
Volume 95, No. 1, April 2007
ISSN 0165-1765
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economics letters
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A change in the timing of auctions with synergies and its impact on bidding behavior

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Received 31 December 2005; received in revised form 7 August 2006; accepted 6 September 2006
Available online 28 November 2006

Abstract

We compare auctions held in simultaneous and multi-round formats, where synergies and the release of relevant information can create differential bidding effects. We find no statistically significant difference in either the bidding patterns observed or the number of bids submitted.

Keywords: Synergies; Procurement auctions

JEL classification: D44; H57

1. Introduction

When bidding on multiple objects, bidders' strategic behavior is often underlined by informational effects and considerations of synergies. These factors can have a significant impact on the revenue rankings of different auction formats. We empirically investigate the impact of a change from a multi-round to a single-round simultaneous auction setting on bidding behavior and participation patterns.

Every month, the Oklahoma Department of Transportation (ODOT) calls sealed bids from prospective bidders to auction off road construction contracts. Until March 2002, ODOT auctioned off these contracts

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doi:10.1016/j.econlet.2006.09.014

in two separate sessions on a single day. A number of projects were auctioned off simultaneously within each session. After the first session, ODOT revealed all information generated, that interested bidders could take into account when submitting bids in the second session. Since March 2002, all auctions are held simultaneously in an effort to reduce operational costs. Using data from 1997 to 2003, we investigate the following questions: (1) Is bidding behavior more aggressive when some auctions are performed in a sequence or is it better to auction all contracts simultaneously? (2) Is the probability of submitting a bid or the number of submitted bids different in the two settings?

One of the primary concerns in recent theoretical work was that the auction mechanism should allow bidders to realize potential synergies. Krishna and Rosenthal (1996) showed that, in the independent private value context, bidders bid more aggressively in the simultaneous auction format if synergies are present. Rosenthal and Wang (1996) analyzed simultaneous auctions when the objects have common values, and also observed aggressive bidding behavior among bidders who could realize synergies. In the absence of synergies, on the other hand, Milgrom and Weber's (2000) work suggests that, due to informational effects, sequential auctions can generate more revenues than simultaneous auctions. When considering revenue enhancing (or cost reducing) changes in auction rules, both the restrictions on the information flow and potential synergies should be taken into account.

The empirical literature has focused on the effect of synergies on seller's revenues in single auctions (see, for example, Gandal, 1997; De Silva, 2005). In experimental work, however, Lunander and Nilsson (2004) compare simultaneous and sequential first-price sealed-bid auctions. They show that, despite the potential for synergies, revenue comparison between formats produced statistically insignificant differences. Our goal is to provide field evidence of the relative performance of multi-round and simultaneous first-price sealed-bid auctions. We do not find a statistically significant difference in bidding that could be attributed to the change in the timing of auctions.

2. Data

We use data from ODOT and the Texas Department of Transportation (TXDOT) on auctions that took place between January 1997 and August 2003.[2] Note that TXDOT had a uniform policy of holding two sessions within a month throughout our period of analysis. This unique natural experiment allowed us to evaluate the impact of the change in the timing of auctions in Oklahoma and compare bidding behavior with a control group.

In both states, bidders learn the location and the detailed project description, the estimated completion time, the engineer's cost estimates, and the plan-holders list (the list of contractors who purchased plans) at least 28 days before an auction. At the conclusion of each session, the bids submitted by each bidder are revealed.

The timing of the auctions can affect the potential to pursue synergies. A road construction company may realize positive synergies by undertaking a number of projects in the same geographic area at the same point in time. Competitive advantages may be associated with equipment sharing or better opportunities on local market resources. On the other hand, negative synergies may arise due to excessive capacity utilization (Jofre-Bonet and Pesendorfer, 2000). The timing can also affect the information flow.

[2] The ODOT data were obtained from four reports, namely the project *plan holder list, as read bid report, low bid report,* and *award notices* which are available on the ODOT website. TXDOT data were gathered from similar reports provided by TXDOT.

In this sequential setting, the project description and engineering estimates are available to all bidders ex ante. The relevant information released pertains to the rival bids. Our study examines timing effects on bidding while taking these factors into account.

We use data from January 1997 to March 2000 to create variables based on bidder history such as capacity utilization, whether the bidder is bidding on a location where he has an ongoing project, and potential rivals' capacity commitment. Data from April 2000 to August 2003 are used to analyze the empirical models.[3] We are interested in examining the bidding behavior of bidders who bid before and after March 2002. Hence, we utilize data of only those firms that submit multiple bids between March 2000 and August 2003 and use panel data techniques to control for unobserved bidder heterogeneity. We have altogether 26,446 plan holders who submit 15,831 multiple bids. For the entire period, 2547 projects were awarded in Texas and 1063 in Oklahoma. The average values for the relative bids before and after the change were 1.060 and 1.029 in Texas and 1.038 and 1.014 respectively in Oklahoma.

