

● Article ●

An Empirical Analysis of Entrant and Incumbent Bidding in Electric Power Procurement Auctions

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Abstract

This paper explores differences in the bidding patterns of incumbents and entrants in electric power procurement auctions. We find that while asymmetry exists, its direction and extent depend on the experience of the entrants.

1 Introduction

When asymmetry among bidders exists, all bidders cannot be treated alike in a first-price sealed-bid auction. Indeed, the literature has shown that when facing asymmetric bidders, the auctioneer may actually be better off exploiting this asymmetry by implementing price-preference treatment (see Myerson 1981; Krishna 2002). The typical finding is that the effects of such preferential treatment depend on the extent of the asymmetry between the favored and nonfavored firms.¹ It has also been shown that asymmetry may act as a barrier to entry and may therefore potentially lessen competition (McAfee and McMillan (1989); Harstad et al. (2003)). Therefore, it is important to assess asymmetry among bidders when considering policies aimed at efficient and revenue-maximizing auction mechanisms. The purpose of this paper is to identify the existence and extent of asymmetry between entrant and incumbent firms in electric power procurement auctions in Japan.

In the Japanese retail electricity market, ten firms originally supplied

electricity locally as monopolists. Liberalization began in 2000, with new firms, called Power Producers and Suppliers (PPS), allowed to enter the market and supply electricity. With this wave of liberalization, public agencies started to utilize first-price sealed-bid auctions for electric power supply contracts. Using bids data from these public electric power procurement auctions, we assess the difference in underlying costs and bidding patterns between the former monopolists and the PPS in this market. We define the former monopolists as incumbents, and the PPS as entrants. If there is large asymmetry in their underlying costs and bidding patterns, the introduction of preference treatment to enhance competition and increase auctioneer revenue may be suggested.²

In general, new entrants may be at a significant disadvantage relative to incumbents in auctions. For instance, they may face higher uncertainty because of a lack of experience. They may also have access to less information that incumbent bidders may have regarding pricing and cost. That is, in the sense of the common value paradigm where the value of the object is assumed to be unknown to the bidders at the time of the auction, incumbents may be better informed of the value of the object while entrants may have comparatively little information. In contrast, incumbents may face an entrant they know little about, while entrants have already learned about an incumbent's characteristics before they enter the market. That is, in the sense of the private value paradigm, where it is assumed that each bidder knows the value of the object, the distribution of entrants' private information as perceived by an incumbent may have greater variance.³ Accordingly, information asymmetry should exist in the Japanese electricity market, and we would expect that entrants cost distribution has greater dispersion.

In addition, the cost structures for entrants and incumbents in this market differ significantly. In the main, all incumbent firms are vertically integrated and have production divisions, while most entrants purchase electricity from outside sources, including the wholesale power exchange market (the Japan Electric Power Exchange or JEPX). Even for entrants that own production divisions, cost disadvantages may still exist because entrants only have thermal power stations that incur higher electricity generation costs than equivalent nuclear power plants, as possessed by most incumbents.⁴ Further, the transmission network is operated only by

incumbents. Therefore, entrants must pay transmission fees to incumbents to use their transmission network to supply electricity to consumers.⁵ Put simply, entrants generally bear a higher cost of supplying electricity.

Because of these informational and structural disadvantages, we expect in turn that the distribution of underlying costs for entrants has greater mean and variance. Our main purpose is to clarify the existence and extent of such asymmetry.

We find that while asymmetry exists, its direction and extent depend on the experience of the entrants. Our findings suggest that the cost distribution of entrants has relatively more density in the lower tail when entrants do not have much experience, while it has relatively less density in the lower tail when they gain experience. One reason for the lower underlying costs of entrants when they have less experience may be that some entrants, because of a lack of experience, believe they have lower costs than they really have. Alternatively, because of a lack of information about entrants, incumbents may believe that entrants have lower costs than they really have. Because this phenomenon disappears in auctions where entrants have relatively more experience, there must be an information acquiring (or learning) process by the participants in these auctions.

