Bank, 1994). Unbundling the once monopolized state utilities, and establishing independent regulatory regimes to oversee them, brought about effective



Note: A theoretical construct

Figure 1.
Risk compared to participation for PPP contracts

competition and efficiency within electricity markets (Joskow and Schmalensee, 1983; Newbury, 2000; Jamasb and Pollitt, 2005). Competition is a prerequisite for markets to work efficiently because it lowers costs and improves product and service quality (Austvik, 2009). An environment of macroeconomic and political stability, policy credibility and the existence of a sound regulatory framework is necessary for lowering the perceived risk of expropriation (Kerf *et al.*, 1998). However, within developing countries, *social regulatory policies* that are geared to support election campaigns are often unpalatable to private investors. To protect investors, regulations can be implemented to protect the rate of return on investments (World Bank, 1994; Burns and Riechmann, 2004). Yet, despite the palpable benefits of PPPs, efforts to deregulate are often met with skepticism, derision and strong resistance (Balouga, 2012).

Establishing central agencies that have the financial and technical capacity to oversee the management of PPP projects is a prerequisite to the successful implementation of PPP contracts (Pistor *et al.*, 2000). Such institutions facilitate transparency in management accounting and financial reporting – essential for performance measurement during the implementation and evaluation of PPP contracts (Demirag *et al.*, 2010). The effectiveness of regulatory institutions depends upon the structure and process of regulation, key aspects of which are: the independence and competence of regulatory agencies; the transparency and openness of the regulatory process; the existence of formal oversight and timely judicial review; and the country's stability and reputation for respecting private property rights (Smith, 1997; Pargal, 2003; Noll, 2000). Effective regulations and institutions provide confidence and assurance for the protection of private sector investment and reduce the risk faced by the host country (Parker and Hartley, 2003).

A country's economic stability (or "pull factor") represents a specific portfolio of investment risks and returns which may, or may not, attract foreign investment (Mody *et al.*, 2001; Ahmed and Zlate, 2013; Dua and Garg, 2013; Taylor and Sarno, 1997; Kinda, 2007). Countries with larger economic size, lower inflation, low external debt and more developed financial markets minimize the economic and financial risks accordingly (Basilio, 2010). From the extant literature, the following economic and financial variables are reported as "triggers" of capital flows: real gross domestic product (GDP) per capita and economic growth; the rate of inflation and international reserves; external debt and general government balance; fuel exports; and population (Eichengreen and Mody, 2000; Rose-Ackerman and Tobin, 2005; Basilio, 2010; Albalade *et al.*, 2012).

Economies that have deregulated utility industries have witnessed an upward surge of PPP in infrastructure investments. Despite these reforms, the availability of a credit market in the host country represents an additional key factor to attracting private sector investors (Zagozdzon, 2013). Accessing capital via the credit market lowers investors' financial constraints and financing costs (Tobin and Brainard, 1963; Boyd and Prescott, 1986) and provides corporate governance by dealing with agency costs and informational asymmetries (Bernanke and Gertler, 1989). In turn, the market facilitates a pooling and sharing of risks posed. A weak credit market in developing countries poses a significant issue (Kleimeier and Versteeg, 2009). The size and depth of the local capital market (equity and debt) is much smaller, less liquid and has a narrower investor base. For this reason, private investors rely upon international capital markets for long-term finance to execute capital projects (Dailami and Leipziger, 1998; Irving and Manroth, 2009).

Various authors have shown the importance of international economic conditions (or "push factor") in determining private finance (Calvo *et al.*, 1993). Key push factors may include: international interest rates, world growth rates (Taylor and Sarno, 1997) and global liquidity as measured by the money supplies of key advanced economies (Ahmed and Zlate,

2013). A decline in the US interest rate may be a driving factor of private finance in developing countries, particularly those who are integrated into the international credit market (Dailami and Leipziger, 1998). For example, Kappeler and Nemoz (2010) in Yuan *et al.* (2012) provide evidence that the global financial crisis of 2008 had a disproportionately strong impact on the development of PPPs within developing countries. This was because private finance for PPP projects became more expensive and market capacity was substantially reduced, leading some commentators to claim that the PPP model was redundant. Based upon this synthesis of literature, the following hypotheses have been developed, namely, that:

- H2. The degree of PPP in energy infrastructure project delivery is positively related to business freedom.
- H3. The degree of PPP in energy infrastructure delivery is positively dependent on the liquidity of the capital market.
- H4. The degree of PPP in energy infrastructure delivery is positively dependent on: (H4a): trade openness; but negatively related to (H4b): fiscal burden.
- H5. The degree of PPP in energy infrastructure delivery is negatively related to the global interest rate.

