Collusion, Breakdown, and Competition in Procurement Auctions*

Tadanobu Tanno† Takayuki Hirai‡

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Abstract

This research investigates reasons to break-down bid rigging and evidence of the character of official-led bid rigging to analyze procurement auctions data in a municipality of Japan. During the collusive period, bid rate and winning bid rate are very high. Municipal officials control designated winning bidder among cartel members based on their backlogs. After investigation by the competition authority, the municipality reformed the auction market. The reform successfully assures competition. Entry induces the incumbents lower bids during the competitive period.

Keywords: Procurement Auctions, Collusion, Bid rigging, Official-led
JEL classifications: D44, H57.

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†Atomi University. Correspondence: 1-9-6 Nakano, Niiza, Saitama 352-8501, Japan. tel: +81-48-478-4110 fax: +81-48-478-4142 email:tanno@atomi.ac.jp This research is supported by the Special Research Fund at Atomi University, as well as by Grant-in-Aid for Scientific Research 21530231.

‡Institute of International Exchange, Tokyo International University.

1 Introduction

Bid-rigging in procurement auctions is a serious problem in Japan. It was implicated in almost half the cases in which the Japan Fair Trade Commission (JFTC) took legal measures during the five years preceding March 2010.[1] A characteristic of collusion in Japanese procurement auctions is bid rigging by officials. Bureaucrats responsible for conducting auctions sometimes promote collusion in their procurements to spend their budget.[2]

This research investigates firms' bidding behavior and market design in procurement auctions at an unidentified Japanese city.[3] In the middle of analysis period, JFTC initiated legal measures against collusive participants in procurement auctions and city officials in the involvement of the bid rigging. We compare collusion and competition in these auctions to understand the characteristics of official-led bid rigging and the effects of auction reform. The timing of JFTC's actions enables this research to separate data into distinct periods of collusion, transition, and competition. We are able to evaluate the changing characteristics of auction markets and assess effectiveness of auction reforms. Our examination of these three periods suggests that JFTC's investigation initiated a breakup of the auction cartel and that city reforms of its procurement auctions were successful.

Porter and Zona (1993) identify evidence of bid rigging by analyzing rank distributions of cartel and non-cartel bids in highway construction auctions. Pesendorfer (2000) analyzes collusive schemes in the awarding of school milk contracts and suggests that collusion augments efficiency by non-cartel members' competitive pressures. A related defense of bid rigging is that officials allocate contracts to colluding firms efficiently. We investigate these hypotheses using data for the unidentified city's procurement auctions. Bajari and Ye (2003) develop a mechanism to detect collusion by comparing the behaviors

[1] See JFTC's Annual Report for Fiscal Year 2010.

[2] When a reserve price is secret, a municipal auctioneer in a bid rigging scheme leaks it to colluding bidders. See McMillan (1991) and Black (2004).

[3] We were able to obtain the data under the condition that the name of the city remained confidential.

of cartel and non-cartel members against cost factors in construction procurement auctions. Many studies on Japanese procurement auctions (Izumida (2005), Iimi (2006), Ishii (2009), and Ohashi (2009)) are conducted in their own interests. Izumida (2005) first analyze procurement auction markets in Japanese local governments. He investigates an effect of configurations of congress in local governments and types of their chiefs on bid prices in these auctions. He shows that in municipalities where mayors belong to Liberal Democratic Party, an average bid price in their procurement auctions on public works is higher. Political and bureaucratic pressure on contractors distort bid price in procurement auctions. Since existing research and evidence concerning behaviors of bidders and officials in official-led bid rigging are insufficient, we analyze bidders' behavior in the official-led bid rigging to compare the collusion with competition in response to changes in market design. We investigate how official-led bid rigging operates rather than how to detect it.

