Transaction costs in public-private partnerships: a first look at the evidence

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Published on: 01 Jun 2006 - Competition and regulation in network industries (SAGE PublicationsSage UK: London, England)

Topics: Transaction cost, Public–private partnership and Procurement

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Working Paper

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Economic and Financial Report, No. 2005/03

Provided in Cooperation with:
European Investment Bank (EIB), Luxembourg

European Investment Bank

Economic and Financial Report 2005/03

TRANSACTION COSTS IN PUBLIC-PRIVATE PARTNERSHIPS: A FIRST LOOK AT THE EVIDENCE

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JEL Classification codes: H54, L33, C14

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Transaction Costs in Public-Private Partnerships: A First Look at the Evidence

Abstract:

This paper presents the results of one of the first systematic analyses of the magnitude and determinants of transaction costs in public-private partnerships (PPPs). Given limited data availability, the analysis is confined to procurement-phase costs of bidding and contract negotiation, thus excluding costs related to contract monitoring and renegotiation in the operational phase. Notably, no attempt is made to compare transaction costs in PPPs to those in traditional public procurement of investment projects, nor to compare them to cost savings achieved through PPPs. Even so, some interesting results emerge. As regards the level of transaction costs in the procurement phase, it is estimated that the total costs amount on average to well over 10 percent of the capital value of the project. Transaction costs to the public sector and the winning bidder vary between countries (legal systems) and sectors, and they are significantly higher in small projects (below £25 million) and in projects that take long (over 50 months) to procure. In contrast, neither experience in setting up partnerships nor the number of bidders affect the costs to the public sector and the winning bidder.

1. Introduction

At a decade and a half, public-private partnerships (PPPs) are old enough for both economic theory and empirical investigation to have tackled most key economic and financial issues that are associated with them (see the EIB Papers, 2005, for an overview). Most notably, the theoretical analysis of why and under what conditions PPPs may be superior to traditional public procurement of investment projects in terms of productive efficiency has been established in the framework of the theory of incomplete contracts (see Välilä, 2005, for an overview). Also, with an increasing number of PPP projects in operation, it has been possible to quantify some of the cost savings that can be achieved through PPPs, at least in the procurement phase of the project (Leahy, 2005).

However, one issue that has not received much attention so far concerns transaction costs in PPPs. Transaction costs in this context refer to the costs of establishing and maintaining a partnership; more specifically, they encompass legal, financial, and technical advisory costs incurred by both public and private sectors in the procurement and operational phases of a project. Costs for organising the bidding process; participating in it; negotiating the contract between the public sector and the winning bidder; monitoring the private sector partner's compliance with the contract and also renegotiating the contract during its life-cycle would all be included among transaction costs.

While there is widespread perception among practitioners and academics alike that PPPs are associated with "high" transaction costs, to the best of our knowledge, no systematic study has yet been undertaken to quantify such costs and to analyse their determinants. The National Audit Office (NAO) in the UK provides anecdotal evidence of high transaction costs in many of its reports (see, for example, NAO, 2003 and 2004), as does the Public Accounts Committee (PAC) of the House of Commons in the UK (PAC, 2003). Indeed, a project size of at least £20 million is considered necessary for a PPP to be a viable option in the UK (HM Treasury, 2003). Torres and Pina (2001) report some evidence related to the US, noting that it has been reported that the monitoring of the performance of the private sector partner in PPP type of arrangements entails extra costs anywhere between 3 and 25 percent of the contract value. As a consequence, it has been recommended in the US context that monitoring costs of 10 percent of the contract value be budgeted in such arrangements.

Against this background, the aim of this paper is to offer the first systematic assessment of the magnitude and determinants of transaction costs in PPPs. Conversely, this paper does not attempt to compare transaction costs in PPPs to those in traditionally procured public investment projects. Neither does it attempt to contrast transaction costs with the cost savings that PPPs can, under certain circumstances, generate. Both these important topics are for future research to address.

Following a brief discussion of why one would expect transaction costs in PPPs to exceed those in traditionally procured public investment projects in Section 2, the data material used in this study is described in Section 3, and the empirical methodologies employed are explained in Section 4. Section 5 reports the results concerning the magnitude of transaction costs in PPPs. Section 6 turns the focus on the determinants of the transaction costs, and Section 7 summarises and concludes.

2. Transaction costs in PPPs: some theoretical considerations

There are several reasons why transaction costs in PPPs would be high, especially compared to traditional procurement of public investment projects. The main sources of higher transaction costs in PPPs are their long-term character, ownership and financing structures, and risk-sharing features. Due to all these reasons, the degree of contractual incompleteness is high in the case of PPPs, and attempts to reduce that contractual incompleteness give rise to correspondingly high transaction costs. Consequently, the search (tendering and bidding), contracting, and monitoring processes become more resource-consuming than in traditional short-term contracting aimed to supply assets, rather than services, to the public sector. Negotiating the contract is especially costly, not least due to the high cost of advisory services, and such costs are not limited to the pre-delivery phase, as renegotiation is almost inevitable in contracts that stretch over decades.

Apart from the direct costs related to tendering, contract negotiation, and monitoring, Domberger and Jensen (1997) emphasise that the long contract period gives also rise to economic costs indirectly. The enforcement of a long-term contract can be difficult because the threat of contract termination can only be used if the public sector is committed to buying the asset at fair value in case of termination; otherwise, expropriation risk would need to be factored into project costs. This cost is obviously the less important the smaller and less specific is the initial investment in the underlying asset. In addition, a long contract period lessens the disciplining power of *ex ante* competition, and it increases the likelihood of costly contract renegotiation.

Also, that a PPP is established for service provision using privately owned assets might entail higher monitoring costs than in-house provision of the same service. The provision of most services is relatively difficult to measure and monitor, especially in terms of quality. While in-house provision, too, necessitates quality control, it can be argued that private asset ownership implies higher monitoring costs for the public sector. After all, if the asset were in public ownership the public sector could always ensure the desired service quality, while private ownership can jeopardise service quality due to excessive investment in productive efficiency. It is therefore more costly to maintain the desired service quality under private asset ownership.

The high transaction costs can have the potential to erode the cost savings achieved through a PPP structure. Apart from their direct negative impact on the financial and economic viability of the project, the high cost of bidding constitutes an obvious hurdle for potential bidders to enter the bidding process. This, in turn, undermines the power of *ex ante* competition, which is in many infrastructure and public service sectors the only form of competition that can exist. The inability to harness the power of *ex ante* competition to support the quest for productive efficiency will, in turn, deter the creation of value for money through a PPP. Besides, as auction theory demonstrates, the design of the bidding process so as to avoid inefficiencies due to collusion or opportunistic behavior is difficult in general and in the case of long-term contracts in particular.

3. Description of data

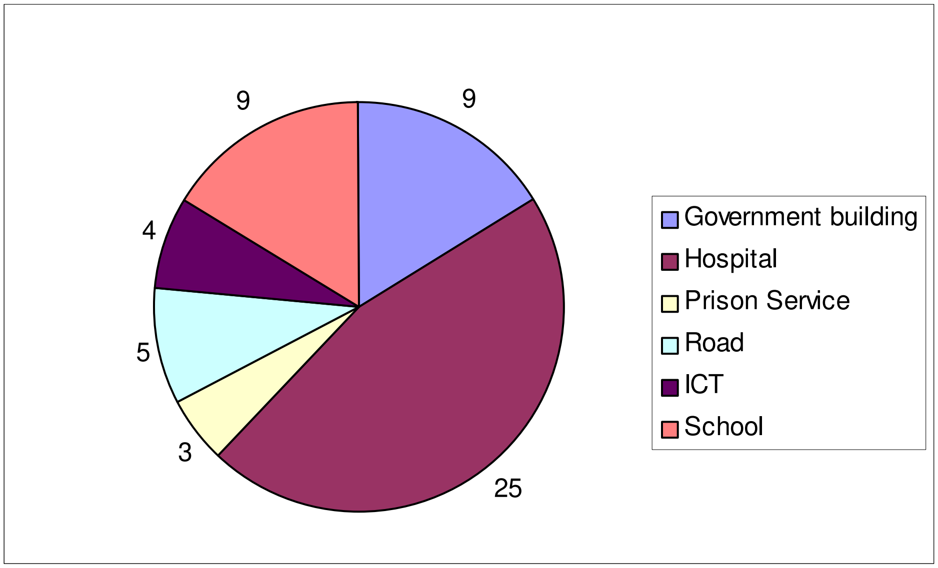
One reason for the absence of empirical studies of the transaction costs is obviously the lack of appropriate data. The problem is twofold: there is only limited information about transaction costs, and even when such information exists, it is often confidential in character. Add to that the still limited experience of the operation of PPP projects, especially from a longer-term perspective, and it would seem next to impossible to say anything general about the topic.

There are, however, a number of data sources that can be combined to give an overview of the magnitude and also determinants of transaction costs in PPPs. For the public sector's part, publicly available information compiled by the NAO and PAC can be used to create a database with 55 PPP projects in 6 different sectors of the UK economy.[1] [2] The projects are identified in Appendix 1. The sample on the public sector's transaction costs, which is illustrated in Graphs 1-3 below, covers some 10 percent all signed PPP projects through December 2004 by number and 15 percent by value.