Methodology

The deductive methodological approach adopted sought to prove hypotheses arising from extant literature using quantitative deterministic modeling techniques and secondary (independent variable) data sources. Secondary data were compiled from the World Bank Public-Private Infrastructure Advisory Facility (PPIAF); Private Participation in Infrastructure (PPI) Project Database; Index of Economic Freedom (IEF); World Bank World Development Indicators (WDI) and Financial Development Database; and the Bank of Ghana annual financial statements. Time series data on forms of PPP contracts and the degree of PPP were obtained from the World Bank PPIAF and PPI Project Database over the period from 1994 to 2013. These databases contain utility PPI project investment information (in millions of US dollars) for telecommunications, energy, water and sewage and transport projects per country. Importantly, the database registers private sector commitments to invest in public infrastructure (rather than actual disbursements) and therefore, tracks private sector intentions to invest. Because the database compiles information on predominantly large PPI projects, smaller projects are often omitted and hence, the total PPI quoted may not be accurate. Despite this omission, the database is the most complete source of PPI data across developing countries. Political and regulatory factors were obtained from the IEF, while domestic/external economic and market conditions variables were sourced from World Bank WDI and financial development database and the Bank of Ghana annual financial statements.

Dependent variables degree of private sector participation

The degree of PPP is determined by the form of PPP contract chosen by the private investor and connotes private investors' risk appetite. The greater the investment commitment and ownership level, the higher the risk, which in itself determines a higher degree of intensity of participation. Therefore, a higher degree of participation in a particular form(s) of PPP contract is represented by a Boolean (binary) variable. Table I presents the project vehicle types, the intensity of private participation and associated Boolean coding.

Independent variables

Independent variables are contained within two thematic groups, namely: *infrastructure project characteristic variables* and *socio-political and economic variables*. There are five infrastructure project characteristic variables, namely:

- (1) *Degree of ownership and risks (OWN)*: Measures the percentage of private investors' resource commitment into each energy project, ranging from 0 to 100 per cent.
- (2) *Size of investment (INVESTSIZE)*: Measures the total amount of investment, in millions of US dollars, committed to the project.
- (3) *Project sector (SECT)*: A binary variable assigned a value of 1 if the project is a power sector project or 0 if the project is an oil and gas sector project.
- (4) *Project segment/network (SEGT)*: A binary variable assigned a value of 1 if the project is in generation segment or 0 if it is in transmission and distribution segment.
- (5) *Revenue source (REVSOURCE)*: A binary variable that assigned a value of 1 if the project has an identified revenue source or 0 if otherwise.

With regard to socio-political and economic variables, a further five variables were apparent, namely:

- (1) *Business Freedom (BFREED) Index*: Provides an overall indicator of the efficiency of government regulation of business. The score ranges from 0 to 100, with 100 indicating the freest business environment.
- (2) *Fiscal Freedom (FISCAL) Index*: Provides a composite measure of the burden of taxes that reflects both marginal tax rates and the overall level of taxation, including direct and indirect taxes imposed by all levels of government, as a percentage of GDP. It is expressed on a scale of 0 to 100.
- (3) *Capital Market Development (CAPMKT)*: Provides a measure of the ratio of stock market capitalization to GDP and rate of turnover in the stock market.
- (4) *Trade openness (OPENESS)*: Provides the sum of imports and exports as a fraction of GDP to represent a measure of the country's receptiveness to foreign investment.
- (5) *Global interest rates (GLOBIR)*: Usually approximated by the US Federal Funds Rate, GLOBIR measures the opportunity cost of alternative investments.