Previous studies have shown that asymmetries potentially arise from firm size, as noted by Laffont et al. (1995), capacity constraints, as in Jofre-Bonet and Pesendorfer (2003), the possession of better information, as in Hendricks and Porter (1992), distance from where the service is required, as in Bajari (1997) and Flambard and Perrigne (2006), and collusion among bidders, as in Porter and Zona (1993) and Bajari and Ye (2003). While asymmetries among bidders caused by many different sources have been empirically examined in existing work, the investigation of asymmetries between incumbent and entrant firms is not common in the literature. The notable exception is De Silva et al. (2003) who investigate differences in the bidding patterns of entrants and incumbents in road construction auctions in Oklahoma. Their findings are consistent with the presumption that entrants are less efficient and their cost distribution has greater dispersion.

The remainder of the paper is structured as follows. Section 2 briefly explains the theory of asymmetric auctions. Section 3 describes our data. This section also provides a brief overview of the structure and liberalization

of the Japanese electricity industry and the letting process of the electric power procurement auctions in this industry. Section 4 provides the empirical model and the results. Section 5 concludes.

2 Theory

This section summarizes an asymmetric auction model. We follow Maskin and Riley (2000*a*, *b*). Consider a first-price sealed-bid auction where two risk-neutral bidders compete for a public contract. The cost of the contract c_i to bidder i is drawn from a known distribution F_i with support $[c_{Li}, c_{Hi}]$. We first assume that the cost of each bidder is distributed independently. The distribution is continuous and twice-continuously differentiable on $[c_{Li}, c_{Hi}]$. The density f_i is assumed to be strictly positive on $[c_{Li}, c_{Hi}]$. Maskin and Riley (2000*b*) show that bid functions are in equilibrium increasing and differentiable, and for each firm i , an inverse exists and is also differentiable.

Let ϕ_j denote firm j 's inverse bid function. Then, at the Bayesian-Nash equilibrium, each bidder i chooses a bid b to maximize his expected profit:

$$\pi_i(b, c_i) = (b - c_i)(1 - F_j(\phi_j(b))).$$

The equilibrium of this model is characterized as the solution to a system of differential equations with boundary conditions, one for each bidder. Maskin and Riley (2000*b*) have also shown that the solution is unique. Specifically, for each bidder i :

$$\phi_j'(b) = \frac{1 - F_j(\phi_j(b))}{f_j(\phi_j(b))} \frac{1}{(b - \phi_i(b))}, \quad (1)$$

where ϕ_i is evaluated at b in $[b_*, b^*]$ and where b_* and b^* are the minimum and maximum winning bids, respectively. The boundary conditions are:

$$\begin{aligned} F_i(\phi_i(b_*)) &= 0 \forall i \\ c_{Hi} &= c_{Hj} \implies b^* = \phi_i(c_{Hi}) = \phi_j(c_{Hi}) = c_{Hi}. \end{aligned}$$

Maskin and Riley (2000a) show that if the distribution of the private cost of a weak bidder stochastically dominates the distribution of the private cost of a strong bidder, a weak bidder will bid more aggressively than the strong bidder in the sense that for any fixed cost, the bid of the weak bidder will be lower than the bid of the strong bidder. Further, the equilibrium bid distribution should also exhibit stochastic dominance.

However, stochastic dominance does not hold in many situations, and De Silva et al. (2003) discuss what we can say about bidding behavior when stochastic dominance does not hold for the entire range of cost distributions when considering asymmetric bidding between entrants and incumbents. Assuming that $c_{Hi} = c_{Hj} = c_H$ and $c_{Li} = c_{Lj} = c_L$, De Silva et al. (2003) show that even when stochastic dominance does not hold for the entire range, if the distribution of the cost estimates of bidder i stochastically dominates that of bidder j in the neighborhood of c_L , then for every bid submitted in the neighborhood of b_* , the associated cost for bidder i will be higher than the cost for bidder j . That is, bidder i will be more aggressive in their bids in the lower tail of the distribution of bids. De Silva et al. (2003) also generalize the result to a model where the cost of the contract c_i to bidder i exhibits both private and common value characteristics.

