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Transaction Costs in PPP Transport Infrastructure Projects: Comparing Procurement Procedures

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Empirical evidence: quantitative analysis of transaction costs in PPP transport infrastructure projects

Antonio Sánchez Soliño

Associate Professor. Universidad Politécnica de Madrid

Pilar Gago de Santos

Researcher. Universidad Politécnica de Madrid

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EMPIRICAL EVIDENCE: QUANTITATIVE ANALYSIS OF TRANSACTION COSTS IN PPP TRANSPORT INFRASTRUCTURE PROJECTS

1 Methodology

The study of transaction costs carried out in this paper restricts its scope to transport infrastructure projects under a PPP contract. For the analysis of the variables determining transaction costs, a multiple regression model has been used. Diverse explanatory variables, including the procurement procedure, have been introduced, as described below. The latter, as a qualitative or categorical variable, has been introduced as a dummy variable, in a model described as follows:

$$Y_i = \beta_1 + \beta_2 X_i + \sum_{k=1}^{m} \beta_k Z_{ki} + \varepsilon_i$$

Equation 1

where:

- Y_i : (natural logarithm of) transaction costs in project i
- β_1, β_2, β_k are the coefficients to be determined
- X_i = 1 for negotiated procedure
- X_i = 0 for open competition procedure
- Z_{ki} represents other features of project i (capital value, type of project, etc.)
- ε_i is an error term

Using this model, we will test the null hypothesis $H_0 : \beta_2 = 0$. If we can reject H_0 at a certain significance level, then we will be able to state that there is a relationship between the procurement procedure used to launch the project and the transaction costs involved. Also, we will analyze other possible determinants of transaction costs, testing the significance of parameters β.

Transaction costs considered in this paper are restricted to the stage of project preparation and bidding, leaving aside the transaction costs incurred during the contract, due to the impossibility of resorting to a database which includes transaction costs that arise during a contract's life-cycle.

To specify the model, no theory yet exists that would allow us to identify *a priori* the factors determining the transaction costs in PPP contracts. Therefore, the study is conducted by taking into account the empirical formulation used in previous studies (Dudkin and Välilä, 2005; NAO, 2007), adding the procurement procedure as an explanatory variable.

Our first step has been to identify the variables to be introduced in the model, namely:

- Procurement procedure
- Capital value
- Type of infrastructure
- Number of bidders

The procurement procedure variable has already been described. The definitions of an Open procedure and a Negotiated procedure are those given by the European Union (2004). The capital value refers to the initial capital expenditure (VAT not included) required for the project and not just the construction costs. With regard to the type of infrastructure, always in the field of transport infrastructure, a distinction has been made between road and railway projects. To include this piece of information in the model, another dummy variable has been inserted. The

number of bidders refers to the 'Invitation to Tender' stage (that is to say, after the pre-qualification stage, whenever that stage applies).

Other variables have also been taken into consideration, such as the country where the project takes place and the amount of time consumed in the bidding stage, both potential determinants of transaction costs. Notwithstanding these variables show a clear linear dependence on the procurement procedure variable. In the case of country variables, the dependence between the variable representing the procurement procedure and the dummy variables representing the countries arises because, in almost every case, each country uses only one of the two procurement procedures. In the case of the procurement time, measured as the number of months required to put the procurement procedure in place, there is also a high correlation with the procurement procedure itself. In Negotiated procedure, the average time of the procurement phase in our sample is 23 months, while Open competition procedure averages near 6 months, showing low dispersion to the mean, especially in the case of Open competition.

Due to the collinearity problem, both countries and procurement time variables have been disregarded as explanatory variables in the model. Notwithstanding, an additional analysis has also been carried out including these variables and eliminating the procurement procedure variable in the model (see annex).

The regression adjustment has been calculated by means of Ordinary Least Squares (OLS), analyzing the significance of the outcome by means of an F-test. To analyze the significance of every single variable, the t-statistic of the β-coefficient for each case has been used. Finally, robustness and diagnostics tests have been carried out, as explained later on.