Data analysis techniques

Inferential analysis was used to make generalizations about the wider population from the sample gathered and specifically to test hypotheses (Gabrenya, 2003; Baddie and Halley, 1995). Sample data collected sought to examine the relationship and differences between variables (Saunders *et al.*, 2009). Significance testing was adopted to measure the probability that a pattern or relationship existing between the dependent and explanatory variables occurs by chance alone (Sirkin, 2005; Borrer, 2009). Statistical significance was used to determine if a null hypothesis should be rejected or retained using probability values (or *p*-values) (Meier *et al.*, 2011). Statistical significance is attained when a *p*-value is less than the significance level or alpha (α) level (Redmond and Colton, 2001; Krzywinski and Altman,

Table I.

Degree of private sector participation

Project vehicle types	Intensity of private participation	Boolean coding
Concession/Greenfield/Privatization	Very high	1
Management/Leasing Contracts	Very low	0

2013; Sham and Purcell, 2014). Significance levels $\alpha = 0.05$ (5 per cent), $\alpha = 0.10$ (10 per cent) and $\alpha = 0.01$ (1 per cent) were used for the analysis.

Estimation model

The *Binary Logistic Regression Model (BLRM)* was adopted as a probabilistic statistical classification model to measure the relationship between the categorical dependent variable and independent variables. This econometric model was chosen because it is capable of accurately modeling a Boolean-dependent variable. The product of calculations undertaken sought to determine which explanatory variables empirically influence the degree of PPP in energy infrastructure delivery.

Model specification

Logistic regression uses a linear regression to model the probability p_i using a linear predictor function (LPF) $f(x)$ for a particular data point i written as:

$$f(x) = \beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \dots + \beta_k x_i \quad (1)$$

Where β_0, \dots, β_m are regression coefficients indicating the relative effect of a particular independent variable on the dependent variable. The logit model belongs to the class of binary response models that models a Boolean-valued outcome variable Y_i for probability p_i into the form:

$$p_i = \Pr(Y_i = 1 | X) = F(\beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \dots + \beta_k x_i) \quad (2)$$

Where p_i is the probability of success; i.e. the probability of the outcome of 1 for trial i ; $F(\cdot)$ is the logistic distribution function taking on values strictly between zero and one: $0 < G(z) < 1$ for all real numbers z .

After estimating the model, the probability that $y = 1$ for each observation can be predicted. For the logit model, the probabilities are limited between 0 and 1. The predicted probability indicates the likelihood of $y = 1$. If the predicted probability is greater than 0.5, we can predict that $y = 1$, otherwise $y = 0$. Equation (2) can be re-written as:

$$p_i = \Pr(Y_i = 1 | X) = \frac{\exp(\beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \dots + \beta_k x_i)}{1 + \exp(\beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \dots + \beta_k x_i)} \quad (3)$$

Based on the model above, the predicted probability for the degree of PPP in energy infrastructure delivery is estimated as follows:

$$\begin{aligned} p_i = \Pr(Y_i = 1 | X) = & F(\beta_0 + \beta_1 OWN + \beta_2 INVSIZ + \beta_3 SECT \\ & + \beta_4 SEGT + \beta_5 REVSOURCE + \beta_6 BFREED + \beta_7 OPNESS \\ & + \beta_8 GLOBIR + \beta_9 FISCAL + \beta_{10} CAPMK) \end{aligned} \quad (4)$$

Parameter estimation

Coefficients. The coefficients returned from a logistic regression model are log-odds ratios. They indicate the log-odds of a “success” change with a one-unit change in the independent variable. Increasing the log-odds ratio of success means increasing the probability that the dependent variable $y = 1$ (makes that outcome more/less likely), and vice versa – decreasing the log-odds of a success means decreasing the probability that $y = 0$. Therefore, the sign of

the log-odds ratio shows the direction of its relationship: (+) means a positive relationship between x_i and the likelihood of a success and (-) means a negative relationship. The signs of the coefficient are interpreted but not the magnitude, as the latter cannot be interpreted using the coefficient because different models (linear probability, logit and probit) have different scales of coefficients.

Odds ratios (relative risk of the logit model). The odds ratios are the exponentiation of the coefficients and can be easier to interpret than the coefficient which is in log-odds units. The odds ratio is $p/(1 - p)$, and it measures the probability that $y = 1$ relative to the probability that $y = 0$. For instance, a ratio of 2 means that the outcome $y = 1$ is twice as likely as the outcome of $y = 0$.