3 The electricity procurement auction data

3.1 The electricity industry

As discussed earlier, liberalization began in the Japanese retail electricity market in 2000 when new firms, known as PPS, were permitted to enter the market and supply power to large demanders of electricity, i.e. those with power and voltage requirements greater than 2,000 kilowatts (kW) and 20,000 volts (V), respectively. In 2004, the target for liberalization was expanded to demanders with power and voltage requirements greater than 500kW and 6,000V, and again in 2005 to demanders with power requirements greater than 50kW.

Despite these ongoing attempts at deregulation, incumbents remain the dominant type of firm in the industry. Figure 1 depicts electric power generation in 2009 by the type of generator. EPCos (electricity power companies) refers to the incumbents. As shown, total electric power

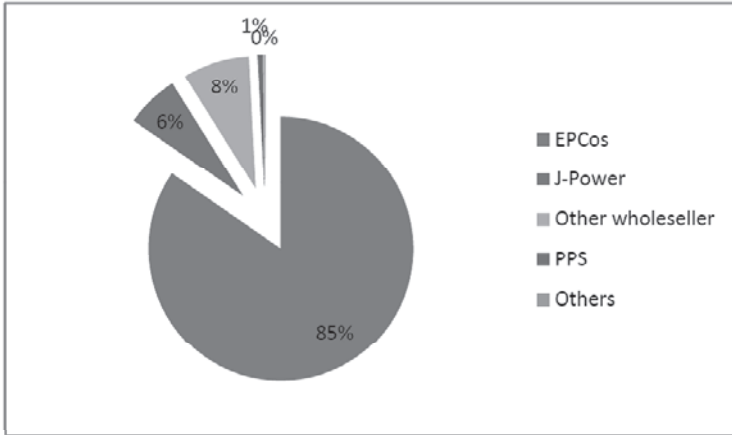


Figure 1 : Electric power generation in 2009 by generator type (Total 925,392,115 kWh. Constructed by the author from METI. Self-generation not included: textquotedblleft Otherstextquotedblright refers to special electric utilities)

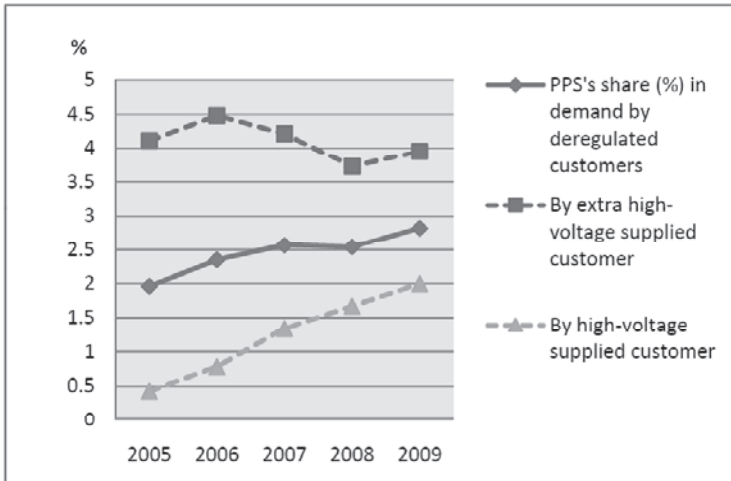


Figure 2 : PPS share in the deregulated retail market

generation in 2009 is 925,392,115 kWh, most of which is generated by the incumbents.⁶ Figure 2 plots the share of deregulated customers held by the PPS between 2005 and 2009. As shown, this remains very small at around 2.5

percent.

With liberalization, public agencies began to utilize bidding systems for electric power supply contracts for public places, including waterworks, roadway facilities, schools, hospitals, and markets. The letting process is as follows. Each public agency advertises auctions on its Web site, in the official gazette or in newspapers, with detailed information including the required maximum (peak) power (kW), the amount of electricity to be supplied (kWh), the delivery period and place, the qualification for participating in tendering procedures, and the time limit for tender. The firm submitting the lowest bid wins the auction and is paid the total of its bid times the tax rate. Although a reserve price exists, it is usually not announced (even after the bids are opened). If the lowest bid is higher than the reserve price, then the contract is not offered. In such a case, the agency either offers a second auction or bargains with one of the bidders. In the case of the latter, a supplier will eventually supply the electricity at a negotiated rate.