Previous research on auctions of public works (Bajari and Ye (2003) and De Silva *et al.* (2003)) incorporates backlogs of uncompleted contracts and distance from a location of a bidder to that of a contract into costs across bidders.[4] We show that the backlog is associated with significantly higher bids during the collusive period, while the distance is not statistically significant during the competitive period. Colluding city officials designated a winning bidder among colluding firms to take account of their backlogs.[5] In this aspect bidders reasonably behave. However, the official-led bid rigging is generally inefficient since the distance as a cost factor is not reflected in their bids. We also show that several measures to reform auctions significantly lower bids. New entry after relaxing regional requirement for participation makes auctions market more competitive. Especially, the reaction of incumbents against entrants lowers bids significantly.

This paper is organized as follows. Section 2 describes the bidding system and its reform. Section 3 examines descriptive statistics of the data. Section

[4]The backlogs increase bidder's cost since workers and machinery needed to complete previous contracts are unavailable for new contracts.

[5]This consideration is documented in JFTC recommendations and newspaper articles.

4 presents estimation results. Section 5 is a conclusion of the paper.

2 Bidding System, Official-led Bid rigging and Reform

This research is grounded in auction data involving civil engineering and landscaping projects for an unnamed Japanese municipality from April 2000 to March 2006. Since many identical firms bid in auctions for both types of projects, we regard them as a unified market.[6] Public works contracts are awarded via first-price sealed-bid auctions. Prior to auction, the city had conducted an engineering estimate of the project's material and labor costs. This undisclosed estimate represented the amount the city was willing to pay, and it became the reserve price for awarding contracts. Firms that submitted the lowest bid beneath the project's estimated engineering cost received the contract.

In May 2002, JFTC began investigating bidding firms and the municipal office for bid rigging.[7] In January 2003, JFTC issued the recommendation decision. It announced that city officials had been secretly leaking engineering cost estimates to a series of pre-designated winning bidders. The chosen firm would bid slightly less than the estimate to secure a profit, and its fellow conspirators submitted higher bids. Besides fining the colluding firms for violating the Anti-monopoly Act, JFTC requested remedial action from the mayor under the Act on Elimination and Prevention of Involvement in Bid Rigging.

The municipality executed several reforms of its bidding system. First of all, to attract new bidders it relaxed the requirement that eligible bidders must reside in the city. Second, it began releasing the engineering cost estimates publicly prior auctions. Third, the city introduced general and designated

[6] The same decision is written in the JFTC recommendation to calculate the payment of a surcharge for violating the Antimonopoly Act.

[7] According to the Japanese press reports, from the beginning this collusion was suspected to be an official-led bid rigging. However, the municipality denied that the bid rigging was led by officials, and stopped auctions to reform its bidding system for a fixed period.

electronic bidding systems so that firms no longer had to appear at the city office to receive specifications and submit bids. The systems removes opportunity for face-to-face interaction among bidders.

In this paper, the data covers 1,004 contracts that consist of civil engineering(865) and landscape gardening (139). The effective number of bids in the auctions is 7,814. Since each contract differs in size, we define the size of bids relative to projects' engineering cost estimates. That is, we use the (winning) bid rate to refer to the ratio of (winning) bids over their engineering cost estimates. Figures 1 and 2 indicate changes in the bid rate and winning bid rate, respectively. We designate the period between JFTC's investigation and its recommendation as the "transition period." We identify bidding before and after the transition period as the "collusive period" and the "competitive period," respectively. Periods A, B, and C denote the collusive period, transition period, and competitive period, respectively. After engineering estimates began to be published before auctions, the maximum bid rate was 100%. As Figures 1 and 2 show, the bid and winning bid rates decline from the collusive to the competitive period.

3 Descriptive Statistics of the Data

Table 1 summarizes descriptive statistics of bid rates and winning bid rates. The arithmetic mean of bid rates diminished gradually across periods. This value decline 5.9% from the collusive (0.998) to the competitive period (0.939). The mean of winning bid rates also fell 9.5% from 0.965 to 0.873. We measure fluctuation in bids by the coefficient of variation (CV).[8] The CV for the bid rates increased by 87.5%, and for the winning bid rates rose by 344.4% from period A to C.[9] This is consistent with the finding in Abrantes-Metz *et al.* (2006), who estimate a relatively small difference in price, but a huge

[8]The CV for a variable is a variance divided by its mean.

