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Release of Construction Clients' Pre-Tender Cost Estimates: An Experimental Study

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Abstract

Clients engage consultant quantity surveyors or cost engineers to perform project cost estimates before calling for tender submissions. This experimental study examines the impact of releasing the clients' pre-tender cost estimates prior to bidding on student subjects' bidding behavioural patterns, and the extents to which their bidding tends to agree with the behavioural patterns proposed by Milgrom and Weber's theory. The results show that the provision of clients' pre-tender cost estimates prior to bidding does affect bidders' bidding behaviour. Bidders with access to the clients' pre-tender cost estimates prior to bidding, on average, recorded lower bids than those with no access to the estimate. However, the lower average bids do not result in statistically significant lower winning bids. These findings provide evidence in support of Milgrom and Weber's theory, demonstrating the practicality of an experimental approach using student subjects for testing theories in building economics research. The practical implication is that construction clients would need to consider their information policy on releasing pre-tender cost estimates to enhance efficiency in their procurement for construction services.

Keywords

Construction bidding, experiment, information release, pre-tender cost estimate.

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Introduction

One of the key choice variables in clients' procurement auction design is what information to reveal to prospective bidders. Some key aspects that the clients need to decide include: (i) how much information to reveal, (ii) what type of information to reveal; (iii) when is the best time to release the information; (iv) whether the information should be publicly available; and (v) whether the information should be released voluntarily or by regulatory mandate. Indeed, the topic of information disclosure has received much attention in the economics, finance, accounting, law and marketing literature (Tadelis and Zettelmeyer 2015). In auction theory in economics, Milgrom and Weber (1982a) stated that information never has a negative value to the decision-maker, and at worst, the decision-maker can ignore the irrelevant information. In a theoretical analysis of information revelation in a sealed-bid auction, they showed that seller's expected revenue rises if the seller commits to reveal information about the valuation of an object publicly. However, the ways in which information disclosure affect market outcomes will depend on the institutional features of a market (Tadelis and Zettelmeyer 2015).

In construction markets, the allocation of jobs to prospective contractors is often in the form of descending first price sealed-bid auctions (i.e., the lowest bidder wins at the lowest bid price). While information disclosure policies vary between client organizations, the common information provided to bidders prior to auction include project drawings and other related tender documents for bid preparation. Less common information includes the identity of competing bidders and the client's pre-tender cost estimate. For post-auction, again, the clients can opt for different levels of bidding feedback information, with some clients not providing feedback information (Drew and Fellows 1996). This study focusses on the release of client's pre-tender cost estimate prior to bidding.

A client's pre-tender cost estimate is an independent estimate of the cost of a project, prepared by a consultant quantity surveyor or cost engineer engaged by the clients. It is also known as pre-bid forecast, and has drawn researchers' attention to accuracy in estimating practices (e.g., Aibinu and Pasco 2008; Skitmore and Drew 2003; Skitmore and Picken 2000). In bid evaluation, this cost estimate forms a benchmark to judge the bids received from contractors. For example, clients may decide to reject a low bid and re-auction the project at a later date if there is a large discrepancy between the low bid and the cost engineer's cost estimate (De Silva at al. 2008). De Silva at al. (2008) have noted the different information release policies on the release of clients' pre-tender cost estimates in the United States, and their analysis provide evidence in support of Milgrom and Weber's theory in which the provision of public information regarding the valuation of an item is likely to induce aggressive bidding behaviour. The bidders in their field auction data of transportation projects had bid more aggressively after the release of public information on client's valuation prior to bidding. In line with De Silva et al. (2008), this experimental study examines the impact of releasing the clients' pre-tender cost estimates prior to bidding on student subjects' bidding behavioural patterns, and the extent to which their bidding tends to agree with the behavioural patterns proposed by Milgrom and Weber's theory. With very limited evidence in the literature, this study will add to our understanding of the effects of release of public information in construction bidding.

Literature Review

TYPE OF INFORMATION RELEASE IN CONSTRUCTION BIDDING

The type of information released in construction sealed-bid auctions can be broadly classified into two categories, namely public information and feedback information (Soo and Oo 2010). As the name implies, the former is publicly available to all bidders, such as project type and size, project location, client identity, project consultant team and geological data of a construction site. The other important piece of public information in construction bidding is the clients' internal cost estimates of projects, i.e., the pre-tender cost estimates. Clients engage consultant quantity surveyors or cost engineers to perform these cost estimates before calling the tender. De Silva et al. (2008) examined the policies on releasing clients' pre-tender cost estimates (known as engineers' cost estimates – ECE) in the United States. These policies may be broadly classified into five main types. These are: (i) no ECE release before or after the bid letting; (ii) actual ECE release before the bid letting; (iii) actual ECE release after the bid letting; (iv) release of a range of possible ECE values before the bid letting; (v) release of a budgeted estimate that may include costs that are not part of the bid amount before the bid letting. For the two last types, they noted that some states provide the actual ECE after the bid letting.