For incumbents, these contracts auctioned by public agencies are not major activities, accounting for less than 1% of their total supply to deregulated customers. Instead, their focus remains on large private users, to which they supply electricity at publicly announced rates, or at rates determined by a bargaining process. Therefore, capacity constraints are unlikely to be binding for the incumbents in these auctions. In fact, the incumbents began supplying these same public agencies before the auctions began, clearly showing that the incumbents hold sufficient capacity.

In contrast, public agencies are relatively more important customers for the entrants, with the amount supplied through these auctions accounting for 14.9%, 10.0%, 10.3%, and 7.0% of their total supply in 2004, 2005, 2006, and 2007, respectively. Nevertheless, we can also expect that capacity constraints are also unlikely to be binding for entrants. To see why, we compare the total power requirements in these contracts and the plant capacity of the entrants.

The total electric power requirements for these contracts were 729 megawatts (mW), 523 mW, 1108 mW, and 1338 mW in 2004, 2005, 2006, and 2007, respectively. To find the entrants' generation capacity, we should include both their own plant capacity and their outside generation sources, with which the PPS undertake bilateral contracts. Although it is difficult to precisely measure this outside capacity, Asano (2006) estimates that the

total capacity of the PPS was 2.3 gigawatts (GW) in 2002 and was expected to reach 4.6 GW in 2010. Therefore, the generation capacities of the PPS are likely to be much larger than the total power required by these auctions.

3. 2 The winning bid data

This sub-section describes the dataset that consists of the winning bids of all of the electricity procurement auctions held throughout Japan between April 2004 and March 2008. The data are offered by the *Electric Daily News*, a newspaper specializing in the electricity industry. The data contain information on the date the bids are opened, the government agency (the auctioneer), the required maximum power (kW), the amount of electricity required (kWh), the contract period, and the delivery place, along with the winner for each auction, the winning bid, either the bidder or the number of other bidders, and other descriptive auction information, including whether there is a restriction on CO_2 emissions.⁷ While the dataset contains a rich number of observations, its disadvantages are that it does not include losing bids and that identification of the losing bidders is not possible for many of the observations.

A total of 1,368 auctions without missing information are observed from April 2004 to March 2008.⁸ Nineteen different firms participate in these auctions, comprising nine incumbents and ten entrants. As noted earlier, we define the former monopolists as incumbents, and the PPS as entrants. The incumbent firms still mainly operate only in their local area. Therefore, we do not observe any auctions where multiple incumbents bid.

Table 1 provides some summary statistics. As shown, the auctions are not very competitive with the average number of active participants only ranging from 1.50 to 2.04. Moreover, in many auctions the incumbent is the only bidder: the PPS are not participating in all auctions.

The number of bidders increased in 2005, but decreased afterwards. This may reflect the fact that the number of auctions with CO_2 emission restrictions has gradually increased since 2006. *Green* refers to a dummy variable that takes a value of 1 if the auction has any restrictions regarding CO_2 emissions, zero otherwise. On this basis, 42% in 2006 and 34% of auctions in 2007 represent auctions including restrictions on CO_2 emissions. Because entrants usually only operate thermal power stations (that generate

Table 1 : Auctions from FY2004 to FY2007

FY	# of Auction	# of Bidder	Average winning Bid (yen/kWh)	kW	kWh (thousand)	Load	Green
2004	335	1.50	14.25	2110.04	9565.24	0.44	0.00
2005	279	2.04	14.75	2047.39	8774.40	0.41	0.00
2006	325	1.97	15.10	1680.67	6755.52	0.38	0.42
2007	429	1.72	15.75	2202.09	9830.32	0.38	0.34
Total	1368	1.08	15.02	2024.12	8819.57	0.40	0.21

relatively more CO_2), they are particularly disadvantaged in auctions with CO_2 emission restrictions.