[1] The actual number of projects is 64, but some were procured as a bundle, with reporting for the bundles aggregating all projects in it. This reduced the number of reporting units (individual projects or bundles) to 55.

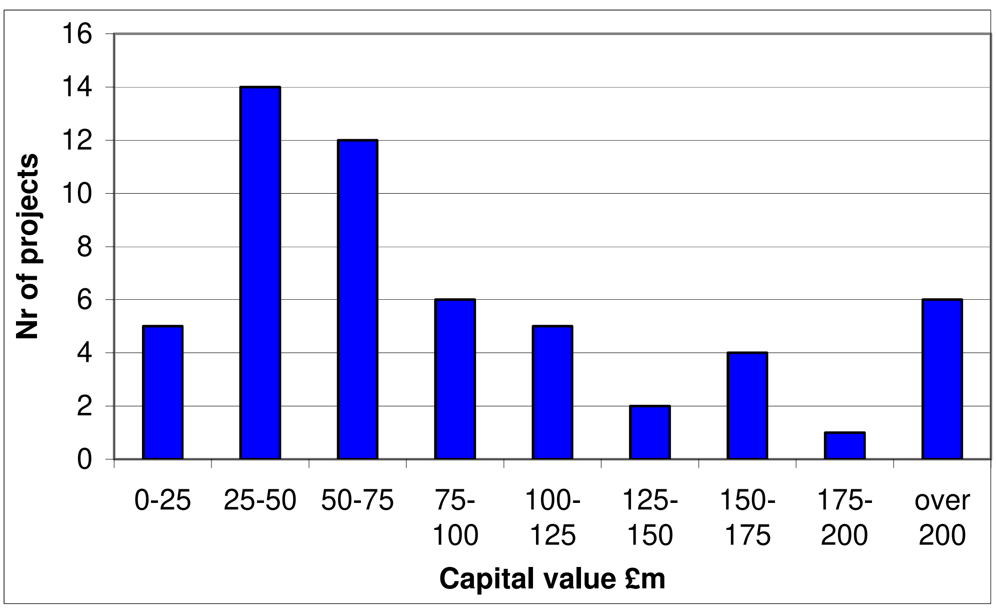
[2] Information about 14 projects was acquired by e-mail inquiries.

Graph 1. Public sector transaction costs: Sample by sector



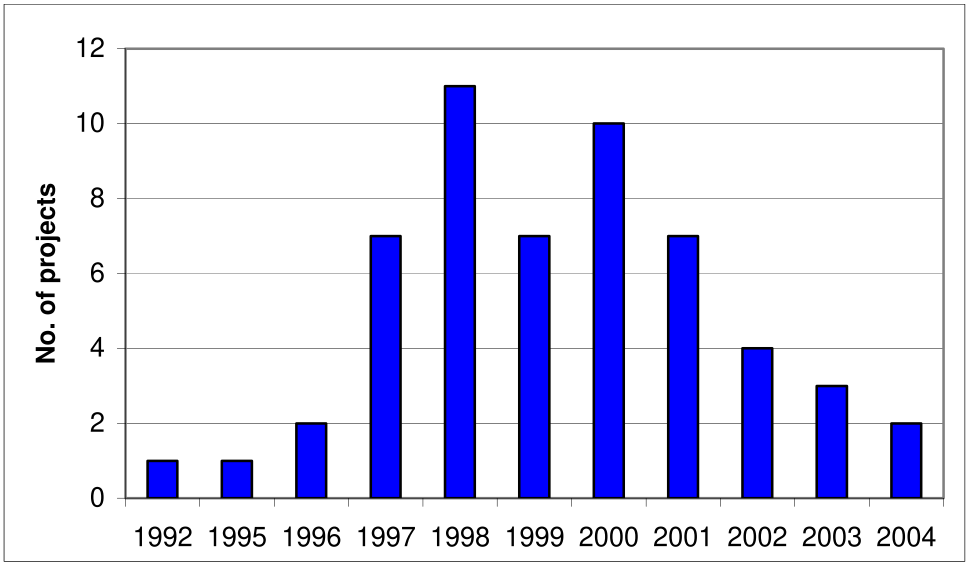
Sources: NAO, PAC.

Graph 2. Public sector transaction costs: Sample by project size



Sources: NAO, PAC

Graph 3. Public sector transaction costs: Sample by year

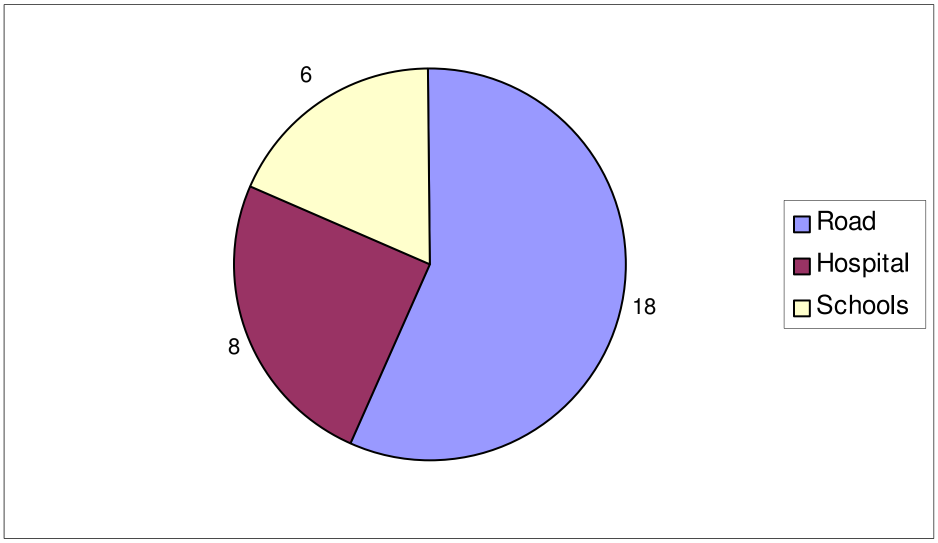


Sources: NAO, PAC.

The information about the public sector's transaction costs covers the procurement phase of the project. It comprises the project name; sector; capital value; year of financial close; procurement time (both estimated and real); number of bidders; bid development cost; financial, legal and techical advisory costs (disaggregated for 34 projects); contract length; and possible occurrence of refinancing.

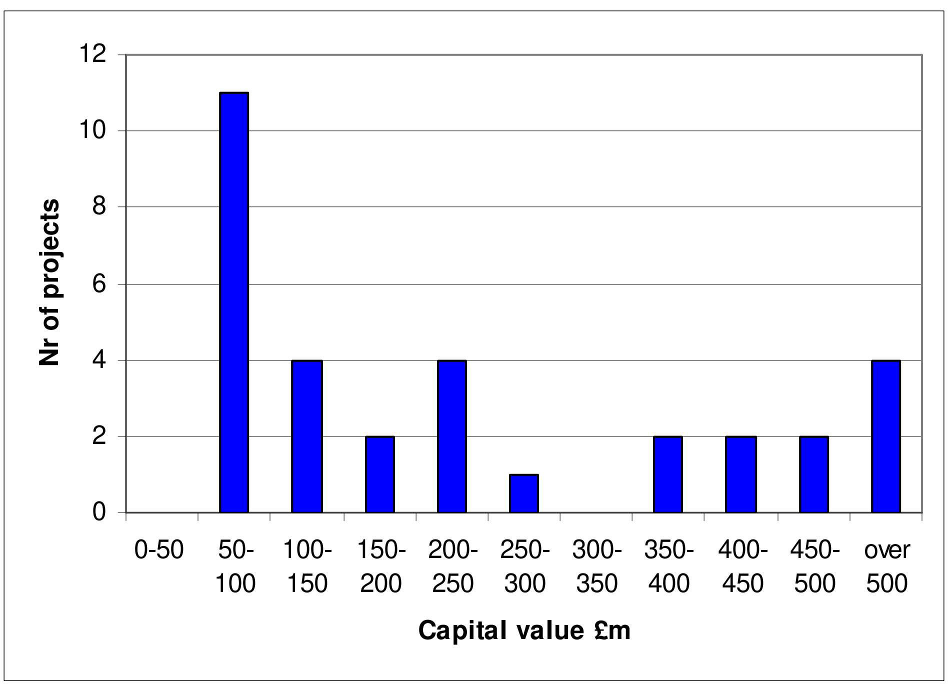
Turning to the sample on the private sector's transaction costs, internal EIB documents were used to obtain information about transaction costs (bidding and contract negotiation costs) incurred by the winning bidder. The sample comprises 32 projects in 3 sectors (hospitals, roads, schools) in 4 countries (Ireland, the Netherlands, Portugal, and the UK) and is illustrated in Graphs 4-6 below. The list of individual projects included in the sample is not reproduced for confidentiality reasons.