Turning into bidding feedback information in construction sealed bid auctions, clients have opted for different information feedback conditions in sequential auctions that are of different levels of competition and projects to bid on. In the full information feedback condition, bidders have access to the identity of all bidders and their respective bids at the end of each auction. In partial information feedback condition, bidders have access to the winning bid and the identity of winning bidder only. The importance of information feedback condition in procurement design have drawn attention from economists to experimentally examine the effects of varying information feedback conditions in sealed-bid auctions (e.g., Issac and Walker 1985; Engelbrecht-Wiggans and Katok 2008; Neugebauer and Perote 2008). Although the experimental findings in the economics literature seem to be mixed, they do provide substantial evidence that varying information feedback conditions affect bidders' bidding behaviour to different degrees in sealed-bid auctions. In the context of construction auctions, a series of experiments in the literature aimed at testing the effect of information feedback on bidders' competitiveness and learning (Soo and Oo 2010, Oo, Abdul-Aziz and Lim, 2011, Oo, Ling and Soo, 2014, Oo, Ling and Soo, 2015). Using inexperienced student subjects, these experiments provide evidence on variations in bids and learning over time for varying information feedback conditions. Nonetheless, there is a need for more empirical work, particularly using field data in exploring the ideal level of feedback information in optimizing procurement design (Oo, Ling and Soo, 2015). The focus of this study is, however, on the extent to which the release of client's pre-tender cost estimate prior to bidding affects bidders' bidding behaviour.

THE RELEASE OF CLIENT'S PRE-TENDER COST ESTIMATE AND BIDDERS' BIDDING BEHAVIOUR

In the theoretical auction literature, Milgrom and Weber (1982a) have shown that the release of public information regarding the valuation of an object will raise the seller's expected revenue. In their Theorem 7, if X and Y are independent estimates from the respective bidder and seller, or they may be estimates that are subject to some common source of error (i.e., X and Y are informational substitutes); they showed that the expected seller's revenue is

higher when the seller adopts a policy of making his information *Y* publicly available (see also Theorem 16 in Milgrom and Weber 1982b). Indeed, they further pointed out that it is common for sellers in auction-like situations to obtain expert appraisals of the items being offered, and to commit themselves to release these appraisals publicly. In a competitive environment, it follows that the release of seller's valuation of an object can make values more predictable and thus encourage more intense competition among bidders (De Silva et al. 2008). While these predictions are widely accepted, De Silva et al. (2008) noted that they remain largely untested in auction theory literature, especially no test has been performed using field auction data. In addressing this knowledge gap, they tested Milgrom and Weber's theory using the auction data of transportation construction projects between January 1998 and August 2003 from Oklahoma Department of Transportation. The dataset covers a period of change in information policy from "no release of ECE" to "full release of ECE" before bid letting that enabled them to examine the effects of change in ECE policy. Their analysis provides evidence in support of the theory where the average level of bids is lower after the release of ECE before bid letting. However, they found that the lower average bids do not result in statistically lower winning bids despite the reduced variances in bids following the change in the ECE policy. In another study, a similar set of auction data from the same department between January 1997 and August 2003 was used to examine the effects of respective change in the ECE policy on bidding behaviour and survival of entrants in the market (De Silva, Kosmopoulou and Lamarche, 2009). The two major findings in their analysis are: (i) the release of the ECE eliminates the bidding differential between entrants and incumbents, and (ii) the entrant bidders who used to exit the market relatively soon are now staying longer in the market.

To the author's knowledge, De Silva et al. (2008) and De Silva, Kosmopoulou and Lamarche (2009) are the only two studies that have specifically examined the effects of the release of client's pre-tender cost estimate prior to bidding on bidding behaviour using field auction data in economics literature. Although their datasets are construction auctions for transportation projects, there are many noise factors (especially for field auction data) that one should try to accommodate in the analysis, which has been well demonstrated in De Silva et al.'s (2008) and De Silva, Kosmopoulou and Lamarche's (2009) statistical modelling attempts. In line with De Silva et al. (2008), this experimental study examines the impact of releasing the clients' pre-tender cost estimates, i.e., the consultant quantity surveyors' cost estimate (CQSCE) prior to bidding on student subjects' bidding behavioural patterns, and the extent to which their bidding tends to agree with the behavioural patterns proposed by Milgrom and Weber's theory. Three research hypotheses are set below that form the foundation of this experimental study:

H1: the provision of CQSCE affects bidders' bidding behaviour.