[9]However, the CV for the winning bid rate declines from the collusive period to the transition period. It is only an exception due to the transition period.

difference in variance after the breakdown of a cartel.[10] Despite there may be differences between the bid rigging and the price-fixing cartel, the bidding prices have shown a similar movement before and after the conspiracy. Findings by Abrantes-Metz *et al.* (2006) and these large variations sufficiently indicate that the city's procurement auctions become more competitive.

Table 1 is also shown descriptive statistics for the electronic biddings. Following JFTC's investigation, the city reformed its bidding system and introduced electronic bidding in general and designated competitive auctions. The mean for the electronic bidding fell to 0.933 from 0.964, and for winning bid rates it decreased to 0.840 from 0.877. The rate of change of CV is 60.0% in a bid rate, and 117.3% in a winning bid rate. After JFTC issued the recommendation, the share of electronic bids to all bids rose to 31.0% from 7.2%.

Next, we provide summary statistics for three groups of bidders in Table 2. The distinction between "insiders" and "outsiders" is whether or not bidders were involved in bid rigging before JFTC's investigation. We labeled bidders who first participated in auctions after JFTC's investigation as "new entrants." In the collusive period, the proportions of bids and winning bids by insiders are 98.6% and 99.2%, respectively. These percentages suggest that this bid-rigging is a nearly all-inclusive cartel. A cartel analyzed by Pesendorfer (2000) has stable market share at around 80% among all contracts. Competitive pressure in the cartel studied here is weaker than the cartel in Pesendorfer (2000). City officials operated successfully in allocating contracts among colluding firms. However, the increase in number of new entrants is caused by the collapse of entry barriers. On average, new entrants are lower bidding than insiders in the transition period. "Winning percentage" is defined as the ratio of winning bids to total bids. As a result, the winning percentage of insiders is reduced from 17.2% to 12.0%.Outsiders submitted the highest bid during the transition period. We infer two reasons why insiders underbid outsiders: (1) JFTC's investigation forced insiders to stop colluding, and (2)

[10] In the retail gasoline market, they find that the mean of price declined by 16% and, CV rose by 332%.

the possibility of free-riding by outsiders. During the collusive period, winning bid rates for outsiders were very high. They might have enjoyed benefits of high price and kept their attitude to the transition period.

In periods from transitional to competitive, outsiders become more competitive. In the competitive period, their winning bid rate (0.836) is the lowest and their winning percentage (21.9%) is the highest in all periods. In contrast, the bid rate for new entrants (0.946) is the highest in the competitive period. Since the share of new entrants rose from 2.8% to 29.5%, an inflow of new entrants into auctions might include inefficient firms.

It follows from these descriptive statistics that (1) the intervention of JFTC completely affects the intent to collude among incumbents, and the competitive auction is introduced by new entrants in the transition period; (2) after the collusion is exposed, auctions primarily become more competitive through outsiders' bidding behavior; (3) it is important that there exist non-cartel members in order to dissolve collusion and to reinstate competition.

4 Estimation

4.1 Regression Variables

This section provides estimation results. Table 3 lists dependent and independent variables. Dependent variables are natural logarithms of bid price (BID) and winning bid price (WIN). We use the following independent variables: a natural logarithm of the engineering cost estimate ($SIZE$), number of bidders per auction ($NBIDDER$), and a natural logarithm of the value of all contracts auctioned off plus one in 90 days ($BACKLOG$). According to the assumption of Porter and Zona (1993), we suppose that each project is required 90 days to complete since there are restrictions on our data. Backlogs diminish proportionally over time.

The dummy variable ($OUTCITY$) equals one if a bidder is located outside the municipality. Given data limitations, we derive this dummy from the distance variable.[11] The dummy (*INSIDER*) takes the value of one for firms that are insiders— i.e., firms involved in bid rigging during the collusive period. The dummy variable (*OUTSIDER*) takes the value of one for firms that are outsiders—i.e., firms that bid during the collusive period but were not involved in bid rigging.