Graph 4. Winning bidder's transaction costs: Sample by sector



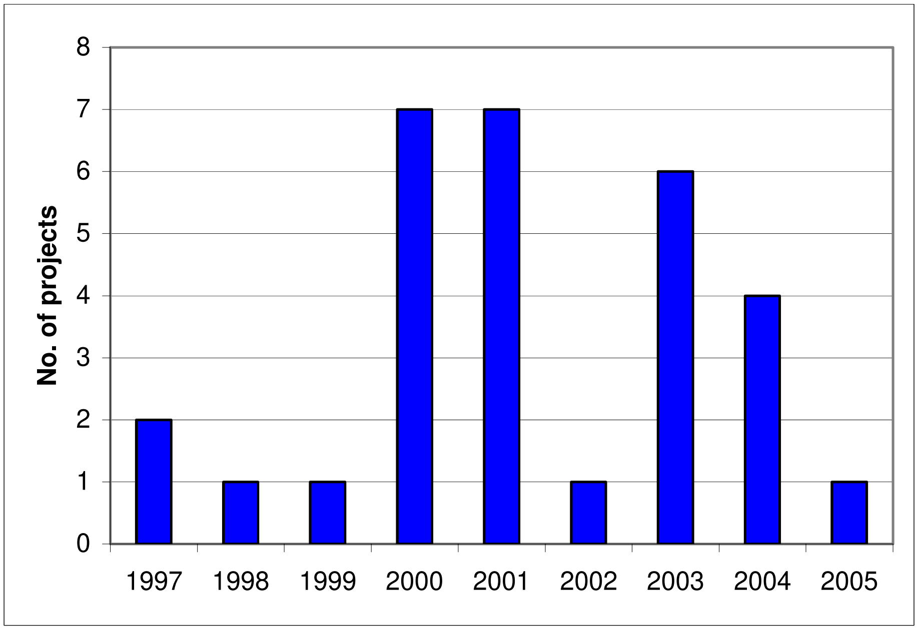
Source: EIB.

Graph 5. Winning bidder's transaction costs: Sample by project size



Source: EIB.

Graph 6. Winning bidder's transaction costs: Sample by year



Source: EIB.

As with public sector transaction costs, the sample on the private sector's transaction costs is confined to the procurement phase. However, as mentioned in Section 2, monitoring and contract renegotiation costs during the operational phase are conceivably significant, especially as the operational phase stretches over decades in PPP projects. By excluding the transaction costs in the operational phase, we are underestimating overall transaction costs in PPPs, possibly by a significant amount. The estimation of overall transaction costs will, however, have to wait until a sufficient number of PPP projects have completed their entire life cycle, which is perhaps another two decades away.

4. Empirical methodology

Given that data availability is as constrained as explained above, the empirical methods that could be used to analyse the data are also constrained. Specifically, the use of standard statistical tests would be questionable, as they hinge on assumptions about the population distribution of the variables of interest that cannot be supported by our small sample size.

One can, however, resort to non-parametric tests to analyse the data. In examining the importance of the various possible determinants of transaction costs in Section 6 below, we will use two such non-parametric tests to assess whether the transaction costs vary significantly across different values of any one determinant, such as country, sector, project size, etc. This precludes, of course, the isolation of the individual impact of any one determinant on transaction costs, as the others cannot be "held constant" in this set-up.

The first test, the Kruskal-Wallis test, is used to assess whether all samples, which can be of different sizes, come from identical populations or not.[3] In our case, the samples represent projects in different countries or sectors; different project sizes etc. Thus, the aim is to test whether or not the samples differ significantly in terms of their transaction costs. The test is based on ranking each observation by magnitude, and the test itself aims to assess whether the samples differ from one another in terms of the variability of ranks within each sample. In other words, we can test whether transaction costs are equal across countries, sectors, project sizes, etc.

The hypotheses for the Kruskal-Wallis test are thus:

H_0: $\mu_1 = \mu_2 = \ldots = \mu_k$
H_1: $\mu_i \neq \mu_j$

where μ denotes the mean ranks of a sample. In other words, the null hypothesis has it that the mean ranks of all samples are equal, while the alternative has it that at least one sample originates from a different population.

To test these hypotheses, the Kruskal-Wallis tests uses the following test statistic:

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[3] The Kruskal-Wallis test has also been described as the non-parametric equivalent of parametric analysis of variance (ANOVA).

$$H = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(n+1)$$

where n denotes the size of a sample; k denotes the number of samples; and R denotes the sum of ranks in a sample. For very small samples ($n < 5$ for each i and $k < 4$), the critical values for the test statistic have been tabled. For larger samples the test statistic H can be assumed to follow χ^2 distribution with (k –1) degrees of freedom.

While the Kruskal-Willis test can be used to test the hypothesis that all samples originate from identical populations, another test is required to test exactly which samples are different in case the null hypothesis is rejected in the Kruskal-Willis tests. To that end, the Wilcoxon rank sum test can be employed.[4] It tests the null that two samples, call them A and B, originate from the same population against the alternative that they do not. The alternative hypothesis can also be formulated more precisely in form of an inequality between the samples. Formally:

H_0: A = B
H_1: A ≠ B or A > B or A < B

The test statistic in the Wilcoxon test is

$$z = \frac{T - E(T)}{\sigma_T}$$

where

$$E(T) = \frac{n_a(n_a + n_b + 1)}{2}$$

[4] As the Kruskal-Willis tests has been likened to ANOVA, the parametric counterpart of the Wilcoxon rank sum test would be a two-sample t-test.

and

$$\sigma_T = \sqrt{\frac{n_a n_b (n_a + n_b + 1)}{12}}$$

For sufficiently large sample sizes, the test statistic z is approximately normally distributed with mean $E(T)$ and standard deviation σ_T.

Intuitively, the Wilcoxon rank sum test assesses how two samples are located with respect to one another, based on ranked data as in the case of the Kruskal-Wallis test. It can be used, for example, to test whether transaction costs differ between any two countries, sectors, project sizes, etc.

5. Size of transaction costs

Before embarking on the analysis of the determinants of transaction costs, let us establish their level. As described in Section 3, there is actual data on the bidding and contract negotiation costs for the public sector as well as for the winning bidder. Notably, we are interested in the total procurement phase transaction costs to the economy, not just the financial cost of the project, so we need to add the bidding costs for the failed bidders. In the absence of actual data on failed bidders' costs they need to be estimated, as explained below.

The public sector's bidding and contract negotiation costs average 3.5 percent in our dataset, which only covers the UK, varying roughly between 1 and 7 percent of the capital value of the project across sectors (see Section 6.2. below).

The winning bidder's costs vary between 3.0 and 5.7 percent across sectors, averaging 3.8 percent. In the 8 projects where a breakdown of the winning bidder's costs into bidding and contract negotiation costs was available, the split is even, with bidding costs amounting to 1.9 percent and contract negotiation costs to another 1.9 percent of the project's capital value.

As for the failed bidders, costs for them were estimated based on information about the winning bidder's bidding costs and the average number of bidders for the projects in the sample. Each failed bidder can be reasonably assumed to spend neither more nor much less than the winning bidder on the bidding process. As the winning bidder spends on average some 1.9 percent of the project's capital value on bidding, and as the average number of bidders in our sample is 4, the costs incurred by the 3 failed bidders amount to some 5 percent of the project's capital value.

Graph 7. Level of transaction costs in PPPs (% of capital value; sample average)

Sources: NAO, PAC, EIB, autors' estimates.

In sum, the procurement phase transaction costs average well over 10 percent of the capital value of the sampled projects, with the cost to public sector at 3.5 percent, cost to the winning bidder at 3.8 percent, and the cost to the failed bidders at about 5 percent.

Notably, this estimate is unlikely to be significantly biased upward because of double-counting that could arise if the winning bidder would systematically inflate his bidding costs to cover his costs for bidding unsuccessfully for other projects. First, this would only happen if the winning bidder's bidding costs were always reimbursed by the public sector, which is not the rule. Second, even in cases where the public sector reimburses such costs, our estimates would not be double-counting them as the public sector figures do not, to the best of our knowledge, include any such reimbursement. Besides, the winning bidder is most likely to recover his bidding costs through higher project cost rather than inflating his own bidding costs.

6. Determinants of transaction costs

Having established their magnitude, let us then turn to an analysis of the determinants of procurement phase transaction costs in PPPs. Because of the absence of actual data on the costs of failed bidders mentioned above, the analysis to follow mainly considers transaction costs incurred by the winning bidder.