Goodness-of-fit measures. To measure the adequacy of a fitted logistic regression model, goodness-of-fit measures were used.

Percent correctly predicted. The overall percentage gives the per cent of cases where the dependent variables were accurately classified as either occurring or not occurring on the basis of our two-variable model. There is no absolute cutoff point which tells us whether this represents good fit, but 100 per cent represents a perfect fit.

Hosmer-Lemeshow test. The Hosmer-Lemeshow (H-L) test is akin to a chi-square test, and indicates the extent to which the model fits the data, as in log-linear modeling. If insignificant, then the model has adequate fit and vice versa. If the H-L goodness-of-fit test statistic is >0.05 , the model estimates fit the data at an acceptable level. That is, well-fitting models show non-significance on the goodness-of-fit test. Akin to other significant tests, H-L determines whether the model fits or not but does not reveal the extent of the fit.

(Pseudo) R^2 . (Pseudo) R^2 is an approximation of the actual (R^2) in linear regression, with its continuous dependent variables. The (Pseudo) R^2 is developed to mimic R^2 for logistic regression models. There are a number of different Pseudo R^2 , but for the purpose of this research, the Nagelkerke's (Pseudo) R^2 is used.

Results and discussion of prior hypothesis

Parameter estimates such as logistic coefficients, odds ratios, goodness-of-fit measures and probability scores were used to examine the significance, direction, magnitude and the overall fit of the relationships in the pattern of data. In all, ten variables (originally obtained from the extant literature) were identified as factors that determine the degree of PPP. Scientific Package for Social Scientists (SPSS) software was used to analyze the data and accompanying literature used to either accept or reject the various hypotheses previously formulated. Analyses are summarized and tabulated in Table II. Logistic regression was performed to ascertain the effects of the independent variables on the degree of PPP. Model 1.1 reports estimates on infrastructure project characteristics variables only, while Model 1.2 reports estimates on both infrastructure project characteristics variables and the socio-political and economic variables.

From the results, the goodness-of-fit measures in Model 1.1 display an overall percentage of cases correctly predicted at around 76 per cent, but this rose to 81 per cent in Model 1.2. This means that 81 per cent of the intensities of PPP have been accurately classified as either higher or lower, which is an improvement when the socio-political and economic variables were added to the infrastructure project characteristics variables. The H-L goodness-of-fit test statistic is insignificant and is greater than 0.05, indicating that the model's estimates fit the data at an acceptable level. The Nagelkerke R^2 reveals that about 14 per cent (Model 1.1) and 38 per cent (Model 1.2) of the proportion of the variation in the degree of PPP in both models can be explained by the independent variables. The predicted probability of Model 1.1 indicates that the infrastructure project characteristics variables alone can predict 0.79 of

Independent variables	Model 1.1	Standard errors	Model 1.2	Standard errors
OWN	0.005	0.014	-0.009	0.018
	1.005		0.991	
INVSIZ	-0.001	0.002	0.002	0.002
	0.999		1.002	
SECT	1.169	0.605	1.324	0.760*
	3.219		3.757	
SEGT	1.036	0.522**	1.277	0.641**
	2.817		3.586	
REVSOU	0.019	0.618	-0.168	0.701
	1.019		0.845	
BFREED			-0.280	0.100***
			0.756	
OPNESS			4.405	1.736**
			81.836	
GLOBIR			0.0309	0.175***
			1.362	
FISCAL			0.026	0.052
			1.026	
CAPMKT			0.113	0.127
			1.120	
Constant	-1.154	1.602	7.780	6.079
	0.315		2393.34	
<i>N</i>	10		10	
% correctly predicted	76		81	
Hosmer-Lemesnow χ^2 test	6.638		3.978	
(Nagelkerke) R^2	0.141		0.381	
Pr($Y = 1$)	0.79		1	

Notes: *Statistically significant at 90% ($p < 0.1$) level, **at 95% ($p < 0.05$) level, ***at 99% ($p < 0.001$) level

Table II.
Summary of analysis

the model. However, when the socio-political and economic variables were added, the probability moved to 1 which illustrates that all the independent variables are key in predicting the likelihood of the private sector participating in higher forms of PPP. The high predicted probabilities reported upon in both models indicate that private investors prefer investing in greenfield, concession and divestiture vehicles as opposed to management and leasing contracts. This may be because whilst such contractual arrangements are high risk, they also offer greater control over the work and a greater opportunity to generate higher profit margins.

