Business and Management Studies
Vol. 2, No. 3; September 2016
ISSN 2374-5916 E-ISSN 2374-5924
Published by Redfame Publishing
URL: http://bms.redfame.com

Public–private Partnerships in Financing Infrastructure Development: Could Some Award Methods Generate X-Inefficiency?

Leopoldo Laborda Castillo[1], Daniel Sotelsek Salem[1]

[1]Institute of Latin American Studies (www.ielat.com), University of Alcalá, Colegio de Trinitarios, C/Trinidad no. 1, 28801 Alcalá de Henares, Madrid, Spain

Correspondence: Daniel Sotelsek Salem, Institute of Latin American Studies (www.ielat.com), University of Alcalá, Colegio de Trinitarios, C/Trinidad no. 1, 28801 Alcalá de Henares, Madrid, Spain.

Received: July 10, 2016 Accepted: July 19, 2016 Online Published: August 4, 2016

doi:10.11114/bms.v2i3.1784 URL: http://dx.doi.org/10.11114/bms.v2i3.1784

Abstract

This article focuses primarily on analyzing the possible relation between infrastructure management projects under a Public-Private Partnerships (PPP) and X-Inefficiency. The premise of our empirical analysis is that some methods of contract awarding for selecting the right private sector partner, when subject to competition and transparency (competitive bidding), may contribute to the overall infrastructure goals of countries in general and in particular to reducing X-Inefficiency. For measuring, we assume that at least some decision making units (DMU) are successfully practicing maximization, while others may not be. The database covers projects awarded in low- and middle income countries as classified by the World Bank and our initial sample consisted of 210 electricity generation [1] projects (energy sector). The results show that award methods based on direct negotiation have a positive effect on increasing technical efficiency (or decreasing X-Inefficiency) compared to alternative methods like competitive bidding.

Keywords: low- and middle income countries, Public-Private Partnership (PPP), X-Inefficiency, panel data, energy sector

JEL Classification: M21, L14, L32, C24

1. Introduction

According to several authors (Aschauer (1990), Gramlich (1994), Esfahani and Ramırez (2003), Romp and De Haan (2007), Irmen and Kuehnel (2009), Égert et al. (2009), and more recently Calderon et al. (2014)), infrastructure brings greater economic returns on investment than many other forms of capital expenditure. It is also well recognized as having a lasting impact on long term prospects for economic growth.

Nevertheless, when the time comes for investments in infrastructure to be made, the old state versus market dichotomy that has long dominated the economic debate once again emerges. The arguments for and against such a system are varied. One side argues to justify state intervention in the economy while others contend that the market is the best instrument for achieving general welfare.

In any case, there is evidence that these investments, whether public or private, and the provision of public goods has a positive effect on aggregate demand and social welfare as long as inflation does not increase. This generates a lack of competitiveness and has negative effects on the external sector and creates a fiscal deficit that leads to debt problems.

To avoid many of the unwanted macroeconomic and sector based effects that public investment and state provisions of public goods and services can cause in the economy, the traditional relationships between the public and private sectors have developed to achieve a counter-cyclical growth thrust, improved efficiency, and ultimately a better distribution welfare. It is in this context that during the 1980s, a new way of looking at the relationship between the State and the market was born. This idea spread quickly, creating what has been called the Public-Private Partnership.

Public-Private Partnership (PPP) arrangements are a relatively new instrument –arising in the 1970s as the result of popular concerns about increased public spending that dominated political debate in English speaking countries. However, the PPP methodology is applied more often in less developed countries, especially in sectors related to infrastructure. Grimsey and Lewis (2004a) discuss the role and give an overall assessment of Public-Private

Partnerships[1] (PPPs) in emerging markets, assuming a lack of budgetary resources and vast infrastructure needs in these economies. Therefore, PPPs remain an attractive policy option for achieving several social, commercial, and environmental goals (Grimsey and Lewis (2004). Regarding the social aspect, PPPs can be designed to ensure that the private sector shares its learning experiences, contributes to technology transfer, and helps the public sector acquire new abilities. Commercially, the benefits of PPPs allow for infrastructure completion deadlines to be shortened and reduce the risk of experiencing delays when circulation channels for goods and services are put into operation. Finally, when considering environmental issues, projects carried out under a PPP can, through the regulatory experience of the public sector, improve energy efficiency and biodiversity as well as reduce pollution.

However, in line with Grimsey and Lewis (2004) and Auriol and Picard (2008), there are some problems with this type of arrangement that must be overcome. As examples, possible difficulties in putting together a cost effective financial package, the restricted financial flexibility of the public sector arising from the commitment of funds under the PPP contract, high transaction costs in the development stage, and the absence of a reliable commercial and legal framework in emerging economies. Another relevant issue is the possible existence of X-Inefficiency[2] as a result of contract awarding methods based on direct negotiation instead of competitive bidding.

X-Inefficiency can occur when managing infrastructure projects under Public-Private Partnerships (PPP). See Marques and Berg (2010); Vining and Boardman, (2008a, b). These articles highlight this aspect, and usually on the empirical analysis of selected projects to test a possible relation between infrastructure management projects under a PPP and X-inefficiency. First, we provide a brief overview on the different ways that the private sector can be involved in financing infrastructures in emerging markets. Afterwards, using an initial sample of 210 electricity generation projects from a database that covers projects awarded in low -and middle income countries as classified by the World Bank, we assume that at least some decision making units (DMU) are successfully practicing maximization, while other may not be.

The results show that the methods based on direct negotiation have a positive effect on increasing technical efficiency (or decreasing X-Inefficiency) compared to alternative methods like competitive bidding. In this regard, the results show some policy implications that could be significant since under these circumstances, direct negotiation could theoretically help save the government money.

In the next section, we provide a brief background. In the third section, an empirical analysis of selected projects is offered and the data, methodology, and results of the study are presented. Finally, some considerations and policy implications are offered.