In the absence of a rigorous theoretical model that could be used to determine a set of determinants for the procurement phase transaction costs in PPPs, we resort to a more *ad hoc* –approach and investigate the relationship between transaction costs and a number of variables that could conceivably affect the magnitude of transaction costs and for which data are available. Such variables include the following:

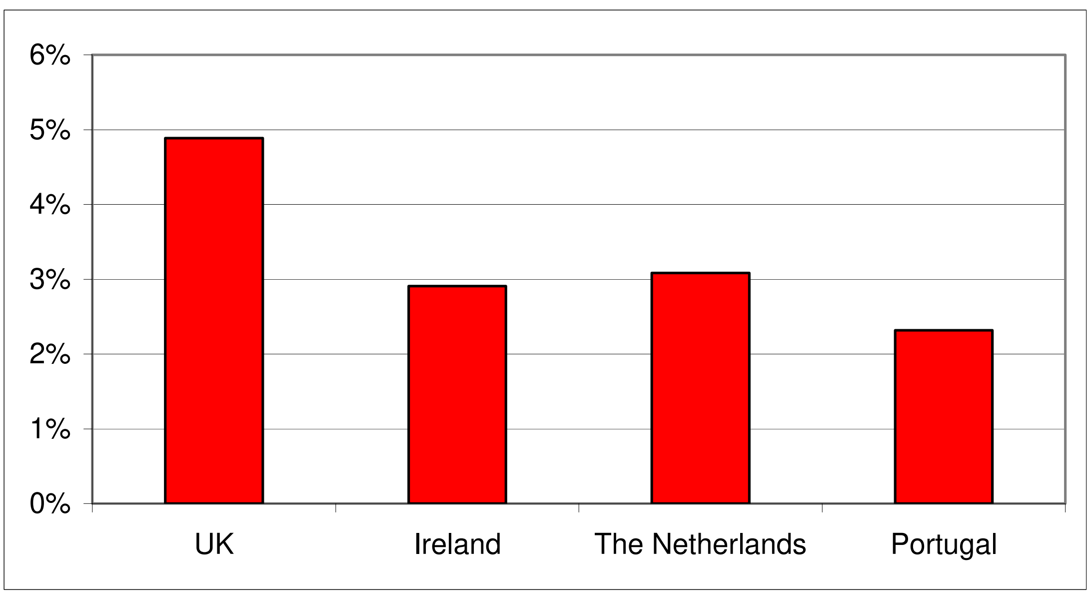
- project country (approximating differences between legal systems);
- economic sector;
- project size (capital value);
- length of procurement process (approximating, among other things, the complexity of the project);
- number of bidders (proxying the intensity of competition at the bidding stage);
- the year when the project was signed (accounting for the hypothesis that transaction costs decline over time as experience with PPPs accumulates, facilitating the set-up process).

Each of these factors is considered in turn below. Although some of the factors are probably interdependent, the analysis below is performed each time in a "one-factor-only" dimension because of data limitations. The results of the statistical tests are discussed qualitatively in this Section; the detailed results are reported in Appendices 2-9.

6.1. Country

A comparison of transaction costs across countries has to be limited to the private sector partner's (winning bidder's) bidding and negotiation costs in the absence of the public sector's costs for countries outside the UK. To control, at least, for differences across sectors, the comparison is limited to road sector projects.

Graph 8. Procurement phase transaction costs to winning bidder in road projects by country (in % of capital value)



Sources: NAO, PAC, EIB.

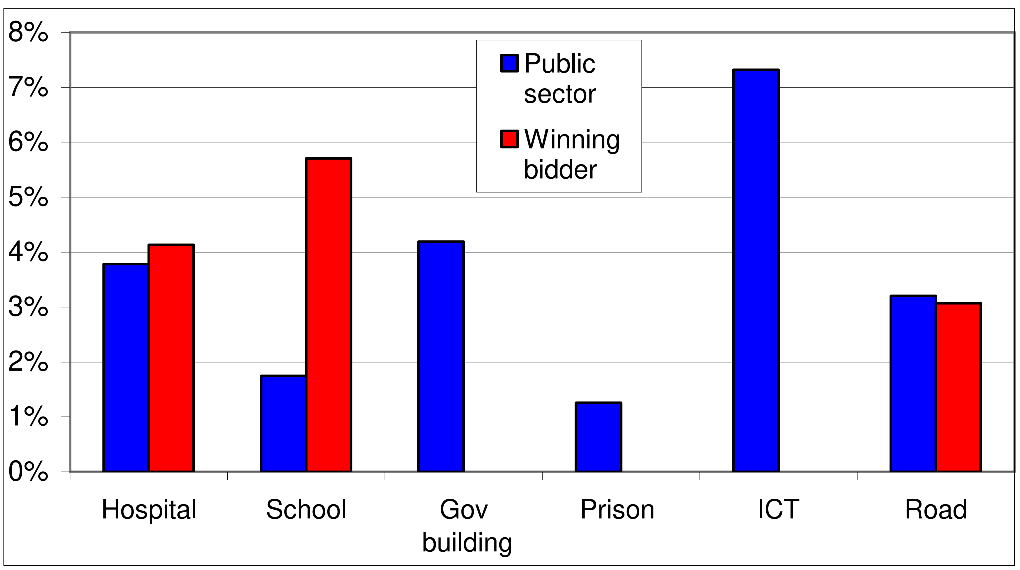
As the graph above illustrates, there is some cross-country variation. The costs are highest in the UK at about double those in Portugal and some two-thirds higher than in Ireland and the Netherlands.

That the UK has higher costs would appear obvious because of its common law legal system, which necessitates high legal advisory costs. However, if that were the only factor at play, the costs in Ireland should be high, too. What other factors may play a role is considered below.

6.2. Sector

As regards cross-sectoral variation, the graph below suggests that the transaction costs are roughly equal for the public sector and the winning bidder in hospital and road projects, adding up to 8 and 6 percent of the project's capital value, respectively.

Graph 9. Procurement phase transaction costs by sector (in % of capital value)



Sources: NAO, PAC, EIB.

In school projects, the total comes also to about 7.5 percent, although the winning bidder shoulders three-quarters of them. There is no obvious explanation to this observation, but there is some anecdotal evidence suggesting that the public sector tends to use in-house resources instead of external technical advisors (e.g., architects) in school projects, which would tend to reduce its explicitly accounted costs. Of course, the economic cost of using in-house resources would still be there and should be added to the explicitly accounted costs to get the total economic cost.

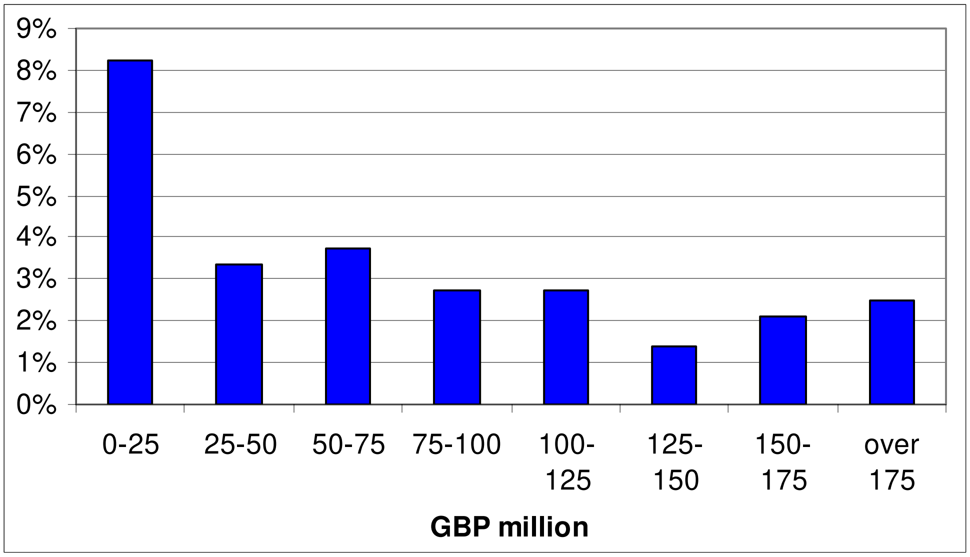
There is also significant variation between the 3 sectors for which we only have data on public sector transaction costs. Notably, the ICT sector includes an outlier, where transaction costs amounted to over 20 percent of the project's capital value. Without that outlier, the average for the ICT sector would be 3 percent.

Interestingly, the public sector's transaction costs for prison projects appear very small. Obviously, this does not necessarily mean that overall transaction costs are low: as with school projects, the winning bidder may bear the bulk of them or they can be, at least in part, not explicitly accounted for.

6.3. Size of project

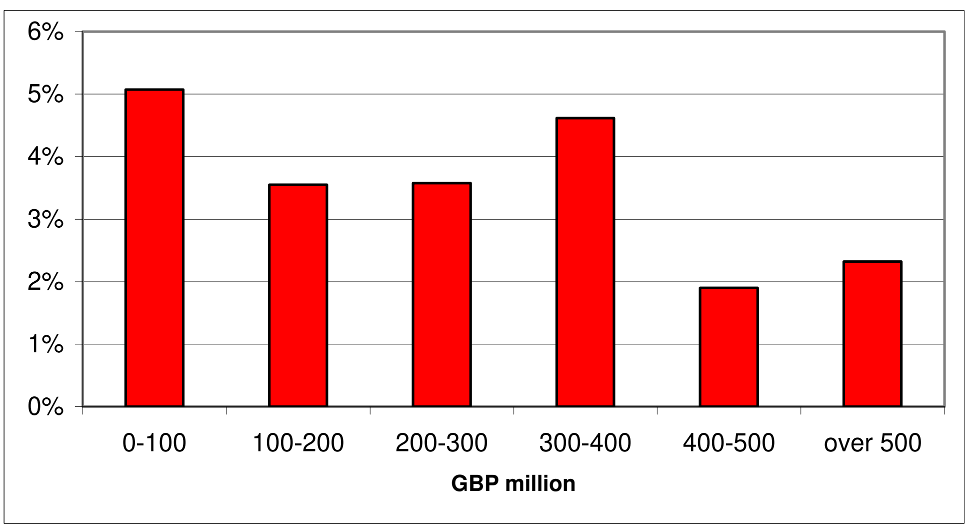
Turning to the size (capital value) of the project, small projects are associated with higher transaction costs (relative to the size of the project) for both public and private sectors. For the public sector, as illustrated below, projects with a capital value below £25 million have significantly higher transaction costs than bigger projects. For the private sector, projects with a capital value below £100 million are significantly more expensive to bid for and negotiate than especially very big projects.