The average winning bids have been increasing during this period. Both the maximum (peak) power (kW) and the size (kWh) decreased until 2006 but increased in 2007. The downward trend until 2006 reflects the fact that the number of auctions of relatively small size increased with the progress of liberalization. In 2007, we observe many public agencies bundling several contracts in a single auction. This may be the reason for the increased size in 2007. *Load* refers to the load factor: the ratio of the average and maximum (peak) usage of electricity during the contract period. This is calculated as the amount required per year divided by the required capacity, i.e. (kWh) / (the maximum power (kW) \times 24 \times 365). In general, the low load factor induces inefficiency because suppliers need to hold capacity for peak usage that is not used for most of the time.

The load factor appears to play an important role in the auction participation and bidding decisions of firms. Table 2 provides summary statistics of winning bids by load factor. As shown in the first two columns, winning bids decrease as the load factor increases, implying that firms can enjoy greater efficiencies with a high load factor. In the third column, we can see that the winning rate of entrants significantly decreases with the load factor. In point of fact, this is partly because an entrant's participation rate also decreases with the load factor, as shown in the fifth column (figures in parentheses are participation rates). The sixth column indicates the number of auctions where entrants win and the entrant winning rate conditional on entrant participation. These again decrease with the load factor. It would then appear that entrants have a significant disadvantage in auctions with

Table 2 : Load factor and bid differences between incumbents and entrants

Load factor	Win bid of incumbent	Win bid of entrant	Entrant win rate	# observations	# with entrants	# entrant wins
- 10%	37.08	27.28	0.83	60	50 (83.3%)	50 (100 %)
10 - 20%	20.24	20.23	0.52	125	70 (56.0%)	60 (85.7%)
20 - 40%	16.10	15.51	0.46	528	266 (50.4%)	243 (91.4%)
40 - 60%	12.89	12.32	0.28	420	175 (41.7%)	116 (66.3%)
60 - 80%	11.09	10.62	0.06	203	37 (18.2%)	13 (35.1%)
80% -	10.56	11.50	0.03	32	1 (3.1%)	1 (100 %)

a high load factor. In other evidence, Takagi and Hosoe (2007) note that as entrants depend on peak power supply, such as petroleum thermal, supplying electricity continuously throughout the day is relatively costly. Therefore, in auctions requiring high load factors, entrants are likely to have a disadvantage.

In the next section, we present the empirical results for the asymmetry between incumbents and entrants after controlling for various factors in the next section.

4 Empirical specification and results

The basic structure of the regression model is as follows:

$$y_i = X_i B + D + T + \varepsilon_i,$$

where the subscript i refers to an auction. Because we have winning bid data, the data are at auction level. We specify the average winning bid (*yen/kWh*), as dependent variable throughout our analysis. The independent variables comprise three sets of controls, where X 's is the control for the auction-level variables, D is a vector of district fixed effects, and T is a vector of year dummies. Because there is only one incumbent in each district, D can also be considered as incumbent fixed effects.

With respect to auction characteristics X , we include the following variables. In order to distinguish entrants and incumbents, we simply include an incumbent dummy variable that takes a value of 1 if the winner is an

incumbent. We also include the number of bidders. We expect that auctions will be more competitive and bids more aggressive as the number of bidders increases. The number of bidders, however, may have a negative effect if auctions are common valued because of the existence of a winner's curse. Because winner's curse is more significant when the number of bidders is large, bidders may become less aggressive as the number of bidders increases in common value auctions.

We also include a high-voltage dummy that takes a value of 1 if the contract for auction is for voltage greater than 20,000V. We also include the load factor as independent variable. Because bids appear to increase with the load factor, but not linearly, we also include its square. The peak power (kW) and the size (kWh) are also included. However, because the two variables kW and kWh perfectly determine the load factor, we include only one in the empirical model. We expect that the size kWh negatively affects winning bids as firms of a larger size can enjoy scale economies. For a similar reason, we expect that the contract length ($year$) has a negative effect on winning bids. The variable *green* is included to identify auctions with CO_2 emission restrictions.