2. Financing Infrastructures in Emerging Markets

Governments, international development agencies, and financial institutions have worked to develop techniques to lower infrastructure project risks by providing structured project financing and credit from specialized financial institutions that allow for equity and debt mobilization by fashioning the finance to the specific infrastructure project and to ensure that risks are not borne by the sponsor alone, but shared with different types of investors, like equity holders, debt providers, or quasi equity investors. Credit enhancement via mechanisms that reduce project risks make borrowers more confident (such as subordinated debt securities) when offering either government level or multilateral development bank guarantees and equity contributions or PPPs with direct government equity support. Governments often offer minimum profit guarantees, special tax treatment, or subordinated royalties while development banks offer guarantees through some form of insurance to private investors via capital that governments already have in these banks.

Several factors need to be taken into account if these techniques are to be developed and successfully implemented, including:

i. The legal framework, which must be set up to protect private sector interests, as in many developing countries this framework does not exist. Therefore, robust systems of laws and trade regulations must be set up to provide the system with a guarantee[3].

[1]This term usually refers to agreements or contracts between the public and the private sector to jointly operate and/or own infrastructure projects. It could apply to existing assets (a company) or a new one that will be constructed by the partnership.

[2]X-Inefficiency (Leibenstein, 1966) occurs when an institution has little incentive to control costs, which causes the average cost of production to be higher than necessary. With this lack of incentive, the institution will not be efficient.

[3]For a correct interpretation of the legal framework its necessary to distinguish at least two aspects; the first one is related to the various categories of agreement for public-private partnership that extend from strictly public, through

ii. Limits on financial indebtedness established by state, local, and municipal governments in order to avoid making commercial banks incur long term commitments which are common in PPPs[4]; and finally,

iii. Tax and accounting systems, which must be designed to ensure that the PPPs work properly, as in many cases neither the taxes nor the accounting are appropriate for this method of project management and implementation.

However, designing a credible framework is not enough to attract funds. Incentives are also essential for promoting cost containment and economic efficiency, especially because the users of infrastructure services need to accept the validity of the public–private arrangements and feel that they are paying prices based on the services received.

According to Berg et al. (2002) and Grimsey and Lewis (2004), three main factors, legitimacy, credibility, and efficiency, are essential to sustain public and private collaboration in infrastructure development. Focusing on the third factor (efficiency), evidence that these authors presented regarding developed economies suggests that PPPs can bring efficiency gains and cost savings compared to traditional procurement. However, it is important to distinguish that these benefits are different depending on how they are analyzed: by allocation efficiency, technical efficiency, or scale efficiency.

3. An Empirical Analysis in the Electricity Generation Sector

Several works, consider selecting the right private sector partner to be a critical issue in PPPs in developing international infrastructure[5], Erdogdu, E. (2011).

Zhang (2005) focuses in the analysis of several studies about critical factors considering the international experience in PPP and lessons learnt, as well as the evaluation of interviews of academic experts and practitioners with experience. The investigation analyzes the relative importance each criteria has among the whole package and the relative importance each package has in the complete questioner’s structure. The results could help developed a general methodology where a multi-criterion best value source selection technique (BVSS) can be used.

Aziz (2007) studied PPPs in the United Kingdom, Canada and British Columbia, which goes beyond the traditional approximation about critical factors analysis and includes legal, political and cultural features as well. Aziz (2007) produces a guide for project implementation that measures the degree of success of each project while accounting for the principles that could characterize the implementation phase of the PPPs at the program level.

According to Kwak (2009), PPPs offer new and long term business opportunities with a chance to deliver infrastructure services of higher quality and efficiency. However, these benefits will only be materialized when a PPP project is properly planned and managed and both the public and private sectors work together successfully.

In a study conducted in Malaysia, Ismail (2013) showed that “good governance”, “commitment of the public and private sectors”, “favorable legal framework”, “sound economic policy” and “availability of finance market” are the top five success factors of PPP implementation. On the other hand, although the rankings of many factors were different between the public and private sectors, the author does not find significant differences in the perception of the public and private sectors concerning the importance of virtually all of the success factors.

Finally, Ogunsanmi (2016), showed that Critical Success Factors (CSFs), such as commitment and responsibility of public and private sectors, strong private consortium and realistic cost/benefit assessment amongst others are critical for PPP implementation. Under this circumstance, the premise of our empirical analysis is that some methods of contract awarding for selecting the right private sector partner, when subject to competition and transparency (competitive bidding), may contribute to the overall infrastructure goals of countries in general and in particular to reducing X -Inefficiency, especially

---

public-private. (Management Contract, Leases and affermage, Build Operate Transfer (BOT), Joint Ventures). The second aspect differentiates the PPP from other public-private partnership is achieved by distinguishing between contractual associations and institutional associations. (Beuve et al, 2014)

The first imply the existence of a contract and among the most common are the infrastructure concessions (Latin term) contracts, similar to Design Build Finance Operate (DFBO) in the UK. In the case of institutional partnerships, however, both parties (public and private) are involved in a management entity. A paradigmatic example of institutional management companies are mixed economy companies of highways in France. Given that the differences in legal constitution can lead to misunderstanding, the most important to bear in mind in the definition of a PPP is that the two parties have responsibilities, take risks in the execution of contracts and therefore derive benefits.

[4]At country level, global finance limits applied to the amount of indebtedness of state, regional, or local government entities may inhibit or even prevent private commercial banks from incurring the long term commitments typical in PPPs.

[5]This literature addresses various selection criteria in order to evaluate packages for PPP projects. In general, they are: financial, technical, safety, health, environmental, and managerial criteria.

when governments have a low technical capacity for selecting projects based on direct negotiation.

Additionally, a second issue is to clarify the distinction between different types of efficiency: the so called allocation efficiency or the improved technical efficiency. The former has a direct effect on prices and directly generates a higher level of well-being whereas the latter depends on the correct use of the factors of production, but also on the scale and the field of production.