Graph 10. Procurement phase transaction costs for the public sector by project size (in % of capital value)



Sources: NAO, PAC.

Graph 11. Procurement phase transaction costs for the winning bidder by project size (in % of capital value)



Source: EIB.

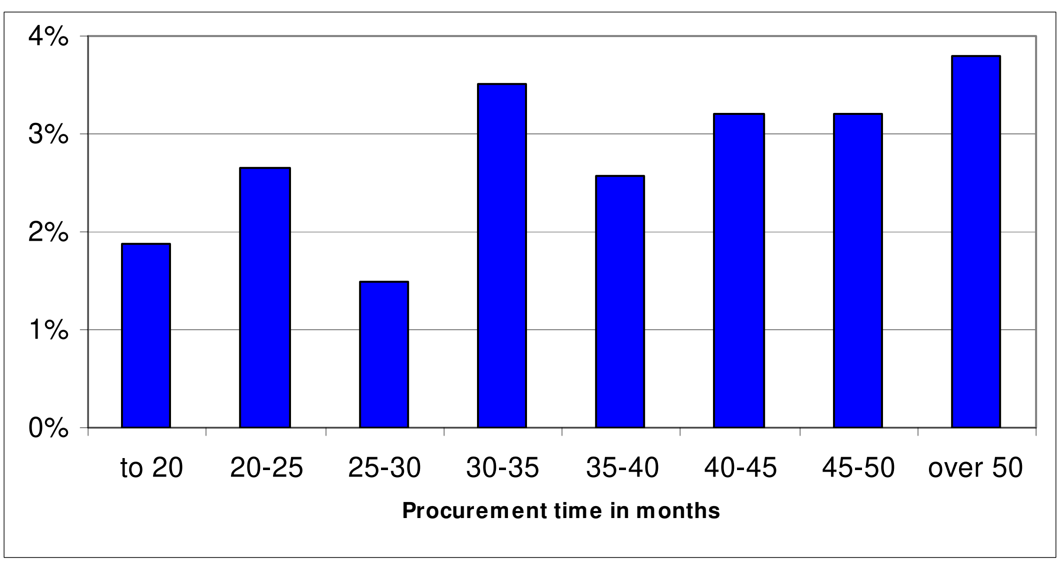
Note that the small number of projects in the sample necessitates different size classification for the analysis of public and private sector transaction costs, respectively.

These findings lend some support to the notion that the high transaction costs in PPPs necessitate a minimum project size for a partnership to be a financially and economically viable option. In the UK, a project size in excess of £20 is now considered necessary for the PPP option to be considered in the first place.

6.4. Procurement time

As regards the procurement time for the project—which reflects in part the complexity of the project—it turns out, unsurprisingly, that projects with long procurement time are associated with significantly higher transaction costs, at least for the public sector. More specifically, there seems to be a statistically significant structural break in transaction costs when procurement time exceeds 50 months: projects that take longer than that to procure have significantly higher transaction costs than projects with procurement time below 50 months.

Graph 12. Procurement phase transaction costs for the public sector by procurement time (in % of capital value)



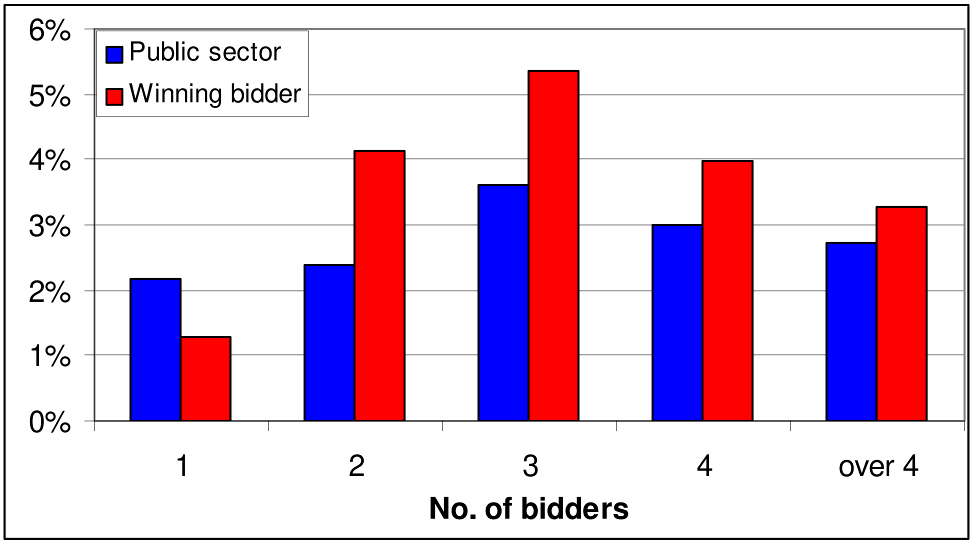
Sources: NAO, PAC, Official Journal of the European Communities

The illustration of the link between transaction costs and procurement time above warrants two comments. First, the bars illustrate median values in each interval, and while the interval above 50 months has the highest median value, it is not obvious from the median values alone that there is significant structural break at 50 months. However, the nonparametric statistical tests are based on ranking the data instead of considering median (or average) values, and such tests suggest unambiguously the presence of a break at 50 months. Second, as with project size, the split of the data into intervals is dictated by the requirement that each interval contain a sufficient number of observations; hence, interval lengths other than those considered would weaken the power of tests employed.

6.5. Number of bidders

One would expect the public-sector cost of bidding to increase with the number of bidders. Interestingly, that hypothesis is not validated by our sample. Data on the number of bidders was available for 23 projects, with the number of bidders varying between 1 and 8. As the chart below shows, transaction costs for the public sector and the winning bidder appear to peak when there are three bidders; otherwise the differences are statistically insignificant.

Graph 13. Procurement phase transaction costs by number of bidders (in % of capital value)



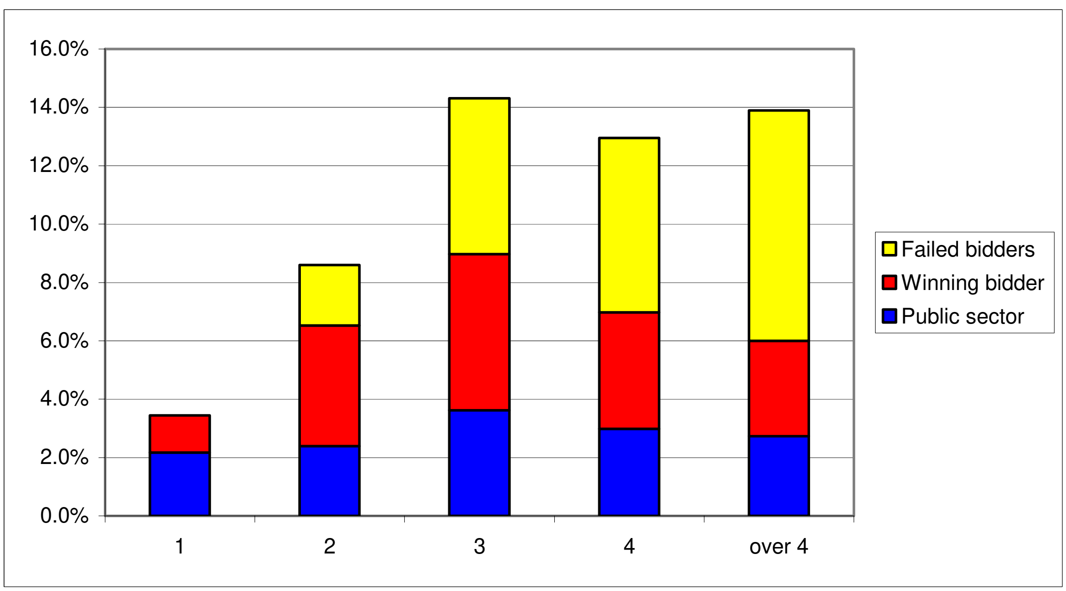
Sources: NAO, PAC, EIB.

While there is no obvious economic reason why transaction costs for the winning bidder would peak with exactly three bidders, it is conceivable that the explanation lies in the way that the presence of three bidders combines the intensity of competition and the likelihood for a bid to succeed. From the perspective of an individual bidder, the presence of two other bidders renders the bidding process at the same time competitive and reasonably likely to result in success. Therefore, any bidder has the incentives to spend quite a lot to win the contract. Such incentives are weaker if either the number of bidders is smaller (which curtails competition and increases the likelihood of winning even if little is spent) or larger (which reduces the likelihood of winning).

While the absence of competition would therefore seem to be associated with relatively low costs of bidding and contract negotiation, it is likely that it increases costs down the road as the lack of competition is likely to result in higher overall costs of the project to the public sector and in a higher probability of contract renegotiation during its life cycle.