We evaluate the effect of entrants. De Silva *et al.* (2003) examine how bidding by entrants and incumbents varies in road construction auctions, and find that entrants bid more aggressively. As mentioned in Section 2, an auction reform to attract new entrants started at the begining of the transition period. This point in time is useful for defining entrants. Bidders during the collusive period are considered "incumbents," and bidders who participated for the first time following begining of the transition period are "entrants." The definition of "entrant" here differs slightly from that of "new entrants" in Section 3. Firms bidding in auctions occurring within one month after their initial participation remain classified as entrants. But, firms that participate in auctions occurring more than one month following their initial bid are classified as incumbents. The dummy (*ENTRANT*) with a value of one indicates bidders who are entrants. Participants in auctions with entrants behave differently than in auctions without entrants. Incumbents who expect aggressive bids from entrants might reduce their bids. Auctions with at least one entrant are designated by the dummy (*ENTRY*) with a value of one.

We assess the effect of introducing general and designated electronic bidding on participants' behavior. Auctions conducted electronically are represented the dummy (*ELEC*) taking the value one. The last two variables are auction-specific dummy.

4.2 Estimation Results

We employ ordinary least squares (OLS) to explain the determinants of bidding behavior. Results for each period appear in Table 4. To highlight collu-

[11] Bajari and Ye (2003) and De Silva *et al.* (2003) measure the exact distance between the project and the bidder's location. However, our data include only bidders' headquarters locations, and the location of some public works sites is ambiguous.

sion, we specify a period of "competition in the broad sense" that joins the transition and competitive periods. Period BC denotes the broad competitive period.

The coefficients of the engineering cost estimate for each period is statistically significant and almost one in estimations concerning bids and winning bids. The coefficient of the number of bidders during the collusive period is positive and significant. This sign clearly contradicts behavior in competitive auction markets. However, the number of bidders in competitive period significantly has negative effect on bids and winning bids. This is convincing evidence that auctions become competitive.

Although the effect of backlogs on both bids and winning bids during the collusive and the transition period is significantly positive, it is statistically insignificant during the competitive period. This finding indicates that city officials permitted bidders to collude and designated a winning bidder to take account of their backlogs. On the other hand, the effect of distance on both bids and winning bids during the collusive period is insignificant. The distance variable as a cost factor is apparently disregarded by officials. Since officials consider only one cost variable, the claim that official-led bid rigging has an efficiency effect is doubtful.

While the effect of insiders on bids is significantly negative during competitive period, it is statistically insignificant during the collusive and transition periods. This may support suppositions about the free-riding of outsiders. The outsiders might understand insiders to collude in the auctions. Higher bid prices caused by the bid rigging are beneficial to the outsiders. They might keep their bids high as well. Alternatively, this may partially explain that insiders knew the engineering cost estimate beforehand, and placed lower bids than the outsiders.[12]

The insiders and entrants have significantly negative effects on winning bids during the transition period. The results imply that new entrants after relaxing regional requirement for participation and insiders' reaction against

[12] The outsiders did not know engineerging cost estimates. They sometimes bid above them.

JFTC investigation made auctions competitive more or less during this period.[13] On the other hand, the coefficient of the outsider dummy on winning bids is statistically insignificant. These may also suggest continuing an outsider's attitude of the free-riding from the collusive period. However, during the competitive period, the outsider effect on bids outweighs the insider and entrant effects. The outsider dummy only has significant effect on winning bids. After competition firmly established, the outsiders mainly deepened competition in auctions.

Next, we examine auction-specific variables. Even though the effects of entrants on bids and winning bids during the competitive period are statistically insignificant, the entry effect on both bids during the period is negative and significant. This differs from the insignificant or ambiguous results in De Silva *et al.* (2003). The size of the coefficient of the entry dummy on winning bids is largest among dummies during the competitive period. The entrants faced tougher rivals on this period, compared with relatively weak rivals during transition period.