3.1 Methodology

According to Leibenstein and Maital (1992: 433), "Data Envelopment Analysis[6] (DEA) is a model built explicitly on maximization. How then can use as an empirical methodology for measuring X-Inefficiency? The answer is by assuming that at least some decision making units (DMU) are successfully maximizing while others may not be."

Although there is no consensus among researchers regarding the way to establish the process for evaluating the influence of Public–Private Partnerships in Financing Infrastructure Development variables on service efficiency levels, this research attempts to detect the repercussion of certain exogenous factors on the efficiency levels by using a two stage process made up of the following steps:

i. Obtain the Charnes, Cooper and Rhodes (CCR) efficiency index. In order to calculate efficiency, the behavior of each unit observed is optimized, thus determining the efficient production frontier by means of linear segments based on the Decision Making Units (DMUs) that operate with the best practices. This corresponds to the set of units considered efficient in Pareto's terms. Therefore, the only requirement established is that each DMU should belong to the frontier envelopment (Cooper, Park and Yu, 2001).

ii. Estimate a truncated regression. The choice was made to estimate this dependency model because, according to the results of Simar and Wilson (2007), it provides better statistical inference than the Tobit regression does. The linear regression model we consider has the form:

$$\vartheta_i = z_i\beta + \varepsilon_i \tag{1}$$

Where the $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ is identically, independently distributed for all i =1,….,m. The left hand side variable is said to be censored when, instead of observing for ϑ_i all observations, we observe:

$$\theta_i = \begin{cases} z_i + \varepsilon_i \; if \; z_i + \varepsilon_i > c_i \\ c_i \; otherwise \end{cases}$$

In this case, ϑ is left censored at the constant c_i, which may vary across observations. Alternatively, ϑ is said to be truncated if we observe $\theta_i = \vartheta_i$ for all $\vartheta_i \geq c_i$, but observe nothing otherwise.

In the case of truncation, if the ϑ_i are assumed normal with left truncation at c_i, β in (1) can be estimated by maximizing the likelihood function:

$$\ell_1 = \prod_{i=1}^{n} \frac{1}{\sigma_\varepsilon} \phi \left(\frac{\theta_i - z_i\beta}{\sigma_\varepsilon}\right) \left[1 - \Phi\left(\frac{c_i - z_i\beta}{\sigma_\varepsilon}\right)\right].^{-1} \tag{2}$$

Where and $\phi(.)$ and $\Phi(.)$ represent the standard normal density and distribution functions, respectively.

In our case ϑ_i represent the dependent variable under two specifications. First, technical efficiency index (considering one output "Capacity" and one input "Total Investment") and second, scale efficiency index. Finally z_i is a vector of independent variables like Percent Private Funding, Debt Equity Grant Ratio, and several control variables (Award Method, Renewable Energy, and PPP Type).

3.2 Data and Key Variables

To conduct our analysis, we employed the Private Participation in Infrastructure Database[7] generated by the World Bank. The database records contractual arrangements with and without investments in which private parties assume operating risks in low- and middle income countries. However, projects included in the database do not have to be

[6]DEA also computes the distance between DMU performance and the efficient frontier (see Figure A1 in the statistical appendix), while dividing up the causes of inefficiency amongst the contributing inputs in a manner that leads to their reduction, or eventually, their elimination. For more details about this technique, see Charnes et al. (1978).

[7]For a more detailed description, see the expanded: http://ppi.worldbank.org/resources/ppi_methodology_ expanded.aspx

entirely privately owned, financed, or operated (some involve public participation as well).

In most cases, the investment amounts in the database represent the total amount of investment commitments entered into by the project entity at the signing of the contract or financial closure[8] (the present study focuses on the year 2012), not the annual investments that were planned or made.

The database covers projects awarded in low -and middle income countries as classified by the World Bank, and focuses on sectors with some monopoly or oligopoly characteristics (energy, telecommunications, transport, and water). Countries are also placed into one of six regions (East Asia and the Pacific, Europe and Central Asia, Latin America and the Caribbean, the Middle East and North Africa, South Asia, and Sub-Saharan Africa).

Our initial sample consisted of 210 electricity generation[9] projects (energy sector). However, one project was eliminated as the total investment, compared to the rest of the projects, allowed us to consider it an outlier (their basic statistics for all samples –Table A1; and these statistics at the country level – Table A2).

The key variables used are listed in the next table 1.

Table 1. Key variables.

Variable	Definition
Capacity (output)	It is the size of a project measured in the units of the capacity type assigned to the project. For electricity generation, the capacity quoted is usually the one expected when project becomes fully operational. Installed megawatts are used for electricity generation projects (1).
Total Investment (input)	It is the sum of investment in physical assets (2) and payments (3) to the government. Investments are recorded in millions of US dollars.
Percent Private Funding	The percentage of the project company that is owned by private sponsors. Data on private shares are cumulative and reflect annual changes. Private share data are entered for all years available in the project history table, even if it has not changed. For the years in which there is no change in the private share, the latest available value is used.
Debt Equity Grant Ratio	Debt ratios measure the ability of the business to repay long term debt. The debt to equity ratio shows the proportion of capital invested by the business owners to the funds provided by external lenders. It gives a comparison of how much of the business was financed by owners' equity and how much was financed through debt or liabilities. The formula used to calculate the debt to equity ratio is: Total Liabilities ÷ Owners' Equity
Dummy Award Method:	This is the method that the government used to award the contract to a private consortium. The options are: 1 = Direct negotiation; 2 = Competitive bidding.
Dummy Renewable Energy: 1 = yes	Renewable energy is generally defined as energy that comes from resources which are naturally replenished on a human timescale such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy replaces conventional fuels in distinct areas like generating electricity. The options are: 1 = Yes; 2 = No.
Dummy PPP Type.	A public–private partnership (PPP) involves several contracted services. The options are: 1 = Services contracted by users; 2 = Services contracted by the government.