Considering total procurement phase transaction costs to the economy—thus including also the bidding costs incurred by failed bidders—we find an irregular pattern, illustrated below. The bidding costs of failed bidders have been estimated by considering the bidding costs of the winning bidder in each category (estimated at one-half of his procurement phase transaction costs, as explained in Section 5 above) together with the number of failed bidders in each case. There is still a large increase from 2 to 3 bidders, but the pattern for 3 or more bidders is irregular. Obviously, a larger number of observations in the categories above 3 bidders would be needed to establish the relationship between the number of bidders and total bidding costs with any degree of confidence.

Graph 14. Total procurement phase transaction costs by number of bidders (in % of capital value)

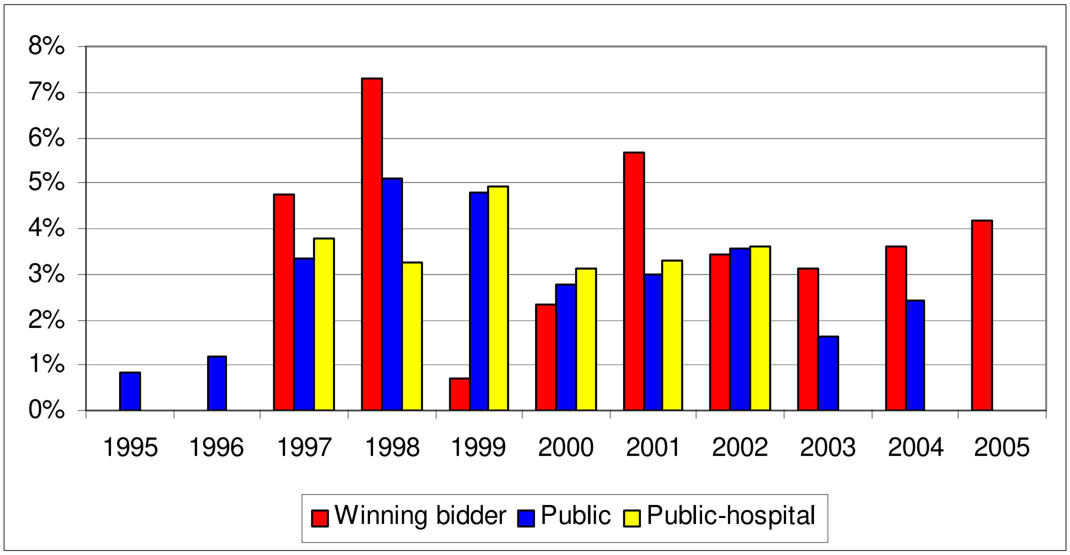


Sources: NAO, PAC, EIB, authors' estimates.

6.6. Experience

Transaction costs do not seem to decline systematically over time. The chart below shows such costs for the public sector and winning bidders during the sample period, and it also shows separately the public sector's transaction costs in hospital projects, as they constitute the single largest sector in the sample.

Graph 15. Procurement phase transaction costs by year of signing (in % of capital value)



Sources: NAO, PAC, EIB.

There is no statistically significant trend in the private sector transaction costs. Notably, the extreme values for the private sector (1998 and 1999) only represent one single observation each and should therefore be taken with a grain of salt. Similarly, there is no significant trend in the public sector transaction costs overall, nor in hospital projects.

These findings contrast with the efforts, most advanced in the UK, to reduce transaction costs by standardising PPP contracts. While the time series analysed above remain short, one cannot at this stage reject the possibility that PPP contracts necessitate such a high degree of individual tailoring that benefits of standardisation remain limited by necessity.

7. Conclusions

This first systematic attempt at quantifying the transaction costs of PPPs suggests the following conclusions. First, even if only the transaction costs related to the procurement phase are considered—thus ignoring the additional costs of monitoring and renegotiating the contract over its life-cycle—they amount on average to well over 10 percent of the capital value of the project. The public sector and the winning bidder's costs reach some 7 percent, which is split between the public sector and the winning bidder roughly equally in hospital and road projects, while the winning bidder shoulders the bulk of the costs in school projects. In addition, the aggregate costs incurred by failed bidders can be estimated at some 5 percent of the project's capital value, brining the total procurement phase transaction costs to well over 10 percent.

Second, transaction costs (in percent of projects' capital value) to the public sector and the winning bidder vary between countries (legal systems) and sectors, and they are significantly higher in small projects (below £25 million for the public sector) and in projects that take long (over 50 months) to procure. In contrast, neither experience in setting up partnerships nor the number of bidders affect the costs to the public sector and the winning bidder.

These results offer some first insights into the issue, but it is important to recognise what they do not do. They do not tell us anything about the magnitude of the difference between traditional public procurement of investment projects and PPPs in terms of transaction costs; however, the prior remains that PPPs are more expensive to set up. Also, these results do not tell us to what extent transaction costs eat up cost savings otherwise achieved by a PPP structure, although that extent would seem to be significant. Both these issues are for future research to tackle.

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Appendix 1. Projects in public sector sample

SCHOOLS

1. Cornwall County Council – Grouped Schools I PFI Project
2. Cornwall County Council – Grouped Schools II PFI Project
3. Bridlington Group Schools Project
4. Liverpool Group Schools Project
5. Newham – Joint Schools Project
6. Rotherham Group Schools Project
7. Ashburton School
8. North Wiltshire Schools
9. Haringey Group Schools Projects

HOSPITALS

1. Darenth Valley Hospital
2. North Cumbria Acute Hospitals
3. South Buckinghamshire NHST Site Rationalisation
4. Norfolk and Norwich University Hospital
5. University Hospital of North Durham
6. West Middlesex University Hospital DBFO
7. Wythenshaw Hospital
8. Queen Elizabeth Hospital, Greenwich
9. Calderdale and Huddersfield NHST Centralisation of Acute Hospital Services – Halifax General Hospital
10. Princess Royal University Hospital
11. Barnet General Hospital Modernisation
12. Worcester Acute Hospitals NHS Trust New District General Hospital
13. Hereford County Hospital
14. Redevelopment of Bishop Auckland General Hospital
15. James Cook University Hospital

16. The Great Western Hospital, Swindon
17. King's College Hospital New Block
18. Leeds Community & Mental Health Services
19. St George's Healthcare NHS Trust - Cardiothoracic & Neurosciences Development
20. University College London Hospitals Site Rationalisation
21. Maternity and Acute Development – Hull Royal Infirmary
22. Dudley Group of Hospitals NHS Trust Redevelopment and Rationalisation of Sites
23. Prospect Park Mental Health Facility
24. Gloucestershire Royal Hospital Site Redevelopment
25. Coventry and Warwickshire NHS Trust - Coventry New Hospitals Project

INFORMATION COMMUNICATION TECHNOLOGIES

1. LIBRA
2. Radiocommunications Agency Strategic IT Partnership
3. Defence Fixed Telecommunications Service
4. National Insurance Recording System 2

PRISONS

1. HMP Altcourse (Fazakerley)
2. HMP Bronzefield
3. HMP Peterborough
4. HMP Parc (Bridgend)
5. HMP Kilmarnock

GOVERNMENT BUILDINGS

1. PRIME
2. Home Office Central London Accommodation Strategy
3. Redevelopment of the Treasury Building, Government Offices Great George Street
4. Berlin Embassy
5. Newcastle Estate Development
6. MoD Main Building Refurbishment
7. STEPS
8. Hereford and Worcester Magistrates' Court
9. Derbyshire Magistrates' Courts

ROADS

1. A1 (M) Alconbury to Peterborough
2. M1 –A1 Link Road
3. A50/A564 Stoke-Derby Link DBFO
4. A30/A35 Exeter to Bere Regis DBFO
5. M40 Junctions 1 to 15
6. A19 Dishforth to Tyne Tunnel DBFO
7. M6 DBFO Project
8. Skye Bridge
9. A55 Llandygai to Holyhead Trunk Road
10. Newport Southern Distributor Road
11. A69 Carslile to Newcastle DBFO
12. A419/A417 Swindon to Gloucester DBFO

Appendix 2. Kruskal-Wallis test results (public sector sample)

Kruskal-Wallis Test Sector

Group	Rank Sum	Observations
Hospitals	842.5	25
Schools	126	9
Gov. Building	295.5	9
Prison Service	23	3
ICT	120	4
Road	133	5
H Stat		15.7895
df		5
p-value		0.0075
chi-squared Critical		11.0705

Kruskal-Wallis Test Nr of bidders

Group	Rank Sum	Observations
1	22	2
2	20	2
3	139.5	11
4	73	6
over 4	21.5	2
H Stat		0.4001
df		4
p-value		0.9825
chi-squared Critical		9.4877

Kruskal-Wallis Test Procurement time

Group	Rank Sum	Observations
to 20	121	7
20-25	234	10
25-30	174	9
30-35	157	5
35-40	103	5
40-45	187	6
45-50	152	5
over 50	250	5
H Stat		19.2224
df		7
p-value		0.0075
chi-squared Critical		14.0671

Kruskal-Wallis Test Time series

Group	Rank Sum	Observations
1995	3	1
1996	15	2
1997	202	7
1998	353	11
1999	276	7
2000	251	10
2001	183	7
2002	122	4
2003	35	3
2004	45	2
H Stat		14.3418
df		9
p-value		0.1107
chi-squared Critical		16.919