From the main results, all the infrastructure project characteristics variables in Model 1.1 did not display significant coefficient estimates, except *SEGT* with a coefficient of 1.036 ($p = 0.047$). This indicates that the generation segment is more likely to influence the degree of PPP. By magnitude, *SEGT* is 2.817 times more likely to increase the degree of participation for every 1 percentage point increase in private investment in the project. However, when the socio-political and economic variables were added (Model 1.2), *project sector (SECT)*, which was insignificant in Model 1.1, becomes significant with a coefficient of 1.324 ($p = 0.082$). The *SECT* variable is 3.757 times more likely to influence private investment, which means that it is a critical consideration in the decision to participate in energy infrastructure delivery. The magnitude of influence of the *SEGT* in private investment is also increased to 3.586

times more likely. This confirms *H1c* and *H1d* that the degree of PPP is significantly dependent on *SECT* and *SEGT*, respectively.

Out of the five socio-political and economic variables added, three of them: *business freedom (BFREED) index*, *trade openness (OPENESS)* and *global interest rates (GLOBIR)* variables were significant at ($p = 0.005; 0.011$ and 0.077), respectively. The *business freedom (BFREED) index*, with a negative coefficient (-0.280), shows an inverse relationship between the regulatory business environment and the extent of private participation, although a positive relationship was anticipated, therefore rejecting *H2*. An increase in *BFREED Index* will reduce the extent of private participation by about 24 per cent (odds ratio of 0.756) (Table II). The *OPENESS* variable, on the other hand, displayed a positive coefficient, indicating that a rise in *Trade Openness Index* for Ghana is more likely to increase the receptiveness of foreign investment into the energy sector, satisfying *H4a* that the degree of participation is positively dependent on trade openness. *GLOBIR* also displayed a positive coefficient, signifying that a higher movement in the US federal funds rate is less likely to induce the degree of participation by 1.362 times in every 1 percentage point increase in the degree of private participation. However, this result is also not consistent with literature (Dailami and Leipziger, 1998; Calvo et al., 1993), suggesting that a decline in the US federal funds' rates is a driving factor of private finance in developing economies and vice versa. Hence, *H5* was rejected.

Conclusion

Meeting the global demand for electricity consumption requires sustainable investments into building new, and maintaining (or upgrading/ replacing) existing, power sector infrastructure. Dealing with the deficit in energy infrastructure is a prerequisite to tackling the fundamental challenges to the economic growth of developing countries. However, mobilization of affordable finance and investment represents a significant challenge. Public funds and donor support have historically been inadequate, especially in jurisdictions where infrastructure provision is the primary responsibility of the prevailing government. For this reason, most economies have resorted to the private sector for delivering energy infrastructure projects, through PPP contracts. The infrastructure project's characteristics and the social-economic-political health of the host country have been determinants of private investment in the energy sector.

From extant literature, the paper identified five infrastructure project characteristics and five socio-political and economic investment environment factors as determinants of the degree of investor participation. The study found that there is a high probability that private investors prefer to invest in higher-risk and potentially more profitable greenfield, concession and privatization vehicles *vis-à-vis* management and leasing contracts. None of the infrastructure project characteristics variables in Model 1.1 displayed significant coefficient estimates, except *Project Segment/Network (SEGT)*, indicating that controlling for both transmission and distribution segments, the generation segment is more likely to influence the degree of PPP. Adding the socio-political and economic variables, however, changed the significance levels of the explanatory variables, with the energy sector together with *business freedom (BFREED) index*, *trade openness (OPENESS)* and *global interest rates (GLOBIR)* variables becoming statistically significant.

New knowledge emanating from this paper provides crucial information on investment drivers to PPP advisors and project managers. Future research is however required to explore competitive routes of infrastructure debt and equity finance options that finance energy projects and measure the impact of any changes in the government policy. In addition, the research needs to be extended to cover other developing nations to expand the

application and impact of the findings. While the work is not a panacea to the energy infrastructure conundrum that developing nations are confronted with, it will engender future discussion among government policymakers responsible for promoting and managing PPP projects.

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