Notes:
(1) While investment figures are either reported on total commitment basis in the year of financial closure or annual flows for some projects, capacity size information is cumulative.
(2) Payments to the government (formerly known as Investment in Government Assets): Resources the project company spends on acquiring government assets such as state owned enterprises, rights to provide services in a specific area, or the use of specific radio spectrums. License fees, canon payments, or divestiture revenues are the common revenue collection mechanisms. Investments are recorded in millions of US dollars.
(3) Investment in physical assets (formerly known as investment in facilities): Resources the project company commits to invest in facilities during the contract period. Investments can be either in new facilities or in expansion and modernization of existing facilities. Data entry varies across sectors.
For projects other than telecommunications and large energy utilities, the total cost of developing or expanding the facility during the contract period is entered as investment data in the year of financial closure (this type of data is typically available).
For telecommunications projects and some large energy utilities, annual investments on facility expansion and modernization are entered as investment data in the year of investment when information is publicly available.
Investments are recorded in millions of US dollars in either the year of financial closure or year of investment, as indicated above.

Source: Authors' calculation from the Private Participation in Infrastructure Database. The World Bank.

[8]Closure occurs when there is a legally binding commitment of private sponsors to mobilize funding or provide services. The definition of financial or contractual closure varies among types of private participation as a result of the availability of public information.

[9]Facilities needed for production of electricity, including the power plant.

3.3 Results

Starting with a descriptive analysis of the data, Table 1 shows large differences between regions when we look at the levels of Technical Efficiency[10] with Variable Returns to Scale (VRS). Of note are the values seen in the Middle East and North Africa (35%) and South Asia (34%). However, regions like Europe and Central Asia (18%) and Sub-Saharan Africa (17%) present more modest values.

Table 2. Descriptive statistics by region: Mean values.

Region	TE (CRS)	TE (VRS)	SE	Capacity	Total Investment	Percentage of Private Funding	Debt Equity Grant Ratio
East Asia and Pacific	0.079	0.232	0.405	106.19	167.66	97.95	2.76
Europe and Central Asia	0.065	0.181	0.464	60.48	138.00	100.00	2.40
Latin America & the Caribbean	0.082	0.296	0.270	165.89	337.45	96.95	2.54
Middle East and North Africa	0.060	0.351	0.166	350.00	913.75	93.75	2.89
South Asia	0.099	0.340	0.327	103.07	134.00	98.92	2.58
Sub-Saharan Africa	0.043	0.177	0.258	60.00	208.10	92.95	2.73

Notes:
TE (CRS): Technical Efficiency with Constant Returns to Scale.
TE (VRS): Technical Efficiency with Variable Returns to Scale.
SE: Scale Efficiency in terms of CRS/VRS.

Source: Authors' calculation from the Private Participation in Infrastructure Database. The World Bank.

However, the Percentage of Private Funding and the Debt Equity Grant Ratio has similar values between regions. In the case of the Debt Equity Grant Ratio[11], we see values of more than 1:1, which could mean that debt is higher than owners' equity, projects are designed negatively, external lenders are bearing more risk than the owners, or external lenders have a stronger financial interest in the project than the owner.

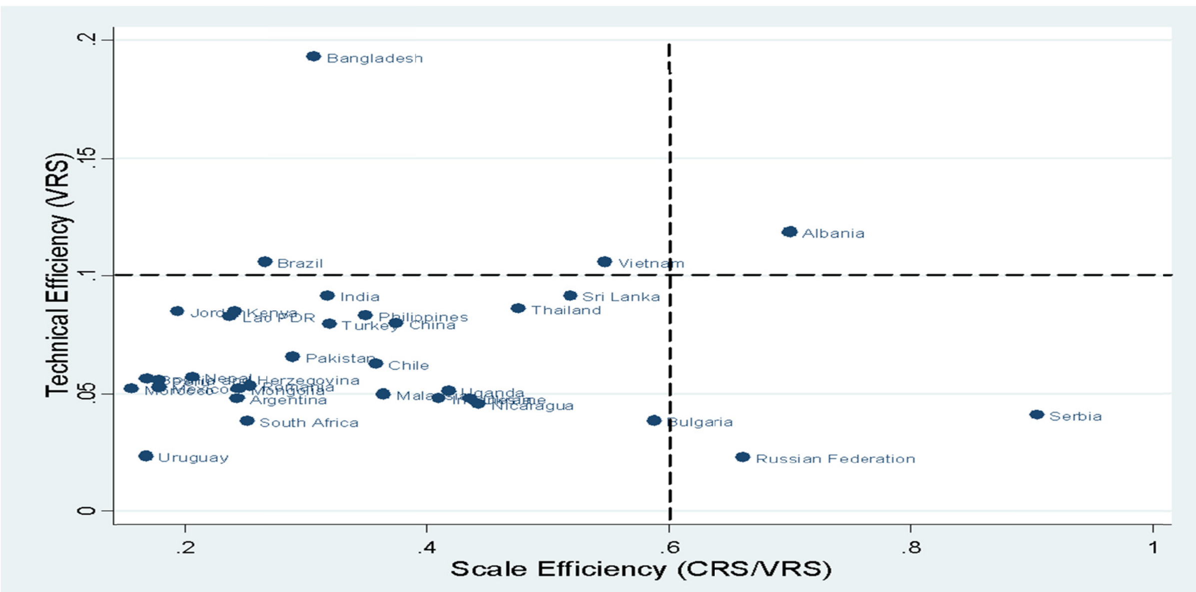

Figure 1. Technical Efficiency and Scale Efficiency by countries: Mean values

[10] According to Leibenstein (1966), a productive unit can be categorized as technically efficient if it is able to produce maximum output given available resources. It has been acknowledged in the literature that a gap normally exists between a firm's actual and potential levels of economic performance.

[11] The higher the ratio, the more the project relies on debt to finance its operations and the greater the risk to external lenders. A debt equity ratio of 1:1 indicates that the external lenders and the owners are bearing the same degree of risk. Generally, a debt to equity ratio in the range of 1:1 to 4:1 is acceptable but will depend on individual projects and industry circumstances.