Kruskal-Wallis Test Capital value

Group	Rank Sum	Observations
0-25	224	5
25-50	428.5	14
50-75	361	12
75-100	164	6
100-125	125	5
125-150	26	2
150-175	63	4
175-200	45	1
over 200	103.5	6
H Stat		14.1769
df		8
p-value		0.0773
chi-squared Critical		15.5073

Appendix 3. Kruskal-Wallis test results (private sector sample)

Kruskal-Wallis Test Sector

Group	Rank Sum	Observations
Road	240	18
Hospital	149	8
School	139	6
H Stat		**5.492**
df		**2**
p-value		**0.0642**
chi-squared Critical		**5.9915**

Kruskal-Wallis Test Country

Group	Rank Sum	Observations
UK	48	4
Portugal	70	9
Ireland	30	3
The Netherlands	23	2
H Stat		**2.1209**
df		**3**
p-value		**0.5477**
chi-squared Critical		**7.8147**

Kruskal-Wallis Test Capital value

Group	Rank Sum	Observations
to 150	319	15
150-300	95	7
300-450	53	4
over 450	61	6
H Stat		7.7701
df		3
p-value		0.051
chi-squared Critical		7.8147

Kruskal-Wallis Test Years

Group	Rank Sum	Observations
1997	35	2
1998	30	1
1999	1	1
2000	69	7
2001	162	7
2002	17	1
2003	90	6
2004	68	4
2005	56	3
H Stat		12.1718
df		8
p-value		0.1437
chi-squared Critical		15.5073

Kruskal-Wallis Test Nr of bidders

Group	Rank Sum	Observations
1	4	1
2	58	3
3	99	5
4	173	10
over 4	194	13
H Stat		3.1081
df		4
p-value		0.5399
chi-squared Critical		9.4877

Kruskal-Wallis Test Country

Group	Rank Sum	Observations
UK	48	4
Portugal	70	9
Ireland	30	3
The Netherlands	23	2
H Stat		**2.1209**
df		**3**
p-value		**0.5477**
chi-squared Critical		**7.8147**

Appendix 4. Wilcoxon rank Sum tests on private sector country data

Wilcoxon Rank Sum Test 1

	Rank Sum	Observations
UK	35	4
Portugal	56	9
z Stat	1.0801	
P(Z<=z) one-tail	0.14	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.28	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 2

	Rank Sum	Observations
Portugal	55	9
Ireland	23	3
z Stat	-0.6472	
P(Z<=z) one-tail	0.2588	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5176	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 3

	Rank Sum	Observations
Ireland	9	3
The Netherlands	6	2
z Stat	0	
P(Z<=z) one-tail	0.5	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	1	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 4

	Rank Sum	Observations
UK	15	4
The Netherlands	6	2
z Stat	0.4629	
P(Z<=z) one-tail	0.3217	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.6434	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 5

	Rank Sum	Observations
The Netherlands	17	2
Portugal	49	9
z Stat	1.1785	
P(Z<=z) one-tail	0.1193	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2386	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 6

	Rank Sum	Observations
UK	18	4
Ireland	10	3
z Stat	0.7071	
P(Z<=z) one-tail	0.2397	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.4794	
z Critical two-tail	1.96	

Appendix 5. Wilcoxon Rank Sum tests on public sector sectoral data

Wilcoxon Rank Sum Test 1

	Rank Sum	Observations
Hospitals	528	25
Schools	67	9
z Stat	3.5328	
P(Z<=z) one-tail	0.0002	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0004	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 2

	Rank Sum	Observations
Hospitals	397	25
Prison Service	9	3
z Stat	2.5626	
P(Z<=z) one-tail	0.0052	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0104	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 3

	Rank Sum	Observations
Hospitals	437.5	25
Gov. Building	157.5	9
z Stat	0	
P(Z<=z) one-tail	0.5	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	1	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 4

	Rank Sum	Observations
Hospitals	405	25
Road	60	5
z Stat	0.9739	
P(Z<=z) one-tail	0.1651	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3302	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 5

	Rank Sum	Observations
Hospitals	375	25
ICT	31	3
z Stat	0.9285	
P(Z<=z) one-tail	0.1766	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3532	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 6

	Rank Sum	Observations
Gov. Building	73	9
Road	32	5
z Stat	0.7333	
P(Z<=z) one-tail	0.2317	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.4634	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 7

	Rank Sum	Observations
ICT	11	3
Road	25	5
z Stat	-0.7454	
P(Z<=z) one-tail	0.228	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.456	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 8

	Rank Sum	Observations
Road	28	5
Prison Service	8	3
z Stat	1.6398	
P(Z<=z) one-tail	0.0505	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.101	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 9

	Rank Sum	Observations
ICT	15	3
Gov. Building	63	9
z Stat	-0.8321	
P(Z<=z) one-tail	0.2027	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.4054	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 10

	Rank Sum	Observations
Prison Service	13	3
Schools	65	9
z Stat	-1.2019	
P(Z<=z) one-tail	0.1147	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2294	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 11

	Rank Sum	Observations
Road	48	5
Schools	57	9
z Stat	1.4	
P(Z<=z) one-tail	0.0808	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1616	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 12

	Rank Sum	Observations
Gov. Building	70	9
Prison Service	8	3
z Stat	2.1264	
P(Z<=z) one-tail	0.0167	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0334	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 13

	Rank Sum	Observations
Schools	59	9
Gov. Building	112	9
z Stat	-2.34	
P(Z<=z) one-tail	0.0096	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0192	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 14

	Rank Sum	Observations
ICT	20	3
Schools	58	9
z Stat	0.0925	
P(Z<=z) one-tail	0.4632	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.9264	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 15

	Rank Sum	Observations
Prison Service	9	3
ICT	12	3
z Stat	-0.6547	
P(Z<=z) one-tail	0.2563	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5126	
z Critical two-tail	1.96	

Appendix 6. Wilcoxon rank sum tests on private sector sectoral data

Wilcoxon Rank Sum Test

	Rank Sum	Observations
Road	221	18
Hospital	130	8
z Stat	-1.2222	
P(Z<=z) one-tail	0.1108	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2216	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test

	Rank Sum	Observations
Hospital	55	8
School	50	6
z Stat	-0.6455	
P(Z<=z) one-tail	0.2593	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5186	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test

	Rank Sum	Observations
Road	190	18
School	110	6
z Stat	-2.3333	
P(Z<=z) one-tail	0.0098	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0196	
z Critical two-tail	1.96	

Appendix 7. Wilcoxon Rank Sum tests on public sector capital value data

Wilcoxon Rank Sum Test 1

	Rank Sum	Observations
0-25	71	5
25-50	119	14
z Stat	1.9442	
P(Z<=z) one-tail	0.0259	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0518	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 2

	Rank Sum	Observations
50-75	92	12
0-25	61	5
z Stat	-1.6865	
P(Z<=z) one-tail	0.0458	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0916	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 3

	Rank Sum	Observations
0-25	40	5
75-100	26	6
z Stat	1.8257	
P(Z<=z) one-tail	0.0339	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0678	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 4

	Rank Sum	Observations
100-125	18	5
0-25	37	5
z Stat	-1.9845	
P(Z<=z) one-tail	0.0236	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0472	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 5

	Rank Sum	Observations
0-25	25	5
125-150	3	2
z Stat	1.9365	
P(Z<=z) one-tail	0.0264	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0528	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 6

	Rank Sum	Observations
150-175	12	4
0-25	33	5
z Stat	-1.9596	
P(Z<=z) one-tail	0.025	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.05	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 7

	Rank Sum	Observations
0-25	43	5
over 200	23	6
z Stat	2.3735	
P(Z<=z) one-tail	0.0088	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0176	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 8

	Rank Sum	Observations
0-25	19	5
175-200	2	1
z Stat	0.8783	
P(Z<=z) one-tail	0.1899	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3798	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 9

	Rank Sum	Observations
25-50	185	14
50-75	166	12
z Stat	-0.2057	
P(Z<=z) one-tail	0.4185	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.837	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 10

	Rank Sum	Observations
50-75	118	12
75-100	53	6
z Stat	0.3746	
P(Z<=z) one-tail	0.354	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.708	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 11

	Rank Sum	Observations
75-100	39	6
100-125	27	5
z Stat	0.5477	
P(Z<=z) one-tail	0.2919	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5838	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 12

	Rank Sum	Observations
100-125	25	5
125-150	3	2
z Stat	1.9365	
P(Z<=z) one-tail	0.0264	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0528	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 13

	Rank Sum	Observations
125-150	7	2
150-175	14	4
z Stat	0	
P(Z<=z) one-tail	0.5	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	1	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 14

	Rank Sum	Observations
150-175	10	4
175-200	5	1
z Stat	-1.4142	
P(Z<=z) one-tail	0.0786	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1572	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 15

	Rank Sum	Observations
175-200	7	1
over 200	21	6
z Stat	1.5	
P(Z<=z) one-tail	0.0668	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1336	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 16

	Rank Sum	Observations
75-100	55	6
25-50	155	14
z Stat	-0.6598	
P(Z<=z) one-tail	0.2547	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5094	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 17