2 Input data

The project sample has been built in accordance with the following criteria:

- Transport infrastructure projects
- Enacted under a PPP contract
- Developed in an EU member state

With regard to the type of infrastructure, the study contains both road and railway projects. Among the latter, mostly all are urban railways. Airport or other transport infrastructure projects have not been taken into account, due to the non-availability of the required data. The lion's share of the sample refers to greenfield projects, although upgrading and maintenance of already existing infrastructure have not been excluded. The study focuses on the EU member countries since their procurement procedures are given under the common legal framework stemming from EU Directives, as already explained.

As far as the demand for dealing only with PPP projects is concerned, the main snag is the absence of a consensus view regarding the definition of a PPP. Actually, the concept of a PPP scheme differs from one country to another. Nevertheless, a comprehensive definition of the main characteristics of PPPs can be found in the Green Paper on Public-Private Partnerships and Community Law on Public Contracts and Concessions (Commission of the European Communities 2004). For the European Commission, the elements that normally characterise PPPs are the following:

- The relatively long duration of the relationship, involving cooperation between the public partner and the private partner on different aspects of a planned project.

- The method of funding the project, in part from the private sector, sometimes by means of complex arrangements between the various players.
- The important role of the economic operator, who participates at different stages in the project (design, completion, implementation, funding). The public partner concentrates primarily on defining the objectives to be attained in terms of public interest, quality of services provided and pricing policy, and it takes responsibility for monitoring compliance with these objectives.
- The distribution of risks between the public partner and the private partner. The precise distribution of risks is determined case by case, according to the respective ability of the parties concerned to assess, control, and cope with the risk.

The criterion regarding the distribution of risks has been applied in a broad way. Thus, for instance, in a toll road under a traditional concession scheme in which clearly the majority of risks are allocated to the private partner, we must consider that, generally speaking, the public sector will usually assume certain risks not transferred to the private sector ('force majeure' risks, for example). In this sense, we consider traditional concession schemes to be a form of PPP agreement. Likewise, in some PFI road projects in the UK, the respective investment has been re-classified for the years 2000-2001, appearing now on the Government balance sheet, perhaps attributable to the fact that insufficient risk had been transferred to the private sector (Edwards, P *et al.*, 2004). In principle, such a modification should not invalidate those projects from being regarded as PPPs, provided that at least a part of the risk (though not the lion's share) is undertaken by the private sector.

Once these criteria have been met, required data availability was our only additional criterion for including a project in the sample. Such project data include: name and brief project description; country where the project is developed; procurement procedure; time consumed at the bidding stage (defined as the period beginning with the announcement of bidding in the Official Journal of

the European Union and ending with contract signature); capital value; number of bidders; and transaction costs in the preparation and bidding of the project (cost breakdowns explained later).

Among all this information, data on the transaction costs are, logically, the most difficult to obtain and have thus determined our final sample size, bearing in mind moreover that the total number of transport infrastructure projects carried out in Europe through a PPP has been limited.

Our research distinguishes between transaction costs borne by the public and by the private sector, given that data availability was different in each case. Thus, transaction-cost data for both sectors does not refer to the same set of projects. In a nutshell, two different samples have been taken into consideration. On the one hand, a sample for the transaction costs borne by the public sector, and on the other, a sample embracing transaction costs borne by the private sector, carrying out the adjustment of two different models, though the explanatory variables have been the same in both cases.

Transaction costs have been allocated to the sector bearing them, no matter which sector pays them in the end. For instance, should a public authority in a given case agree to reimburse bidders for costs incurred while preparing their tenders, such costs would be allocated to the private sector anyway.

In any case, the research tried to gain access to transaction costs accrued in every stage of the tendering process. Hence, for the public sector, a breakdown between the project preparation costs (preliminary studies, including Environmental Impact Assessment; feasibility study; preliminary design) and its own bidding costs (tender documentation preparation; negotiation costs) was considered. At the same time, our goal was to distinguish, at every stage, between external costs (such as technical, legal and financial advice) and in-house costs.