Source: Authors' creation from the Private Participation in Infrastructure Database. The World Bank.

In Figure 1 we have classified the countries according to their technical and scale efficiencies. In the upper right quadrant, we find countries with high levels of both efficiency measures, we can see that only Albania is located in this quadrant.

Table 3 shows large differences between groups by income level when we compare the current values of Technical Efficiency with VRS. Note the value for low income countries (49%) is almost twice the values seen by lower middle - and upper middle income countries.

Table 3. Descriptive statistics by income level: Mean values.

Income Group	TE (CRS)	TE (VRS)	SE	Capacity	Total Investment	Percent Private Funding	Debt Equity Grant Ratio
Low income	0.148	0.493	0.296	171.55	179.26	100.00	2.21
Lower middle income	0.081	0.276	0.347	90.85	164.03	98.27	2.64
Upper middle income	0.071	0.235	0.351	114.34	234.43	97.38	2.66

Notes: TE (CRS): Technical Efficiency with Constant Returns t

TE (VRS): Technical Efficiency with Variable Returns to Scale.

SE: Scale SE:Efficiency in terms of CRS/VRS.

Source: Authors' calculation from the Private Participation in Infrastructure Database. The World Bank.

Table 4 also shows large differences between Technical Efficiency with VRS values when we compare IDA[12] status groups. Note that the value for the IDA status group (38%) is almost double that of the non-IDA status group.

Table 4. Descriptive statistics by IDA status: Mean values.

IDA Status	TE (CRS)	TE (VRS)	SE	Capacity	Total Investment	Percent Private Funding	Debt Equity Grant Ratio
Blended	0.088	0.298	0.328	93.60	136.94	98.85	2.62
IDA	0.114	0.385	0.355	107.61	132.73	97.86	2.27
Non-IDA	0.070	0.231	0.353	114.98	244.13	97.45	2.69

Source: Authors' calculation from the Private Participation in Infrastructure Database. The World Bank.

In Table 5 we estimate several truncated regression models[13]. Concerning contract awarding methods, we conclude that projects that use direct negotiation have higher technical efficiency with VRS (see models 1-4). The significant positive effects that we found could be related to a reduction in X-Inefficiency. As we will discuss in the next section, this result could be due to the positive relationship between competitive award methods for selecting projects and a reduction in X-Inefficiency measured in terms of technical efficiency.

Finally, we conclude that Renewable Energy projects have lower technical efficiency with VRS (see models 1-4) but higher scale efficiency (see models 5-8). However, the impact of the debt equity grant ratio is the opposite (i.e., lower debt equity grant ratios have a positive and significant effect on technical efficiency with VRS (see models 1-4), and projects with the lowest ratios have a higher scale efficiency. See models 5-8.

[12] Eligibility for IDA support depends first and foremost on a country's poverty level, which is defined by having a GNI per capita below an annually established threshold (in fiscal year 2014: $1,205). Some countries are IDA-eligible based on per capita income levels and are also creditworthy for some IBRD borrowing. They are referred to as "blend" countries.

[13] According to the results of Simar and Wilson (2007:59), it provides better statistical inference than the Tobit regression does.

Table 5. Truncated regression models.

Model	Technical Efficiency VRS (1)	Technical Efficiency VRS (2)	Technical Efficiency VRS (3)	Technical Efficiency VRS (4)	Scale Efficiency RCS/VRS (5)	Scale Efficiency RCS/VRS (6)	Scale Efficiency RCS/VRS (7)	Scale Efficiency RCS/VRS (8)
Variables	Coef./ Std. Err.	Coef./ Std. Err.	Coef./ Std. Err.	Coef./ Std. Err.	Coef./ Std. Err.	Coef./ Std. Err.	Coef./ Std. Err.	Coef./ Std. Err.
Percent Private Funding	0.0017513 0.0021045	.0009925 .0011591	.0010452 .0012392	.0011474 .0012406	.0025372 .0018022	.0018899 .0016659	.0023977 .0018305	.0023841 .0018283
Dummy Award Method: 1 = Direct negotiation	0.1780643*** 0.047732	.2136556*** .0416981	.1662854*** .0361085	.1741172*** .034815	.0757641 .0462875	-.0151909 .0604186	.0675307 .055194	.0675307 .0534088
Dummy Renewable Energy: 1 = yes	-0.3691624*** 0.063281	-.6428261*** .0708779	-.2364492*** .0511583	-.2293151*** .0484644	.1735176** .0769863	.3466035*** .1304278	.1814257** .0942602	.1872042** .0906529
Debt Equity Grant Ratio	-0.03846* 0.0207209	-.0371434*** .012666	-.0183329 .0124551	-.0186099 .0125052	-.0210845 .0178582	-.0093979 .0170997	-.0194824 .0180545	-.0191718 .0180998
Dummy PPP Type: 1= Services contracted by users	-0.0143838 0.1254386	-.0525271 .0809769	.0010151 .0855136	.0026845 .085597	-.0555451 .1300763	-.0144339 .1198243	-.0566756 .1297666	-.0567939 .1297028
Europe and Central Asia		-.3759675*** .0963716				-.0681815 .1639404		
Latin America & the Caribbean		.1297789 .0868762				-.3101472** .1353477		
Middle East and North Africa		-.4323741*** .1021418				-.0076928 .1669298		
South Asia		.1128659* .063365				-.199945* .1023876		
Sub-Saharan Africa		.1162665 .0747708				-.2877411** .1177044		
Lower middle-income			-.5288829*** .1301688				-.0418768*** .1738373	
Upper middle-income			-.5439963*** .124002				-.0591267*** .16283	
Dummy IDA status: 1= IDA				.5457446*** .1265643				.0475083 .1669128
Dummy IDA Status: 2 = Non-IDA				-.0008975 .0324928				-.0183268 .0493967
Cons	0.4440291** 0.2222576	.6818142*** .1338232	.8808117*** .1677498	.3254417** .1409367	-.0783085 .1981535	.0481123 .2008878	-.0231336 .227874	-.069716 .2159973
Sigma	0.1147018*** 0.0170144	.0738534*** .0093942	.0789573*** .0102982	.079073*** .0103085	.1193761*** .0154029	.1091449 .0136786	.1190166*** .0153438	.1189662 *** .0153351
Wald chi2	48.40	152.45	101.19	100.92	10.90	18.74	11.10	11.14
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0535	0.0437	0.1341	0.1328
Log likelihood	36.290377	48.936565	46.68909	46.59774	30.090202	33.157842	30.215518	30.230173
Num. of obs	39	39	39	39	39	39	39	39