	Rank Sum	Observations
25-50	150	14
100-125	40	5
z Stat	0.9258	
P(Z<=z) one-tail	0.1773	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3546	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 18

	Rank Sum	Observations
125-150	7	2
25-50	129	14
z Stat	-1.5878	
P(Z<=z) one-tail	0.0562	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1124	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 19

	Rank Sum	Observations
25-50	147	14
150-175	24	4
z Stat	1.4868	
P(Z<=z) one-tail	0.0685	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.137	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 20

	Rank Sum	Observations
175-200	12	1
25-50	108	14
z Stat	0.9258	
P(Z<=z) one-tail	0.1773	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3546	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 21

	Rank Sum	Observations
25-50	170.5	14
over 200	39.5	6
z Stat	1.9382	
P(Z<=z) one-tail	0.0263	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0526	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 22

	Rank Sum	Observations
50-75	96	12
125-150	9	2
z Stat	1.0954	
P(Z<=z) one-tail	0.1367	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2734	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 23

	Rank Sum	Observations
100-125	39	5
50-75	114	12
z Stat	-0.6325	
P(Z<=z) one-tail	0.2635	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.527	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 24

	Rank Sum	Observations
150-175	23	4
50-75	113	12
z Stat	-1.3339	
P(Z<=z) one-tail	0.0911	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1822	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 25

	Rank Sum	Observations
50-75	81	12
175-200	10	1
z Stat	-0.8018	
P(Z<=z) one-tail	0.2113	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.4226	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 26

	Rank Sum	Observations
50-75	127	12
over 200	44	6
z Stat	1.2176	
P(Z<=z) one-tail	0.1117	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2234	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 27

	Rank Sum	Observations
125-150	5	2
75-100	31	6
z Stat	-1.3333	
P(Z<=z) one-tail	0.0912	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1824	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 28

	Rank Sum	Observations
75-100	41	6
150-175	14	4
z Stat	1.7056	
P(Z<=z) one-tail	0.044	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.088	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 29

	Rank Sum	Observations
175-200	7	1
75-100	21	6
z Stat	1.5	
P(Z<=z) one-tail	0.0668	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1336	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 30

	Rank Sum	Observations
75-100	45	6
over 200	33	6
z Stat	0.9608	
P(Z<=z) one-tail	0.1683	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3366	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 31

	Rank Sum	Observations
150-175	16	4
100-125	29	5
z Stat	-0.9798	
P(Z<=z) one-tail	0.1636	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3272	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 32

	Rank Sum	Observations
100-125	15	5
175-200	6	1
z Stat	-1.4639	
P(Z<=z) one-tail	0.0716	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1432	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 33

	Rank Sum	Observations
100-125	37	5
over 200	29	6
z Stat	1.278	
P(Z<=z) one-tail	0.1006	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2012	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 34

	Rank Sum	Observations
175-200	3	1
125-150	3	2
z Stat	1.2247	
P(Z<=z) one-tail	0.1103	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2206	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 35

	Rank Sum	Observations
125-150	10	2
over 200	26	6
z Stat	0.3333	
P(Z<=z) one-tail	0.3694	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.7388	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 36

	Rank Sum	Observations
150-175	20	4
over 200	35	6
z Stat	-0.4264	
P(Z<=z) one-tail	0.3349	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.6698	
z Critical two-tail	1.96	

Appendix 8. Wilcoxon Rank Sum tests on private sector capital value data

Wilcoxon Rank Sum Test 1

	Rank Sum	Observations
to 150	198	15
150-300	55	7
z Stat	1.7975	
P(Z<=z) one-tail	0.0361	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0722	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 2

	Rank Sum	Observations
150-300	43	7
300-450	23	4
z Stat	0.189	
P(Z<=z) one-tail	0.4251	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.8502	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 3

	Rank Sum	Observations
300-450	24	4
over 450	31	6
z Stat	0.4264	
P(Z<=z) one-tail	0.3349	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.6698	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 4

	Rank Sum	Observations
to 150	197	15
over 450	34	6
z Stat	2.4912	
P(Z<=z) one-tail	0.0064	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0128	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 5

	Rank Sum	Observations
over 450	38	6
150-300	53	7
z Stat	-0.5714	
P(Z<=z) one-tail	0.2839	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5678	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 6

	Rank Sum	Observations
to 150	164	15
300-450	26	4
z Stat	1.4	
P(Z<=z) one-tail	0.0808	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1616	
z Critical two-tail	1.96	

Appendix 9. Wilcoxon Rank Sum tests on public sector procurement time data

Wilcoxon Rank Sum Test 1

	Rank Sum	Observations
to 20	54	7
20-25	99	10
z Stat	-0.8783	
P(Z<=z) one-tail	0.1899	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3798	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 2

	Rank Sum	Observations
20-25	107	10
25-30	83	9
z Stat	0.5715	
P(Z<=z) one-tail	0.2838	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5676	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 3

	Rank Sum	Observations
25-30	57	9
30-35	48	5
z Stat	-1.4	
P(Z<=z) one-tail	0.0808	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1616	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 4

	Rank Sum	Observations
30-35	34	5
35-40	21	5
z Stat	1.3578	
P(Z<=z) one-tail	0.0873	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1746	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 5

	Rank Sum	Observations
40-45	36	6
45-50	30	5
z Stat	0	
P(Z<=z) one-tail	0.5	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	1	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 6

	Rank Sum	Observations
40-45	21	6
over 50	45	5
z Stat	-2.7386	
P(Z<=z) one-tail	0.0031	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0062	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 7

	Rank Sum	Observations
30-35	48	5
20-25	72	10
z Stat	0.9798	
P(Z<=z) one-tail	0.1636	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.3272	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 8

	Rank Sum	Observations
25-30	64	9
35-40	41	5
z Stat	-0.4667	
P(Z<=z) one-tail	0.3204	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.6408	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 9

	Rank Sum	Observations
to 20	59	7
25-30	77	9
z Stat	-0.0529	
P(Z<=z) one-tail	0.4789	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.9578	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 10

	Rank Sum	Observations
to 20	42	7
35-40	36	5
z Stat	-0.5684	
P(Z<=z) one-tail	0.2849	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.5698	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 11

	Rank Sum	Observations
to 20	34	7
30-35	44	5
z Stat	-1.8676	
P(Z<=z) one-tail	0.0309	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0618	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 12

	Rank Sum	Observations
to 20	37	7
40-45	54	6
z Stat	-1.7143	
P(Z<=z) one-tail	0.0432	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0864	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 13

	Rank Sum	Observations
45-50	28	5
30-35	27	5
z Stat	0.1044	
P(Z<=z) one-tail	0.4584	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.9168	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 14

	Rank Sum	Observations
40-45	35	6
30-35	31	5
z Stat	-0.1826	
P(Z<=z) one-tail	0.4276	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.8552	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 15

	Rank Sum	Observations
35-40	21	5
40-45	45	6
z Stat	-1.6432	
P(Z<=z) one-tail	0.0502	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1004	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 16

	Rank Sum	Observations
to 20	35	7
45-50	43	5
z Stat	-1.7052	
P(Z<=z) one-tail	0.0441	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0882	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 17

	Rank Sum	Observations
20-25	74	10
45-50	46	5
z Stat	-0.7348	
P(Z<=z) one-tail	0.2312	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.4624	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 18

	Rank Sum	Observations
45-50	47	5
25-30	58	9
z Stat	1.2667	
P(Z<=z) one-tail	0.1026	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2052	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 19

	Rank Sum	Observations
35-40	37	5
20-25	83	10
z Stat	-0.3674	
P(Z<=z) one-tail	0.3567	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.7134	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 20

	Rank Sum	Observations
20-25	74	10
40-45	62	6
z Stat	-1.1931	
P(Z<=z) one-tail	0.1164	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2328	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 21

	Rank Sum	Observations
25-30	60	9
40-45	60	6
z Stat	-1.4142	
P(Z<=z) one-tail	0.0786	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.1572	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 22

	Rank Sum	Observations
45-50	33	5
35-40	22	5
z Stat	1.1489	
P(Z<=z) one-tail	0.1253	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.2506	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 23

	Rank Sum	Observations
30-35	15	5
over 50	40	5
z Stat	-2.6112	
P(Z<=z) one-tail	0.0045	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.009	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 24

	Rank Sum	Observations
35-40	15	5
over 50	40	5
z Stat	-2.6112	
P(Z<=z) one-tail	0.0045	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.009	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 25

	Rank Sum	Observations
40-45	21	6
over 50	45	5
z Stat	-2.7386	
P(Z<=z) one-tail	0.0031	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0062	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 26

	Rank Sum	Observations
25-30	45	9
over 50	60	5
z Stat	-3	
P(Z<=z) one-tail	0.0013	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0026	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 27

	Rank Sum	Observations
20-25	55	10
over 50	65	5
z Stat	-3.0619	
P(Z<=z) one-tail	0.0011	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0022	
z Critical two-tail	1.96	

Wilcoxon Rank Sum Test 28

	Rank Sum	Observations
to 20	28	7
over 50	50	5
z Stat	-2.842	
P(Z<=z) one-tail	0.0022	
z Critical one-tail	1.6449	
P(Z<=z) two-tail	0.0044	
z Critical two-tail	1.96	