In Section 3 we see that bids and winning bids in electronic bidding system are lower than in ordinal bidding system. While the effect of electronic bidding system on bids is insignificant during transition and competitive periods, the system has strong effects on lowering winning bids during both periods. The two auctions specific variables, entry and electronic bidding, strongly influence winning bids during the competitive period. Adding to these two auction specific variables, the number of bidders also has negative effect on the winning bids during competitive period. While the backlog variable is not statistically significant in the bid regression during competitive period, it has significantly positive effect on bids and winning bids during broad competitive period (period BC). Large sample size seizes characteristics of competition. During the broad competitive period, the backlog and disanace variables has significantly positive effect on bids and the effects of outsider, entry , and electronic bidding

[13]Since the size of the coefficient of the entrant dummy is much larger than the coefficient for insiders ($0.1015 > 0.0201$), the entrant effect on competition is larger than the effect of dissolution of bid rigging.

system are negative and statistically significant at the 1%level.

In brief, although new entrant itself does not suppress prices so much, their rivals' reactions make auctions competitive during the competitive period. Introduction of electronic bidding significantly lowers winning bids. We conclude that the force for sustaining the competitive bidding originates from the auction reform and the incumbents' reaction against entrants.

5 Concluding Remarks

This paper has examined the reasons behind breakdown of bid rigging and the features of official-led bid rigging by using bidding data of public works auctions in an unidentified Japanese city. It produced the following findings for the collusive, transition, and competitive periods.

During the collusive period, bid rate and winning bid rate are very high. Estimation results clearly contradict competitive behavior. However, only contracted backlogs reasonably affect bidding behavior. Officials designated the winning bidder from among cartel members based on their backlogs. The bid rate and winning bid rate during the transition period are declined from the previous period. New entrants promoted lower winning bids. Relaxing the eligibility of bidders improves competition in auctions and introducing the electronic bidding system keeps winning bids low.

During the competitive period, the bid rate and winning bid rate furthermore become lower. The reaction of incumbents against entrants has an influence on keeping lower bidding. The breakup in the bid rigging by JFTC's investigation has started to change auctions to more competitive ones. In addition, municipal reforms of its auction market are important in assuring competition. Pro-competitive policies and bidding reform complement each other.