Regarding the transaction costs assumed by the private sector, data inserted in the model refer to transaction costs borne by the winning bidder, also subject to cost breakdown, insofar as possible, between different tendering stages. In each stage, a distinction is also made between external costs (technical, legal and financial advice, and others) and in-house costs, as well as success fees, when applicable.

A complete cost breakdown has not been possible in most cases, but the approach has nonetheless served to guide our task of data collection in order to homogenise the requested data, detailing the transaction costs under consideration.

Regarding the sources on public sector data, the paper considers already published data as well as direct sources. Published information on transaction costs in individual transport infrastructure projects is scarce. A few publications of the National Audit Office refer to projects carried out in the UK (NAO, 1997; NAO, 1998; NAO, 1999 and NAO, 2004), while relevant data for some particular road projects in the UK have been obtained from Debande (2001). The remaining data on transaction costs for the public sector have been drawn from personal interviews with staff of the respective public authorities, in some cases via e-mail.

As a whole, data on transaction costs for the public sector have been collected for 25 projects across three different EU countries (the UK, Spain, and Austria). In some cases, not just one project but a package of projects were tendered almost simultaneously, explaining why they are here treated as one project; hence, the number of sample observations has been reduced to 18. Of these, 6 refer to railway projects and 12 to roads. As regards the procurement procedure, 8 have been enacted by a Negotiated procedure and 10 by an Open competition procedure. The average capital value of the projects is €380 million for the public sector sample.

With regard to data on transaction costs for the private sector, information was received in most cases by means of personal interviews with CEOs of firms involved in the projects under analysis.

In this context, data have been collected for a sample of 44 projects corresponding to five countries (Ireland, Portugal, the UK, Spain, and the Netherlands). In some cases, we have dealt with a package of projects tendered almost simultaneously and where the bidders were identical in all projects; therefore they have been considered collectively as one project. In this sense, the sample number of observations has been 35, of which 5 correspond to railway projects and 30 to roads. As regards the procurement procedure, 21 correspond to Negotiated procedure and 14 to Open competition procedure. The average capital value of the projects is €485 million for the private sector sample.

3 Results

As stressed previously, the model used, given by **Equation 1**, has been applied separately to transaction costs for the public and private sectors. Results achieved are also studied separately in this section.

a) Transaction costs for the public sector

The regression analysis carried out for public sector data shows that (the natural logarithm of) transaction costs for the public authority in the procurement phase of PPP projects are explained by the type of project, (the natural logarithm of) the capital value of the project, and the procurement procedure, as significant variables. Table 1 summarises the results obtained for this model, where transaction costs and capital value are measured in millions of euros.

Table 1. Public sector model. Results of the regression analysis.

Variable	**Coefficient β**	**Standard error**	**t-statistic**
Intercept	-1.6196	0.3908	-4.1441
Procurement procedure	1.1367	0.1321	8.6061
Capital value	0.4721	0.0652	7.2434
Infrastructure type	-0.5874	0.1401	-4.1917

Number of variables (including intercept) = 4

Number of observations = 18

R Squared = 0.9092

Adjusted R Squared = 0.8897

F = 46.7082

Out of these results, the good adjustment of the model should be highlighted first. The F test carried out shows the significance of the determination coefficient (R Squared).

Regarding the analysis of the individual variables, it should be pointed out that the negative sign of the coefficient for the 'infrastructure type' variable means that transaction costs are lower for road projects than for railway projects. This variable was put into the model as a dummy, with a value equal to 1 for roads and to 0 for railways. This result can be explained by considering that railway projects may require more complex preparation. Indeed, although civil works usually imply a similar degree of complexity in both types of projects, installations are much more complex in railroad projects. On the other hand, in most railway PPP projects, the operation of the transport

service is included in the contract, so the specification of the output in the operating phase is much more complex than in road projects.