3. Empirical model and results

First, we test how a change in the timing of auctions affected bidding behavior in Oklahoma compared to Texas using a panel-data differences-in-differences (DID) methodology. Our econometric specification, allowing for differential effects across the two time periods is

$$\text{rbid}_{iat} = \alpha_i + \beta_1 D_t^{\text{OK}} + \beta_2 D_t^{\text{AF}} + \beta_3 D_t^{\text{OK,AF}} + \beta_4 D_t^{\text{OK,AF}} {*}\text{capacity}_{it} + X\Gamma + \varepsilon_{iat}$$

where the unit of observation is firm i bidding in auction a in time period t. The dependent variable used throughout the analysis is the relative bid. The independent variables include controls for the change in the timing of auctions, variables on auction characteristics, bidder characteristics, rival characteristics and characteristics of the business environment.

The β's measure the changes in bidding in Texas and Oklahoma across periods. The coefficient on D_t^{OK}, β_1, measures the average difference in bidding in auctions in Oklahoma relative to Texas throughout the period of analysis. β_2, captures the average difference in bidding between all auctions held before and after March 2002. β_3 measures the difference in bidding that occurs in Oklahoma auctions compared to Texas auctions in the period after the change in the timing. It captures the effect of the timing on bidding in the presence of positive synergies and informational effects (due to the linkage principle). β_4 isolates any differential impact on bidding due to capacity utilization. Our main interest is in the coefficients β_3 and β_4. For an accurate prediction of the effect of the change in the timing of auctions in Oklahoma we must control for the other factors that could impact Oklahoma auctions held after March 2002 differently than Texas auctions.

There are two auction-level variables—the expected number of bidders and a set of project type dummies. Since the actual number of bidders is not known to participants, it may not be the best measure of competition in this setting. Instead we incorporate the expected number of rivals which is calculated using past information for each potential bidder on the list of plan holders.[4] We have also identified six

[3] Since April 2000 ODOT and TXDOT release similar information before and after each session. Before April 2000 ODOT did not release the engineer's cost estimate.

[4] This variable is constructed in the spirit of the measure on expected number of bidders developed by Hendricks eet al. (2003). For each plan holder at time t, we construct the participation probability as the past bidding to plan holder ratio. Then for an auction at time t, we sum across these participation probabilities, for all potential competitors, to create the variable on expected number of rivals.

Table 1
Relative bid regression results

Variable	Base model multiple bids (1)	Multiple bids in a given month (2)	Multiple bids on the same division in a given month (3)
Oklahoma bids (β_1)	.001 (.051)	−.023 (.071)	−.341 (.242)
Bids after March 2002 (β_2)	−.035** (.010)	−.037** (.013)	−.026 (.024)
Oklahoma bids after March 2002 (β_3)	.015 (.016)	.022 (.018)	.019 (.028)
Oklahoma bids after March 2002 × Capacity(β_4)	−.019 (.031)	−.029 (.039)	−.054 (.098)
Firm bidding on a division where there is an ongoing project	−.009* (.004)	−.005 (.005)	−.016** (.007)
Expected number of rivals	−.009** (.001)	−.008** (.001)	−.009** (.002)
Capacity	.026** (.010)	.020 (.012)	.034** (.017)
Distance to project location	.007** (.003)	.007** (.003)	.003 (.005)
# Obs	15,831	12,390	9579
Adj R^2	.137	.122	.212

**Denotes statistical significance at the 5% level and * at the 10% level. Robust clustered standard errors using firm level clusters are in parentheses. All regressions include a constant term, five project class dummy variables, the closest rival's distance to the project location, the rivals' minimum backlog, 11 monthly dummy variables, and four controls for the business environment.

different project types: asphalt-related projects, concrete work, bridge projects, traffic lights and signals, grading and drainage projects, and erosion control projects. We include two variables that measure the cost heterogeneity of bidders, in addition to firm fixed effects: bidder's capacity utilization rate (*capacity*) and bidder's distance to a project. Further, we include a dummy variable, if a firm is bidding on a division where there is an ongoing project, to control for any such geographical synergies. We constructed two variables to measure rival characteristics. We include the rivals' minimum distance to the project and the minimum backlog.[5] Finally, we control for changes in factors other than the timing rule. Four variables control for the business environment.[6]

All DID models are estimated with firm fixed effects to control for bidder heterogeneity and the standard errors reported are cluster-robust where the clustering is on firms. We estimate the models on three distinct samples of bids. One sample includes all multiple bids submitted by bidders (analyzed in model (1) of Table 1). A second sample estimates the model using only bidders who had an interest in multiple projects within a single month and could take advantage of some synergies by submitting multiple bids (model (2)). The third sample considers multiple bids submitted in the same division by each firm that could identify stronger synergies (model (3)). This sample will assess the potential impact of synergies with a focus on location. Ceteris paribus, if the timing change induces more aggressive bidding

[5] These variables are similar to variables used by Bajari and Ye (2003), Jofre-Bonet and Pesendorfer (2000) and De Silva et al., (2005b).