Notes:

Limit: lower = 0, upper = 1. Dummy Award Method: variable competitive bidding omitted. Dummy Renewable Energy: variable no renewable energy omitted. Dummy variable PPP type: variable services contracted by the government omitted. Dummy region: region East Asia and Pacific omitted. Dummy IDA status: variable Blended omitted. Dummy income level: variable Low-income omitted. VRS: variable returns to scale.

Source: Authors' calculation from the Private Participation in Infrastructure Database. The World Bank.

4. Conclusion and Policy Implications

Our empirical results show that award methods based on direct negotiation have a positive effect on increasing technical efficiency (or decreasing X -Inefficiency) compared to alternative methods like competitive bidding.

Of course, these are preliminary findings, however, their relevance in terms of policy implications could be significant. A complementary analysis of this issue that considers additional sectors and methodologies to estimate technical efficiency might be useful. A deeper analysis at the micro level of the characteristics of different award methods might be significant.

On the other hand, some authors like Hodges and Dellacha (2007) argue that private proponents consider that governments can avoid unnecessary expenses by skipping a tendering process when they are confident that the original proponent will win or that there will not be any other proposals. Under these circumstances, direct negotiation could theoretically help save the government money. However, considerations in terms of efficiency and cost of this partial analysis might underestimate the cost benefits of competitive bidding.

Acknowledgement

The author (Daniel Sotelsek) of this study would also like to thank the University of Columbia (ILAS), which have provided invaluable discussion forums for the ideas, put forward in this study during his 2013–2014 visiting scholar; the theories defended and any possible errors are the sole responsibility of the authors.

References

Aziz, A. M. (2007). Successful delivery of public-private partnerships for infrastructure development. *Journal of Construction Engineering and Management*, *133*(12), 918-931. http://dx.doi.org/10.1061/(ASCE)0733-9364(2007)133:12(918)

Aschauer, D. A. (1990). Why is infrastructure important?. In Conference Series, pp. 21-68. Federal Reserve Bank of Boston.

Asian Development Bank Staff. (2000). Developing Best Practices for Promoting Private Sector Investment in Infrastructure. Asian Development Bank. Electronic preference formats recommended by www.Artery.org. Retrieved June 2005 from: (http://www.artery.org/AtlanticSteel.htm).

Auriol, E., & Picard, P. (2004). Privatizations in Developing Countries and the Government's Budget Constraint. IDEI – Institut d´ Economie Industrielle

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis, *Management Science*, *30*(9), 1078–1092. http://dx.doi.org/10.1287/mnsc.30.9.1078

Berg, S. V., Pollitt, M. G., & Tsuji, M. (Eds.). (2002). *Private initiatives in infrastructure: Priorities, incentives, and performance*. Edward Elgar Publishing.

Beuve J. et al (2014). Renegotiations, Discretion and Contract Renewals: An Empirical Analysis of Public-Private Agreements, Working Paper EPPP, Sorbonne Business School

Calderon, C., Moral-Benito, E., & Servén, L. (2014). Is infrastructure capital productive? A dynamic heterogeneous approach. Journal of Applied Econometrics.

Charnes, A., Cooper, W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units, *European Journal of Operational Research*, *2*, 429–444. http://dx.doi.org/10.1016/0377-2217(78)90138-8

Cooper, W. W., Park, K. S., & Yu, G. (2001). IDEA (Imprecise Data Envelopment Analysis) with CMDs (Column Maximum Decision Making Units), *Journal of the Operational Research Society*, *52*(2), 176-181. http://dx.doi.org/10.1057/palgrave.jors.2601070

Égert, B., Kozluk, T., & Sutherland, D. (2009). Infrastructure and Growth: Empirical Evidence (No. 685). OECD Publishing. http://dx.doi.org/10.1787/225682848268

Esfahani, H. S., & Ramírez, M. T. (2003). Institutions, infrastructure, and economic growth. *Journal of Development Economics*, *70*(2), 443-477. http://dx.doi.org/10.1016/S0304-3878(02)00105-0

Erdogdu, E. (2011). What happened to efficiency in electricity industries after reforms? *Energy Policy*, *39*(10), 6551-6560. http://dx.doi.org/10.1016/j.enpol.2011.07.059

Farrell, M. J. (1957). The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society, Series A (General)*, *120*(3), 253-290. http://dx.doi.org/10.2307/2343100

Gayle, A. Y., & Trabant, A. (2008). Public-Private Partnerships in Spain: Lessons And Opportunities. *International Business & Economics Research Journal*, *7*(2).

Gramlich, E. M. (1994). Infrastructure investment: a review essay. *Journal of economic literature*, 1176-1196.