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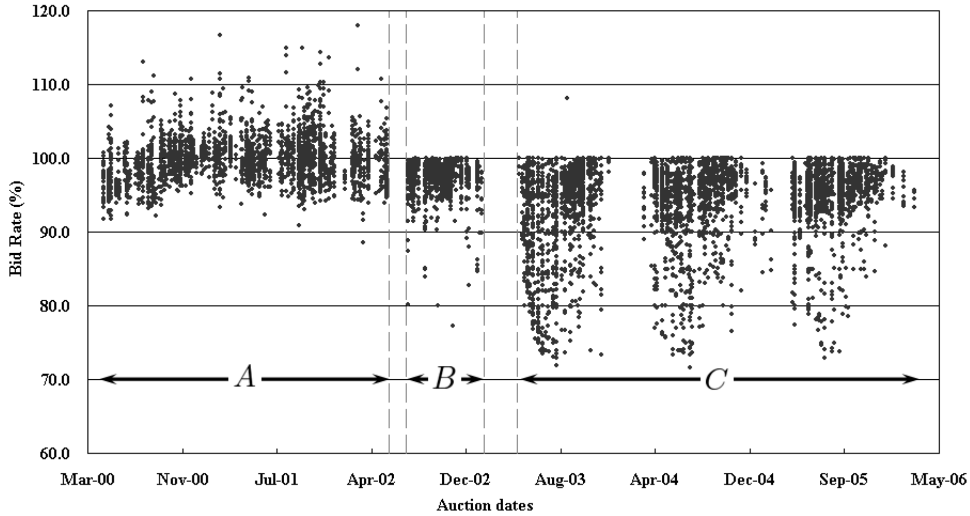
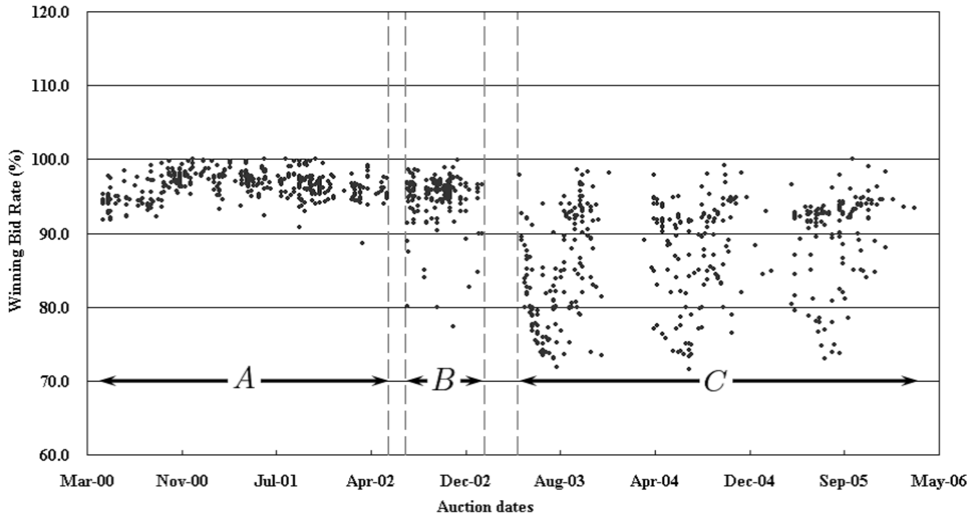


Note: Bid rate (%) = bid price / engineering cost estimate.

Figure 1　Bid Rate from April 2000 to March 2006



Note: Winning bid rate (%) = winning bid price / engineering cost estimate.

Figure 2　Winning Bid Rate from April 2000 to March 2006

Table 1 Descriptive Statistics of Bid Rate and Winning Bid Rate

	Period A	Period B		Period C	
Bids					
Observations	2257	1435	[104]	4122	[1279]
Mean	0.998	0.976	[0.964]	0.939	[0.933]
Coefficient of Variation	0.032	0.022	[0.031]	0.060	[0.068]
Share			[7.2%]		[31.0%]
Winning					
Observations	386	174	[4]	444	[104]
Mean	0.965	0.949	[0.877]	0.873	[0.840]
Coefficient of Variation	0.018	0.036	[0.043]	0.080	[0.086]
Share			[2.3%]		[23.4%]
Average Number of Bidders per Auction	5.9	8.3		9.3	

Note: The values in brackets are based on the electronic bidding systems.

Table 2 Descriptive Statistics for Insiders, Outsiders and New Entrants

	Period A			Period B			Period C		
	Insider	Outsider	New Entrant	Insider	Outsider	New Entrant	Insider	Outsider	New Entrant
Bids									
Obs.	2226	31	—	1357	38	40	2695	210	1217
Mean	0.998	1.003	—	0.976	0.985	0.968	0.938	0.914	0.946
CV	0.032	0.035	—	0.021	0.013	0.035	0.058	0.083	0.060
Share	98.6%	1.4%	—	94.6%	2.6%	2.8%	65.4%	5.1%	29.5%
Winning Bids									
Obs.	383	3	—	163	4	7	303	46	95
Mean	0.965	0.957	—	0.950	0.963	0.929	0.883	0.836	0.857
CV	0.018	0.019	—	0.034	0.023	0.064	0.072	0.088	0.092
Share	99.2%	0.8%	—	93.7%	2.3%	4.0%	68.2%	10.4%	21.4%
Winning Percentage	17.2%	9.7%	—	12.0%	10.5%	17.5%	11.2%	21.9%	7.8%