[6] The first is the monthly, seasonally unadjusted, state-level unemployment rate for Oklahoma and Texas, gathered from the US Bureau of Labor Statistics. Next, we use the three-month average of the real volume of projects, constructed from the engineering cost estimates. Next, we consider the state-specific three-month average of the number of building permits collected from the US Bureau of Economic Analysis. Finally, we use monthly dummies to control for any seasonal variations. Since they are not our focus here their effects are omitted from the table for brevity. Some of those controls have also been used in De Silva et al. (2005a).

Table 2
Probit regression results

Variable	Probability of bidding (1)	Probability of winning conditional on bidding (2)
Oklahoma bids (β_1)	−.140** (.025)	.007 (.020)
Bids after March 2002 (β_2)	.042* (.022)	−.027 (.019)
Oklahoma bids after March 2002 (β_3)	.019 (.030)	.021 (.024)
Oklahoma bids after March 2002 × capacity (β_4)	−.103 (.064)	−.078 (.048)
Firm bidding on a division where there is an ongoing project	.139** (.013)	.057** (.010)
Expected number of rivals	−.022** (.003)	−.032** (.002)
Capacity	.060** (.020)	−.033** (.016)
Distance to project location	−.021** (.006)	−.016** (.003)
# Obs	26,448	15,831
Wald χ^2	539.47	434.68

**Denotes statistical significance at the 5% level and * at the 10% level. Robust clustered standard errors using firm level clusters are in parentheses. All regressions include a constant term, five project class dummy variables, the closest rival's distance to the project location, the rivals' minimum backlog, 11 monthly dummy variables, and four controls for the business environment.

in a simultaneous setting, as suggested by the literature, β_3 should become more negative and significant as we move from model (1) to model (2) and then to (3).

In Table 1, the key parameter of interest, β_3, shows that there is no difference in bidding between Oklahoma and Texas auctions that can be attributed to the change in the timing. This result holds across all models even if strong synergies could be realized by undertaking multiple projects in the same division. Given the nature of information flow available here, the differential effect of the linkage principle between models (2) and (3) should be small. Model (3) on the other hand, should display a relatively larger synergy effect since we focus on multiple bids in the same division. In theory, there should be a significantly positive difference in β_3 across the two models. We find no such evidence here, suggesting that even in the presence of strong synergies there is no significant timing effect. The interaction effect between the dummy and the variable on capacity utilization suggests that the potential diseconomies of scale do not have a differential impact on bidding due the change in the timing of auctions. With regard to the other variables, we identified the following patterns across timing rules. Firms, bid more aggressively in divisions where there are ongoing projects. If more competitors are expected the procurement costs becomes lower. Bidders with a higher capacity utilization rate tend to bid higher. The larger the distance of a bidder from a project location, the less aggressive is his bidding behavior. The variables that measure business conditions show weak effects. Further, we estimate these models for relative winning bids and find no effect of the change in timing on winning bids either. These results can be obtained from the authors upon request.

Another way that information from an early session can affect the auction process is by changing the probability to submit a bid and the number of submitted bids. In column 1 of Table 2, we report the probit model results for bid submission. Column 2 shows the probability of winning conditional upon bidding. We find no statistically significant effect in the parameters of interest, β_3 or β_4.[7]

[7] Alternatively, we considered the effect of the format change on the number of bids submitted by a bidder in a single month. We estimated a count data model on the number of bidders. In this specification, we also used the log of the engineering estimate, the number of plan holders and included 32 project location dummies. We found no statistically significant effect in the parameter of interest, β_3 here either.

4. Conclusion

In this paper, we investigate the impact of a timing change in ODOT auctions on bidding behavior. Using the DID approach, we find that the change has no statistically significant effect on firms' bidding behavior and bidder participation patterns. We considered three different models and found that, even in the presence of potentially stronger synergies, the timing change has no significant impact on bidding.

Acknowledgments

The authors would like to thank Timothy Dunne and the referees of this journal for the valuable comments.

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