We also include a dummy variable *single* in our empirical model that takes a value of 1 if no entrant participates in the auction. Because we do not typically observe multiple incumbents in an auction, there is only one bidder (the incumbent) in the auction when *single* = 1. We include this variable in order to control for the participation decision of entrants. As shown in Table 2, we readily observe that entrants do not participate in all auctions. For example, only 3.1 percent of auctions with a load factor greater than 80% are observed to include entrants. If we cannot control for all of the variables that affect the participation decision of entrants and bidding behavior simultaneously, our results are likely to be biased. Gilley and Karels (1981) point out the importance of a link between the dichotomous bidding decision (bid, do not bid) and the bid level decision, and suggest using Heckman two - stage estimation (Heckman 1979). However, as we do not have data on losing bids and cannot identify losing firms, we cannot employ this estimation method. Therefore, we control for auctions where an incumbent is the only bidder using this dummy variable.

Table 3 presents the estimation results with and without kW and kWh .

Table 3 : Estimation results: Basic specification

	(1)	(2)	(3)	(4)
Incumbent wins	0.652* (0.340)	0.648* (0.340)	0.657* (0.340)	0.64% (0.339)
Number of bidders	-0.401*** (0.135)	-0.404*** (0.135)	-0.406*** (0.135)	-0.402*** (0.135)
Single	-0.946*** (0.362)	-0.946*** (0.362)	-0.954%*** (0.362)	-0.937*** (0.361)
High voltage	-1.122*** (0.215)	-1.123*** (0.211)	-1.111*** (0.204)	-1.157*** (0.197)
Load	-0.554*** (0.166)	-0.555*** (0.017)	-0.555%*** (0.017)	-0.554*** (0.166)
Load 2	0.004*** (0.000)	0.004*** (0.000)	0.004*** (0.000)	0.004*** (0.000)
Kw	0.044 (0.052)	-0.010 (0.022)		
Kwh	-0.010 (0.008)		-0.003 (0.004)	
Contract length	0.002 (0.163)	-0.030 (0.161)	-0.017 (0.161)	-0.032 (0.160)
Green	0.139 (0.234)	0.136 (0.234)	0.132 (0.234)	0.141 (0.234)
Constant	30.780*** (0.650)	30.905*** (0.641)	30.874*** (0.341)	30.893*** (0.640)
F-statistic	123.99	130.10	130.19	137.02
R-squared	0.6592	0.6589	0.6590	0.6589
# of obs.	1368	1368	1368	1368

Notes : Dependent variable is average winning bid (yen/kwh). (1) to (4) include district and year dummies. Standard errors in parentheses.

The dependent variable is the average winning bid (*yen/kWh*). The results are robust to the four specifications given in the table. Most importantly, the incumbent dummy has a positive and significant effect on the winning bid. That is, entrants win with much more aggressive bids compared with the bids of incumbents. The results show that there is clearly an asymmetry in bidding patterns between incumbents and entrants.

Our estimation results shed light on several other facts. The dummy variable *single* has a negative and significant effect on the winning bid.

This may imply that entrants do not enter auctions in which they have a significant disadvantage. We can also see that the number of bidders has a negative and significant effect on the average bid. This may suggest that the electric power procurement auctions are likely to fit the private value paradigm.⁹ Contracts for voltage greater than 20,000V are won with a lower bid. As expected, the load factor has a negative and significant effect on the winning bid, though this effect appears to weaken with higher values of the load factor.

The coefficients on size (kWh) and contract length are negative (except in specification (1)), implying scale economies exist. These effects are, however, not statistically significant. The variable *green* has a positive effect implying that auctions with CO_2 emission restrictions are more costly for suppliers. However, this effect is again statistically insignificant.

We next utilize quantile regressions to see whether entrants bid aggressively across the entire range of the distribution. As shown in Section 2, even when stochastic dominance does not hold, a bidder, whose cost distribution stochastically dominates the other at the lower end of the distribution, should bid aggressively near the minimum winning bids (De Silva et al. (2003)). To see this, we are particularly interested in the bidding behavior at the lower quantile. For the quantile regressions, we use the observations of auctions with entrants (that is, $single = 0$) and with a range of load factor between 40% and 60%.¹⁰

Table 4 presents the results from the quantile regressions.¹¹ We can see that the effect of the incumbent dummy is positive for any quantile. This may suggest that entrants bid aggressively across the entire range and that stochastic dominance holds between the two distributions. The effect is, however, significant only for the 5 percentile of the winning bid. We can also see that the winning bids of entrants are smaller than those of incumbents by a larger margin at the lower quantile than the higher quantile, except at the 95 percentile.