H2: the average level of bids for bidders with access to CQSCE is lower than for those with no access to CQSCE.

H3: the provision of CQSCE affects winning bids.

FIELD AND EXPERIMENTAL FINDINGS

Before proceeding to describe the experiment, it is appropriate to discuss the importance of having both field and experimental findings in construction bidding research in justifying the

adopted experimental approach. It has been widely recognized that field data for empirical analyses on bidding is limited by the difficulties of obtaining data (Skitmore and Runeson 2006). Indeed, it is not uncommon to note that existing data sources were repeatedly used in different analyses to test the respective phenomenon of interest (e.g., De Silva, Kosmopoulou and Lamarche 2009; Skitmore and Runeson 2006; Skitmore 1991). While the lack of realism and generalizability may not be an issue in field results, there are many noise factors in field bidding data that one should consider in data analysis as highlighted above. Experimental results, on the other hand, have contributed to a body of experimental knowledge in construction bidding on causal relationships between variables of interest via active manipulation of variables, which can only be achieved in an experimental setting (Oo 2016). Guala and Mittone (2005) referred this body of experimental knowledge as a 'library of robust phenomena'. Nonetheless, Oo (2016) pointed out that many researchers in the discipline are still reluctant to accept laboratory evidence due to the problem on generalizability (i.e., the external validity). There is not currently, and has never been a serious debate on the external validity of laboratory evidence and that adds to reluctance by researchers of using experiments in construction bidding research. In addressing these problems, Oo tested the external validity of an experimental approach in terms of subject pool effects via a direct replication of a bidding experiment in Oo (2007) by replacing its nonstudent construction executives (professional) subjects with student subjects. Her findings suggest that the subject pool *per se* is not a threat to external validity of the bidding experiment in which the student subjects' bidding behavourial patterns, in terms of decision to bid and mark-ups are sufficiently similar to that of the professionals. These findings provide evidence on the robustness of experimental results in building economics research that used student subjects, and similarly in this study where student subjects were used. Although Oo's (2016) study is the only study hitherto that examined external validity of experimental studies in building economics research, this problem has been much debated in the social sciences of which building economics and construction bidding research are parts. In defending the external validity of experimental studies, many authors have concluded that field and laboratory results are highly complementary, and that both are important to the progress of knowledge in social sciences (e.g., Levitt and List 2007, Falk and Heckman 2009, Kessler and Vesterlund 2015), and this is true also for building economics and construction bidding research (Oo 2016). To illustrate that field and experimental findings are complementary in construction bidding research, consider the following hypothetical example. Suppose that the field findings with quantitative results (i.e., the point predictions) show that there is an inverse relationship between number of bidders and contractors' mark-up levels, and that similar relationship was observed in experimental findings (i.e., the direction on response is similar); these complementary results show no significant difference in a way that would lead us to draw a different conclusion. However, even if in a scenario where the respective field and experimental findings do not agree with each other, future attempts should aim to test the relationship (theory) where the disagreement can be resolved by reference to facts, i.e., a theory should be positive and testable (Runeson and Skitmore 2008). Runeson and Skitmore (2008) state that a theory is progressive, i.e., useful, if it generates scientific progress. It is important to use tried and tested theories and methodologies in progressing science in the construction management and economics research (Runeson and de Valence 2015). This paper aims to test the Milgrom and Weber's theory using experimental data.

Research Method

An experimental research design was adopted in this study. A group of students enrolled in a construction estimating course at the University of New South Wales participated in the experiment in 2016. The subjects were randomly assigned to one of the two experimental treatments: biding for hypothetical projects with (Y) and without (N) access to consultant quantity surveyors' cost estimate (CQSCE). There were 44 subjects in each treatment group. It was a single-round experiment where the subjects were given a list of ten hypothetical projects and they were required to decide which project to bid for, and the bid price if deciding to bid. This was done to examine the student subjects' intuitive responses when they were exposed to the two experimental treatments.

The general instruction to the subjects was that their ultimate aim was to survive and prosper in competition with up to six ($N = 6$) bidders where the lowest bidder wins the job. For both groups, the subjects were provided with project information on location, duration, client, contract type, and a contractor's in-house cost estimate (termed as your firm's cost estimate in the instrument) for each hypothetical project. The contractor's cost estimate was defined as unbiased project construction cost estimate that included site overheads and project preliminaries (i.e., total of direct cost estimate + site overheads). Subjects in treatment Y were, however, also given the CQSCE along with the contractor's in-house cost estimate. The CQSCE was defined as the pre-tender cost estimate of the project, estimated by a consultant quantity surveyor engaged by the client. Identical hypothetical projects were given to both treatment groups to enable direct comparisons.