Grimsey, D., & Lewis, M. (2002). Accounting for Public Private Partnerships. *Accounting Forum*, *26*, 245-270. http://dx.doi.org/10.1111/1467-6303.00089

Grimsey, D., & Lewis, M. (2004). Public private partnerships: The worldwide revolution in infrastructure provision and project finance. Edward Elgar Publishing. http://dx.doi.org/10.4337/9781845423438

Grimsey, D., & Lewis, M. K. (2004). The Governance of Contractual Relationships in Public-Private Partnerships. *Journal of corporate citizenship*, *15*. http://dx.doi.org/10.9774/GLEAF.4700.2004.au.00010

Irmen, A., & Kuehnel, J. (2009). Productive government expenditure and economic growth. *Journal of Economic Surveys*, *23*(4), 692-733. http://dx.doi.org/10.1111/j.1467-6419.2009.00576.x

Hodges, J. T., & Dellacha, G. (2007). *Unsolicited infrastructure proposals: how some countries introduce competition and transparency* (No. 10718). The World Bank.

Ismail, S. (2013). Critical success factors of public private partnership (PPP) implementation in Malaysia. *Asia-Pacific Journal of Business Administration*, *5*(1), 6-19. http://dx.doi.org/10.1108/17574321311304503

Kwak, Y. H., Chih, Y., & Ibbs, C. W. (2009). Towards a comprehensive understanding of public private partnerships for infrastructure development. *California Management Review*, *51*(2), 51-78. http://dx.doi.org/10.2307/41166480

Leibenstein, H. (1966). Allocative efficiency vs." X-efficiency". *The American Economic Review*, 392-415.

Leibenstein, H., & Maital, S. (1992). Empirical estimation and partitioning of X-inefficiency: a data-envelopment approach. *American Economic Review*, *82*(2), 428-433.

Marques, R. C., & Berg, S. (2010). Revisiting the strengths and limitations of regulatory contracts in infrastructure industries. *Journal of Infrastructure Systems*, *16*(4), 334-342. http://dx.doi.org/10.1061/(ASCE)IS.1943-555X.0000029

Ogunsanmi, E. (2016). Critical success factors (CSF) determining the implementation of public-private partnership projects. *Covenant Journal of Research in the Built Environment*, *1*(2).

Romp, W., & De Haan, J. (2007). Public capital and economic growth: A critical survey. *Perspektiven der Wirtschaftspolitik*, *8*(S1), 6-52. http://dx.doi.org/10.1111/j.1468-2516.2007.00242.x

Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of econometrics*, *136*(1), 31-64. http://dx.doi.org/10.1016/j.jeconom.2005.07.009

UE (2004). Green Paper: On Public-Private Partnerships and Community Law on Public Contracts And Concessions. Retrive from: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV%3Al22012

Vining, A. R., & Boardman, A. E. (2008a). Public—Private Partnerships Eight Rules for Governments. *Public Works Management & Policy*, *13*(2), 149-161. http://dx.doi.org/10.1177/1087724X08323843

Vining, A. R., & Boardman, A. E. (2008b). Public - private partnerships in Canada: Theory and evidence. *Canadian public administration*, *51*(1), 9-44. http://dx.doi.org/10.1111/j.1754-7121.2008.00003.x

Yuan, J., Zeng, A. Y., Skibniewski, M. J., & Li, Q. (2009). Selection of performance objectives and key performance indicators in public–private partnership projects to achieve value for money. *Construction Management and Economics*, *27*(3), 253-270. http://dx.doi.org/10.1080/01446190902748705

Zhang, X. (2005). Criteria for selecting the private-sector partner in public–private partnerships. *Journal of construction engineering and management*, *131*(6), 631-644. http://dx.doi.org/10.1061/(ASCE)0733-9364(2005)131:6(631)

Zhao, Z. Y., Zuo, J., Zillante, G., & Wang, X. W. (2010). Critical success factors for BOT electric power projects in China: thermal power versus wind power. *Renewable Energy*, *35*(6), 1283-1291. http://dx.doi.org/10.1016/j.renene.2009.09.016

Statistical Appendix

Technical Efficiency with VRS.

The original DEA estimator proposed by Charnes, Cooper, and Rhodes (1978), referred to as the CCR formulation, allows for the efficiency of any Decision Making Unit (DMU) to be measured from the maximization of a ratio of weighted outputs with respect to weighted inputs, subject to the restriction that similar ratios for the rest of the DMUs are less than or equal to the unit.

Let $X_i$be the vector of inputs into the i^{th} DMU. Let Y_I be the corresponding vector of outputs. Let X_0 be the inputs into a DMU whose efficiency we wish to determine, and let X_0 be the outputs. So, the X's and the Y's are the data. The measure of efficiency for DMU_0 is given by the following linear program:

$$\min \theta_0 \qquad (1)$$

Subject to:

$$\sum \lambda_i X_i \le \theta X_0 \qquad (2)$$

$$\sum \lambda_i X_i \ge Y_0 \qquad (3)$$

$$\lambda \ge 0 \qquad (4)$$

where λ_i is the weight given to the i[th] DMU in its ability to affect DMU_0 and θ is the efficiency of DMU_0. So, the λ's and θ's are the variables. Since DMU_0 appears on the left hand side of the equations as well, the optimal θ cannot possibly be more than 1. When we solve this linear program, we find a number of things:

i. the efficiency of DMU_0 (θ), with θ = 1 meaning that the unit is completely efficient;

ii. the unit's "comparables" (those DMU with a nonzero λ);

iii. the "goal" inputs (the difference between X_0 and $\sum \lambda_i X_i$); and alternatively

iv. we can keep inputs fixed and get goal outputs . $(\frac{1}{\theta}\sum \lambda_i X_i)$

The measurement of technical efficiency calculated by the Banker, Charnes, and Cooper (1984) formula (referred to hereafter as BCC efficiency) makes it possible to find out whether there is proper use of resources in relation to the production of goods or services of the DMU analyzed. As for scale efficiency, it is equal to the quotient of BCC efficiency and CCR efficiency, and provides a measurement of the distance from the analyzed DMU to a virtual DMU that operates with the most productive scale size (MPSS).

For this purpose, these authors suggest a single difference between the envelopment of the BCC and the CCR formulations: the inclusion of the restriction of convexity (relating to the k[th] DMU): $\sum_{j=1}^{n} \lambda_{jk} = 1$.