We next divide our sample into two groups. The first group consists of observations of auctions with required electric peak power and voltage requirements greater than 2,000kW and 20,000V. As described before, this range of electric power demand has been liberalized since 2000. Therefore, entrants have several years of experience in supplying electric power for

Table 4 : Estimation results: Quantile regression

	.05	.25	.75	.95
Incumbent wins	0.401*** (0.156)	0.212 (0.145)	0.177 (0.153)	0.303 (1.192)
Number of bidders	-0.352*** (0.059)	-0.129 (0.079)	-0.161* (0.086)	-0.032 (0.364)
High voltage	-1.242*** (0.112)	-1.325*** (0.165)	-1.734*** (0.142)	-1.312* (0.758)
Load	-0.658*** (0.221)	-0.567*** (0.191)	-0.395** (0.192)	-0.456 (1.214)
Load 2	0.006*** (0.002)	0.005*** (0.002)	0.003 (0.002)	0.003 (0.012)
Kwh	-0.001 (0.002)	-0.006*** (0.002)	-0.003 (0.004)	-0.007 (0.014)
Contract length	-1.220*** (0.120)	0.180 (0.163)	0.006 (0.160)	3.004*** (0.522)
Green	0.486*** (0.136)	0.290 (0.192)	0.340* (0.202)	0.871 (1.227)
Constant	34.402*** (5.260)	30.686*** (0.190)	26.172*** (4.787)	25.513 (29.870)
Pseudo R-squared	0.4827	0.4115	0.5638	0.5923
# of obs.	175	175	175	175

Notes : Dependent variable is average winning bid (yen/kwh). The sample consists of observations of auctions with entrants and with a load factor of 40 – 60%. All equations include district and year dummies. Standard errors are in parentheses.

this first type of demand in our dataset (Note our data start in 2004). The second group consists of the remaining observations of auctions with lower demand. The key feature is that liberalization of the market for a lower level of demand took place only after 2004. Therefore, the entrants have relatively less experience in supplying electric power for this second type of demand in our dataset (assuming that supplying electric power to large or small demanders differs in at least some aspects and suppliers cannot use experience from meeting large demanders when providing for smaller demanders). By examining the two groups separately, we are able to see whether the relative positions of the two cost distributions changes depending on the entrants' experience.

Table 5 presents the results for the first group. With this type of demand, entrants have relatively more experience. We can see that the table provides similar results as Table 4. In contrast, Table 6 presents the results for the second group. In these auctions, entrants have relatively less experience. We can see that in Table 6, the effects of the incumbent dummy on the lower quantiles of the winning bids are negative and significant while those on the higher quantiles are positive and significant. That is, incumbents bid more aggressively at the lower end of the winning bid distribution and less aggressively at the higher end.

The results from the second group also show that stochastic dominance does not hold between the cost distributions of incumbents and entrants for these auctions, because the sign of the coefficient for the incumbent dummy

Table 5 : Quantile regression: Power and voltage greater than 2,000 kw and 20,000V (Entrants have relatively more experience)

	.05	.25	.75	.95
Incumbent wins	0.555*** (0.000)	0.320** (0.144)	0.004 (0.285)	0.715 (9.662)
Number of bidders	-0.067*** (0.000)	-0.034 (0.078)	-0.106 (0.139)	0.068 (1.713)
Load	-1.234*** (0.000)	-0.624*** (0.191)	-0.109 (0.325)	0.547 (4.098)
Load 2	0.012*** (0.000)	0.005*** (0.002)	-0.000 (0.003)	-0.007 (0.040)
Kwh	-0.008*** (0.000)	-0.006*** (0.002)	0.006 (0.003)	-0.006 (0.089)
Contract length	-0.031*** (0.000)	0.178 (0.147)	0.125 (0.227)	0.491 (2.155)
Green	-0.169*** (0.000)	0.149 (0.203)	0.345 (0.317)	0.185 (7.171)
Constant	42.314*** (0.000)	28.135*** (4.667)	16.273** (7.885)	-0.027 (108.677)
Pseudo R-squared	0.4949	0.4309	0.3948	0.4482
# of obs.	95	95	95	95

Notes : Dependent variable is average winning bid (yen/kwh). The sample consists of observations of auctions with entrants, with a load factor of 40 – 60%, and power and voltage higher than 2,000kw and 20,000V. All equations include district and year dummies. Standard errors are in parentheses.