To ensure that the experiment effectively tested the research hypotheses, various measures were adopted to control extraneous variables (project type, size, location, duration and client type). All the hypothetical projects were, for instance, created using the information from past real contracts obtained from the New South Wales e-tendering website. They were all public sector general building projects (schools and public buildings) ranging from approximately $4 to $ 10 million dollars. Both subject groups were exposed to situations that were exactly alike except for the differing conditions of accessing CQSCE. The experiment was conducted in class where the subjects were given a chance to ask questions after reading the instructions, and were presented with the descriptive experimental results a week after the experiment as a feedback to facilitate their learning. Indeed, based on the students' feedback, the experiment could be further developed into a game play for teaching and learning purposes. Interested readers could refer to Oo and Lim (2016) for a bidding game that was designed for teaching and research use and has had been used in different universities in Asia and Australia.

For comparing the two treatment groups, the measure in De Silva et al. (2008) was adopted where a subject's bid was measured as the bid divided by the CQSCE, known as relative value of bid. Relative value of bids less than unity indicate that the subjects' bids were below the CQSCE and vice versa. Both the relative value of bids and winning bids were examined in the analysis. Although the contractor's in-house cost estimate of a project (that is identical between two treatment groups) could also be used as the baseline to calculate the mark-up values of each submitted bid, the CQSCE was used in the analysis. This was done because the primary interest here is to measure the between-subjects' variations for the effect of the treatment variable – CQSCE. It should also be noted that: (i) bids judged to be non-serious (i.e. outliers) with ratios greater than 1.25 (more than 25% above the CQSCE) were excluded, and (ii) non-parametric statistical tests were used in the analysis as a Kolmogorov-Smirnov test indicated the data sample was not normally distributed.

Results

RELATIVE VALUE OF BIDS

Table 1 shows the breakdown of the data sample and the relative value of bids. The data sample is relatively balanced between the two treatment groups in terms of numbers of bids or no-bids and outliers. A total of 317 and 310 serious bids were received from the treatment groups Y and N, respectively. The relative values of the bids show that the average relative bids for group Y (1.0360) is lower than group N (1.0572), indicating the average level of bids is lower for those with access to CQSCE (i.e., *H2*). Group Y also appears to bid more consistently compared to group N with a slightly lower standard deviation value. Although there is evidence that group Y generally bid lower with access to CQSCE, it is interesting to note that the recorded minimum relative value of bid for the group is actually about 6% higher than for group N. This seems to suggest that access to CQSCE made the subjects in group Y more attentive in their bidding, without inducing them to submit extremely low bids.

Table 1 Relative value of bids

Access to CQSCE	Bids	No-bids	Outliers	Relative value of bids			
				Mean	Min	Max	Std. Dev.
Yes (Y)	317	100	23	1.0360	0.8759	1.2498	0.0730
No (N)	310	104	26	1.0572	0.8230	1.2383	0.0800

In testing *H1* and *H2*, a Mann-Whitney U-test was performed to test the difference in distributions of the relative value of bids for the two treatment groups. The test shows a statistically significant result (mean rank: 288.32 [Y]; 340.26 [N]; $U = 40{,}995$; $Z = -3.59$; $p < 0.05$), providing evidence of a lower average level of bids from group Y. This means that the two different experimental treatments have resulted in statistically different distributions of the relative value of bids where the subjects do consider the CQSCE in their bidding decision making in support of *H1*, and that average level of bids for bidders with access to CQSCE is lower than for those with no access to CQSCE in support of *H2*.

RELATIVE VALUE OF WINNING BIDS

In examining the relative value of winning (lowest) bids for the ten hypothetical projects, a data exploration procedure in Oo (2007) was adopted and performed to extract the sample of potential lowest bids from all possible bid combinations for each hypothetical project. For example, in a competition of six bidders, a total of 33 bidders (out of 44) submitted bids, the data exploration procedure was performed to extract the sample of six potential lowest bids. Table 2 shows the descriptive statistics of the relative value of the ten winning bids for both treatment groups obtained from the data exploration procedure. In contrast to average relative value of bids, it can be seen the relative value of winning bids from group Y is now marginally higher (0.17%) than group N, indicating an overall higher level of winning bids. However, a test of the distributions of the relative value of winning bids show that there is no statistically significant difference between two treatment groups at $p < 0.05$ level (mean rank: 13.10 [Y]; 7.90 [N]; $U = 24$; $Z = -1.965$; $p = 0.052$). This finding is not in support of *H3*, i.e., the provision of CQSCE does not result in statistically significant lower winning bids.