The sign of the coefficient corresponding to the logarithm of capital value is positive, as we could have foreseen, reflecting that transaction costs are related to the size of the project. However, it is interesting to note that in this model the coefficient of the capital value variable has a specific meaning, representing the elasticity of transaction costs on the capital value of the project. In this case, the value of the coefficient is well below 1: this fact reflects the existence of important economies of scale in the preparation and bidding of projects. Thus, tendering a PPP contract requires a quantity of resources justified only in projects of a certain minimum size (and upwards). This outcome is coherent, for instance, with the guidelines of the British Treasury, which exclude the use of the Private Finance Initiative (PFI) for those projects with a capital value under 20 million pounds sterling (NAO, 2007).

The positive sign of the coefficient of the "public procedure" variable reflects higher transaction costs in projects undertaken via Negotiated procedure. This is a significant outcome. In our sample, the average value for transaction costs under Open procedure is 0.92% of capital value, while the average value for projects tendered under Negotiated procedure is 2.54%.

A robustness and diagnostic testing of this model has been carried out. For the robustness analysis, the regression was run for the following sub-samples:

1) Only projects whose capital value was not below 80 million euros or above 600 million euros were included in the analysis (sub-sample 1).

2) Only those projects with the value of the dependent variable within 1.5 standard deviations from the sample mean were included in the analysis (sub-sample 2).

For the diagnostic testing, the Jarque-Bera test was used to verify the normality of residuals, and the White test was used to verify the homoscedasticity hypothesis. The results are as follows:

Table 2. Public sector model. Robustness and diagnostic testing.

		Coefficients			
	Number of observations	**Procurement procedure**	**Ln Capital value**	**Infrastructure type**	**R^2 adjusted**
Full sample	18	1.1367	0.4721	-0.5874	0.8897
Sub-sample 1	12	1.0705	0.4119	-0.5934	0.8717
Sub-sample 2	17	1.0827	0.4382	-0.6237	0.8831

	Jarque-Bera statistic	**White statistic**
Full sample	0.8021	10.4015
Sub-sample 1	0.8509	6.6806
Sub-sample 2	0.8168	11.1230

Table 2 shows that, in the first place, the parameters obtained in the regression analysis are robust. In particular, the parameter for the "procurement procedure" variable is within the rank [1.07/1.14]. Secondly, the values obtained for the Jarque-Bera test confirm that we cannot reject the hypothesis of normality of the residuals at a 5% significance level. Similarly, according to the results obtained for the White test, we cannot reject the hypothesis of homocedasticity at a 5% significance level.

Using this model, we could estimate, for example, the transaction costs to the public sector in the case of a PPP road project of medium capital value (€200 million). Transaction costs would be €1.34 million for the Open procedure (0.67% on capital value) and €4.18 million for the Negotiated procedure (2.09% on capital value). In the case of a railway project with the same capital value, we would obtain €2.41 million (1.20% on capital value) for the Open procedure and €7.52 million (3.76% on capital value) for the Negotiated procedure.

b. Transaction costs for the private partner

The analysis undertaken for transaction costs for the private partner is similar to that used for the public sector. Initially, the same independent variables were taken into consideration: procurement procedure, capital value, type of infrastructure, and number of bidders. Notwithstanding, in this case both the type of infrastructure and the number of bidders were disregarded as explanatory variables, because they were not significant in the regression analysis. Therefore, the type of infrastructure appears as an explanatory variable for transaction costs to the public sector, but not to the private partner. An explanation for this result might be that the type of infrastructure has an impact on the preparation costs of the project (feasibility study and so on), but not on costs during the bidding phase.

Therefore, the final model is the one that contains as explanatory variables only the capital value and the procurement procedure, yielding the following results:

Table 3. Private partner model. Results of the regression analysis.

Variable	Coefficient β	Standard error	t-statistic
Intercept	-2.5356	0.6291	-4.0304
Procurement procedure	1.6576	0.1796	9.2307
Capital value	0.4946	0.1048	4.7208

Number of variables (including intercept) = 3

Number of observations = 35

R Squared = 0.7757

Adjusted R Squared = 0.7617

F = 55.3479

As we may observe, the adjustment is slightly worse than in the case of the public sector. Nonetheless, the high value of the t-statistic shows the significance of the variables in the model.