Table 3 Definition of Regression Variables

Dependent Variable	
BID:	Natural logarithm of the bid price.
WIN:	Natural logarithm of the winning bid price.
Independent Variable	
SIZE:	Natural logarithm of the engineering cost estimate.
NBIDDER:	Number of bidders.
BACKLOG:	Natural logarithm of the value of all contracts auctioned off in 90 days before the bid plus 1.
OUTCITY:	A dummy variable that equals 1 if a firm locates outside the city of the municipality.
INSIDER:	A dummy variable that equals 1 if a bidder is an insider.
OUTSIDER:	A dummy variable that equals 1 if a bidder is not an insider.
ENTRANT:	A dummy variable that equals 1 if a bidder is an entrant.
ENTRY:	A dummy variable that equals 1 if a bidder is faced an entrant.
ELEC:	A dummy variable that equals 1 if an auction is based on a designated competitive and a general electronic bidding system.

Table 4 Determinants of Bids and Winning Bids

	Dependent variable: *BID*			
	Period A	Period B	Period C	Period BC
Constant term	0.1107*** (0.0194)	−0.0246 (0.0183)	−0.1818*** (0.0235)	−0.0699*** (0.0168)
SIZE	0.9918*** (0.0014)	0.9995*** (0.0013)	1.0089*** (0.0016)	1.0012*** (0.0011)
NBIDDER	0.0033*** (0.0012)	0.0003 (0.0006)	−0.0013*** (0.0004)	0.0004 (0.0003)
BACKLOG	0.0004*** (0.0001)	0.0004*** (0.0001)	0.0002 (0.0001)	0.0007*** (0.0001)
OUTCITY	0.0067 (0.0058)	−0.0014 (0.0114)	0.0086** (0.0036)	0.0098*** (0.0035)
INSIDER	−0.0067 (0.0072)	0.0022 (0.0042)	−0.0113*** (0.0025)	−0.0042* (0.0024)
OUTSIDER		0.0136*** (0.0050)	−0.0356*** (0.0062)	−0.0284*** (0.0055)
ENTRANT		−0.0033 (0.0157)	−0.0016 (0.0065)	0.0015 (0.0061)
ENTRY		−0.0033 (0.0025)	−0.0252*** (0.0029)	−0.0272*** (0.0026)
ELEC		−0.0149 (0.0093)	−0.0033 (0.0036)	−0.0216*** (0.0032)
N	2257	1435	4122	5557
$\bar{R}^2$	0.9990	0.9995	0.9958	0.9965

	Dependent variable: *WIN*			
	Period A	Period B	Period C	Period BC
Constant term	−0.1527*** (0.0234)	0.0626 (0.0741)	−0.3845*** (0.0895)	−0.1943*** (0.0694)
SIZE	1.0063*** (0.0015)	0.9916*** (0.0057)	1.0184*** (0.0062)	1.0055*** (0.0050)
NBIDDER	−0.0005 (0.0013)	0.0035 (0.0025)	−0.0035* (0.0018)	−0.0007 (0.0018)
BACKLOG	0.0003*** (0.0001)	0.0009* (0.0004)	0.0001 (0.0005)	0.0008** (0.0004)
OUTCITY	0.0052 (0.0083)	−0.0292** (0.0137)	−0.0342* (0.0199)	−0.0323 (0.0212)
INSIDER	0.0157 (0.0137)	−0.0201** (0.0085)	0.0056 (0.0117)	0.0168 (0.0109)
OUTSIDER		0.0104 (0.0117)	−0.0336** (0.0166)	−0.0287* (0.0164)
ENTRANT		−0.1015*** (0.0166)	−0.0369 (0.0287)	−0.0203 (0.0271)
ENTRY		0.0113 (0.0108)	−0.0425*** (0.0096)	−0.0494*** (0.0094)
ELEC		−0.0990*** (0.0361)	−0.0295** (0.0140)	−0.0602*** (0.0131)
N	386	174	444	618
$\bar{R}^2$	0.9997	0.9988	0.9946	0.9950

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. White's (1980) robust standard errors are in parentheses.