Nonetheless, as expected, the variability of winning bids for group Y is lower than group N as shown by the recorded standard deviation values.

Table 2 Relative value of winning bids

Access to CQSCE	No. of projects	Relative value of winning bids			
		Mean	Min	Max	Std. Dev.
Yes (Y)	10	0.9777	0.9626	1.0007	0.0120
No (N)	10	0.9760	0.9558	1.0485	0.0324

Discussion

Overall, the empirical analysis using the experimental dataset provides evidence in support of Milgrom and Weber's theory that the provision of public information regarding the valuation of an item affects bidders' bidding behaviour. The results show that the provision of CQSCE do affect the subjects' bidding behaviour with lower average bids for those with access to CQSCE. However, the lower average bids do not result in statistically significant lower winning bids. Also, the variance of bids is lower when CQSCE is provided. These three main findings are consistent with the findings in De Silva et al. (2008) which were based on a large collection of field bidding data for testing the Milgrom and Weber's theory. Interestingly, the average relative value of bids (Table 1) and winning bids (Table 2) are also consistent with those of De Silva et al. (2008). In both treatment groups, the average relative value of bids is greater than unity while the average relative value of winning bids is below 1 but greater than 0.9. This seemingly suggest that, despite the provision of CQSQE to subjects in group Y which may induce aggressive bidding behaviour, all subjects in the experiment had bid rationally with very low number of outliers (i.e., only between 6 to 8% of total number of bids in both treatment groups). The other evidence on the subjects' rationality in bidding is the recorded lowest winning bids for the ten hypothetical projects that are just 4 to 5% below the CQSCE for both treatment groups.

Nonetheless, it is acknowledged that this experimental study provides a very limited test on the tenability of Milgrom and Weber's theory in construction bidding. The robustness of the experimental data and subsequent analysis, however, warrant further experimental studies on the effects of provision of public information on valuation of an item prior to bidding. This information policy would have implications on clients' procurement practices. In particular, if further studies confirm De Silva, Kosmopoulou and Lamarche's (2009) findings that the provision of client's pre-tender cost estimate prior to bidding would eliminate the bidding differential between entrants and incumbents, and thus enhancing competition with potential efficiency gains, a more informed decision can then be made by the clients as to whether or not to release this information.

Lastly, one must not forget that the participants in this experimental study were student subjects. The subjects submitted rationale bids that support the use student subjects in similar studies testing theories as advocated in Oo (2016). Together with the groups of experimental studies on information feedback in construction bidding that used student subjects as highlighted in the above review, the robust findings in this study should lead to more confidence in the use of experimental approaches in building economics research.

Conclusion

Clients' decisions to release or not to release their pre-tender cost estimates prior to bidding is an important procurement design variable that has implications on procurement efficiency. However, there is very little evidence about the consequences of the respective information policies. With a simple, yet effective experiment, this study examined the impact of releasing the clients' pre-tender cost estimates, i.e., the consultant quantity surveyors' cost estimate (CQSCE) prior to bidding on student subjects' bidding behavioural patterns. Promisingly, the results are largely consistent with a similar test in De Silva et al. (2008) that used field bidding data, providing further evidence in support of Milgrom and Weber's theory. The results show that the provision of CQSCE affect bidders' bidding behaviour in support of *H1*, and that average level of bids for bidders with access to CQSCE is lower than for bidders with no access to CQSCE as suggested in *H2*. However, the lower average bids do not result in statistically significant lower winning bids, and this finding is not in support of *H3*. Despite the statistically insignificant effect on winning bids, the results have prompted further investigations on the significance of releasing public information on client's valuation of an item prior to bidding. Both public and private construction clients would need to consider their information policy on releasing pre-tender cost estimates to enhance efficiency in their procurement for construction services.

Together with the groups of experimental studies on information feedback in construction auctions that used student subjects, this study has again demonstrated the practicality and suitability of using experiment with student subjects in testing theory in construction bidding research. It is recognized that experimental approach is a viable alternative to field studies and that it should be considered for a wider range of applications in advancing the progress of knowledge in building economics research. One possible experiment in future work would be to replicate the experiment with multiple bidding rounds to simulate the recurrent sequential bidding in construction. In this, one could examine the bidders' bidding behaviour in terms of competitiveness and learning over time with this information release.

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