The elasticity of transaction costs on the capital value of the project has a very similar value to that obtained in the public sector model, and it is well below 1. This means that economies of scale are also important for the private partner.

On the other hand, the positive sign of the coefficient of the 'procurement procedure' variable reflects, again, higher transaction costs in projects undertaken by the Negotiated procedure, as in the public sector model. In our sample, the average value for transaction costs for the winning bidder is 0.46% of capital value when the Open procedure is applied, while under the Negotiated

procedure this average value is 2.74% for projects tendered. Therefore, the differences between the two procedures are greater than in the case of transaction costs for the public sector.

The results of the robustness and diagnostic testing of this model are shown in **table 4**. The definition of the sub-samples for the robustness analysis is the same as in the public sector model.

Table 4. Private partner model. Robustness and diagnostic testing.

		Coefficients		
	Number of observations	**Procurement procedure**	**Ln Capital value**	**R^2 adjusted**
Full sample	35	1.6576	0.4946	0.7617
Sub-sample 1	21	1.5801	0.4067	0.6826
Sub-sample 2	30	1.4628	0.3209	0.6663

	Jarque-Bera statistic	**White statistic**
Full sample	0.1124	11.5861
Sub-sample 1	0.6279	8.9921

Sub-sample 2	0.4657	10.4329

As it can be observed, the parameters obtained in the regression analysis are robust, especially for the procurement procedure. The parameter for this variable is within the rank [1.46/1.66], slightly wider than in the public sector model. Regarding the diagnostic testing, the values obtained for the Jarque-Bera test show again that we cannot reject the hypothesis of normality of the residuals at a 5% significance level. Similarly, according to the results obtained for the White test, we cannot reject the hypothesis of homocedasticity at a 5% significance level.

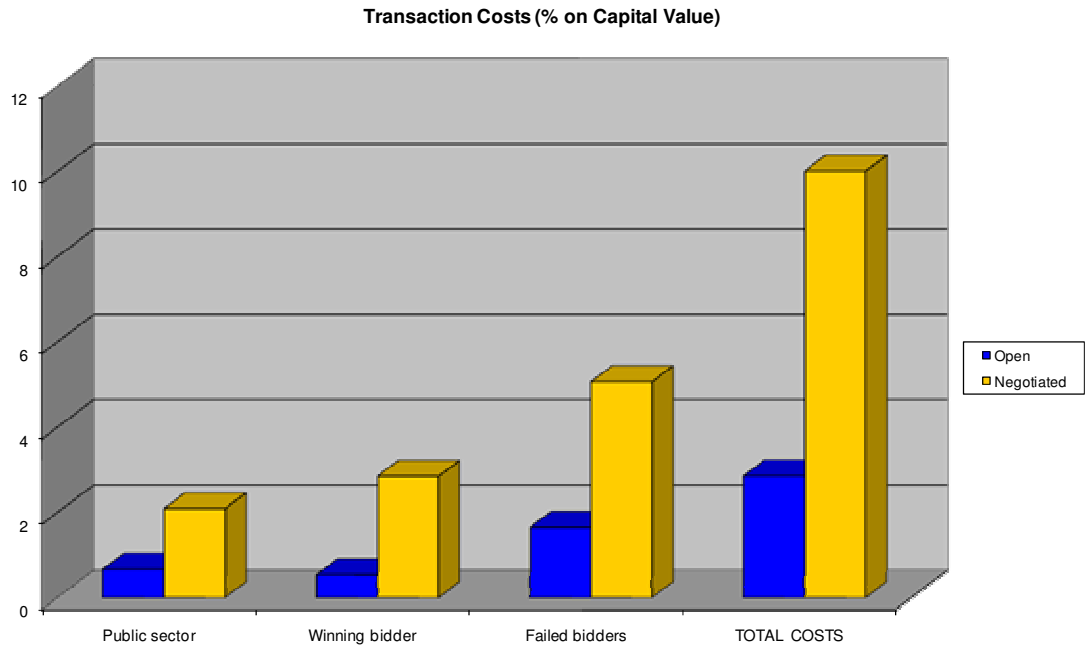
Again, we could use this model to estimate, for example, the transaction costs to the private partner in a PPP road or railway project of medium capital value (€200 million). Transaction costs would be €1.09 million for the Open procedure (0.54% on capital value) and €5.71 million for the Negotiated procedure (2.85% on capital value).