Table A1. Basic statistics: all sample.

Variable	Obs	Mean	Std. Dev.	Min	Max
Technical Efficiency (CRS)	209	0.079	0.081	0.004	1.000
Technical Efficiency (VRS)	209	0.263	0.189	0.019	1.000
Scale Efficiency (CRS/VRS)	209	0.347	0.197	0.102	1.000
Capacity (output)	209	108.92	220.75	1.00	1820.00
Total Investment (input)	209	206.26	345.65	1.20	2211.00
Percent Private Funding	209	97.84	8.94	41.00	100.00
Debt Equity Grant Ratio	87	2.62	0.99	0.67	7.33

Notes:

CRS: Constant Return Scale; VRS: Variable Return Scale.

Source: Authors' calculation from the Private Participation in Infrastructure Database. The World Bank.

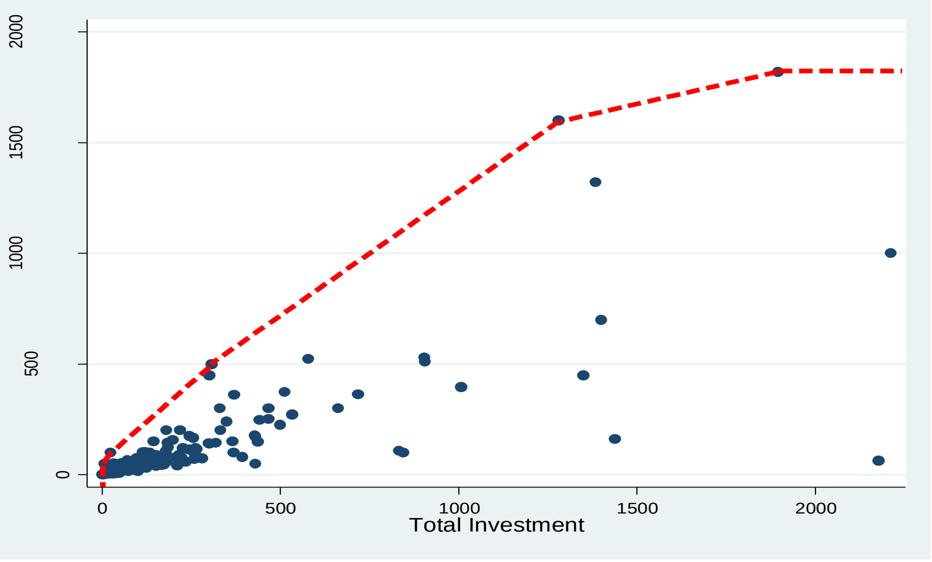

Figure A1. Efficiency Frontier output oriented.

Source: Authors' creation from the Private Participation in Infrastructure Database. The World Bank

Table A2. Descriptive statistics by country: Mean values.

Country	Number of Projects	TE (CRS)	TE (VRS)	SE	Capacity	Total Investment	Percent Private Funding	Debt Equity Grant Ratio
Albania	6	0.119	0.172	0.701	9.12	9.77	100.00	
Argentina	4	0.048	0.199	0.243	56.25	145.75	100.00	2.10
Bangladesh	7	0.193	0.617	0.307	226.14	203.29	100.00	1.72
Bosnia and Herzegovina	1	0.056	0.333	0.169	300.00	661.90	100.00	1.94
Brazil	25	0.106	0.359	0.266	198.84	310.30	94.64	2.09
Bulgaria	8	0.039	0.082	0.588	13.46	46.23	100.00	2.23
Chile	6	0.062	0.198	0.358	53.22	118.50	100.00	
China	14	0.080	0.205	0.375	27.14	51.28	100.00	2.61
India	38	0.092	0.320	0.318	103.47	133.67	100.00	2.54
Indonesia	3	0.048	0.149	0.410	33.07	96.00	100.00	3.17
Jordan	1	0.085	0.438	0.194	240.00	350.00	100.00	3.35
Kenya	2	0.085	0.351	0.241	85.00	126.00	100.00	2.92
Lao PDR	2	0.083	0.333	0.237	119.50	250.71	92.50	
Malaysia	3	0.050	0.247	0.364	339.83	754.73	86.67	4.00
Mexico	2	0.053	0.294	0.179	270.00	663.00	100.00	2.33
Mongolia	1	0.052	0.212	0.244	50.00	120.00	75.00	2.33
Morocco	3	0.052	0.321	0.157	386.67	1101.67	91.67	2.67
Nepal	1	0.057	0.275	0.206	120.00	262.90	100.00	1.94
Nicaragua	2	0.046	0.130	0.443	24.50	65.00	100.00	2.41
Pakistan	9	0.066	0.232	0.290	57.21	134.54	93.33	3.24
Peru	3	0.056	0.332	0.179	360.00	673.00	100.00	3.29
Philippines	3	0.083	0.291	0.350	161.00	317.63	100.00	2.33
Romania	7	0.053	0.236	0.254	100.41	211.47	100.00	2.42
Russian Federation	1	0.023	0.035	0.662	2.40	13.00	100.00	
Serbia	2	0.041	0.046	0.905	1.60	5.70	100.00	4.00
South Africa	18	0.038	0.161	0.251	59.78	226.89	91.78	2.74
Sri Lanka	5	0.092	0.305	0.519	6.94	12.80	99.00	
Thailand	9	0.086	0.259	0.476	194.44	169.49	100.00	
Turkey	11	0.079	0.275	0.320	107.05	234.61	100.00	2.07
Uganda	1	0.051	0.122	0.418	14.00	34.00	100.00	2.03
Ukraine	5	0.048	0.123	0.436	26.24	96.44	100.00	
Uruguay	2	0.024	0.111	0.168	57.35	1160.50	100.00	
Vietnam	4	0.106	0.223	0.547	30.15	42.20	100.00	2.52

Source: Authors' calculation from the Private Participation in Infrastructure Database. The World