Finally, we have estimated overall transaction costs in the tendering process of PPP transport infrastructure projects, taking into account the average number of bidders in each procurement procedure. First, we have estimated that transaction costs for each failed bidder are, on average, 48% of transaction costs for the winning bidder. This estimation is based on the separation of different transaction costs for the winning bidder, taking into account that some of these costs (negotiation costs for the preferred bidder, success fees) are not applicable in the case of a failed bidder. Then we have calculated the average number of bidders, which is equal to 7.3 in the case of the Open procedure, and 4.7 in the case of the Negotiated procedure.

Applying our model, overall transaction costs are, for a medium size (€ 200 million capital value) road project, equal to € 5.73 million (2.86% on capital value) in the Open procedure and € 20.03

million (10.01% on capital value) in the Negotiated procedure. The distribution of these costs is represented in figure 1.

Figure 1. Distribution of transaction costs in road PPPs.



Source: Authors' estimates

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ANNEX

Table A.1. Public sector model with country variables.

Variable	Coefficient β	Standard error	t-statistic
Intercept	-0.3579	0.5638	-0.6349
UK	-0.2153	0.3086	-0.6978
Spain	-1.2967	0.3253	-3.9855
Capital value	0.5341	0.0681	7.8387
Infrastructure type	-0.6988	0.1768	-3.9527
Number of bidders	-0.0277	0.0291	-0.9499

Number of variables (including intercept) = 6

Number of observations = 18

R Squared = 0.9299

Adjusted R Squared = 0.9008

F = 31.8815

Table A.2. Private sector model with country variables.

Variable	Coefficient β	Standard error	t-statistic
Intercept	-0.7920	0.6760	-1.1715
Spain	-1.3206	0.4323	-3.0546
UK	0.5175	0.4263	1.2139
Portugal	0.6457	0.4398	1.4681
Ireland	-0.0177	0.4268	-0.0415
Capital value	0.4260	0.1209	3.5228
Infrastructure type	-0.1050	0.3015	-0.3481
Number of bidders	0.0128	0.0317	0.4032

Number of variables (including intercept) = 8

Number of observations = 35

R Squared = 0.8349

Adjusted R Squared = 0.7921

F = 19.5107

Table A.3. Public sector model with procurement time variable.

Variable	Coefficient β	Standard error	t-statistic
Intercept	-2.1008	0.5911	-3.5540
Procurement time	0.4933	0.1296	3.8065
Capital value	0.5032	0.0825	6.0936
Infrastructure type	-0.3595	0.2027	-1.7733
Number of bidders	-0.0819	0.0330	-2.4783

Number of variables (including intercept) = 5

Number of observations = 18

R Squared = 0.8665

Adjusted R Squared = 0.8255

F = 21.1059

Table A.4. Public sector model without procurement procedure and without country variables.

Variable	Coefficient β	Standard error	t-statistic
Intercept	-0.8606	0.6911	-1.2452
Capital value	0.5184	0.1156	4.4858
Infrastructure type	-0.0520	0.2605	-0.1994
Number of bidders	-0.1487	0.0392	-3.7881

Number of variables (including intercept) = 4

Number of observations = 18

R Squared = 0.7178

Adjusted R Squared = 0.6573

F = 11.8718

Table A.5. Private sector model without procurement procedure and without country variables.

Variable	Coefficient β	Standard error	t-statistic
Intercept	-2.1162	1.0471	-2.0209
Capital value	0.5279	0.1726	3.0593
Infrastructure type	1.2258	0.4167	2.9417
Number of bidders	-0.1175	0.04572	-2.5699

Number of variables (including intercept) = 4

Number of observations = 35

R Squared = 0.4241

Adjusted R Squared = 0.3684

F = 7.6113