Table 6 : Quantile regression: Power and voltage less than 2,000 kw and 20,000V (Entrants have relatively less experience)

	.05	.25	.75	.95
Incumbent wins	-0.312*** (0.000)	-0.225*** (0.073)	0.159 (0.593)	0.499*** (0.000)
Number of bidders	-0.555*** (0.000)	-0.533*** (0.055)	-0.226 (0.320)	-0.142*** (0.000)
Load	-0.249*** (0.000)	-0.280*** (0.112)	-0.617 (0.765)	0.174*** (0.000)
Load 2	0.001*** (0.000)	0.002 (0.001)	0.005 (0.008)	-0.003*** (0.000)
Kwh	-0.082*** (0.000)	-0.032 (0.023)	0.012 (0.161)	0.089*** (0.000)
Contract length	-1.291*** (0.000)	-0.301* (0.161)	-0.000 (0.841)	3.300*** (0.000)
Green	0.360*** (0.000)	0.237*** (0.096)	0.301 (0.656)	0.621*** (0.000)
Constant	24.428*** (0.000)	24.606*** (2.930)	32.972* (18.980)	10.434*** (0.000)
Pseudo R-squared	0.6891	0.5609	0.5251	0.6979
# of obs.	80	80	80	80

Notes : The sample consists of auctions with entrants. Dependent variable is average bid (yen/kwh). All equations include district and year dummies. Standard errors are in parentheses.

is not consistent. Further, if the assumption of a common range holds, then the results can be interpreted that the cost distribution of incumbents stochastically dominates at the lower end (though not entirely) and thus, entrants bid aggressively at the lower end. That is, the density of entrants' cost at the lower end is greater than that of incumbents in auctions where entrants have little experience.

The different results from the two sample groups imply that the relative positions of the two distributions differs depending on entrant experience. That is, while the entrants' cost distribution exhibits greater density at the lower end when they have less experience, it stochastically dominates the incumbents as entrants acquire experience.

We can also interpret this result in that the greater density of

entrant costs in the lower tail is because some entrants, due to their lack of experience, may believe that they have lower costs than they really have. However, as they gain experience, they adjust their estimates. Consequently, the density of the cost estimates in the lower tail also becomes lower. It may also be that incumbents at first believe that entrants potentially have lower costs than they really have. As a consequence, the entrant cost distribution, as perceived by the incumbents, has greater density at the lower end. However, as incumbents learn more about the entrants, they update their perceptions and the cost distribution of entrants begins to stochastically dominate that of the incumbents. Our findings are consistent with this account.

5 Conclusion

This study explores differences in the underlying cost distributions of entrants and incumbents in electric power procurement auctions in Japan. In this market, there is significant asymmetry in the production cost structure of the incumbents and the entrants. Therefore, we expect that entrants incur higher costs because of specific features of their production process.

Nevertheless, we observed that the cost distribution of entrants has greater density in the lower tail relative to that of incumbents in auctions where entrants have relatively less experience. This may be because some entrants, due to a lack of experience, believe that they have lower costs than they really have. Alternatively, it may be because the incumbents, due to a lack of information about the entrants, believe that the entrants have lower costs than they really have. This phenomenon disappears in auctions where entrants have relatively more experience, suggesting an information acquiring (or learning) process is at play.

We intend to conduct future research in this area in the following directions. First, because of the limited nature of our dataset, the current study is restricted to very simple estimation methods. For example, because our dataset is at the auction level, we cannot include any individual level variables in the estimation model, and we cannot fully control for the participation decisions of entrants. We are now in the process of collecting losing bids along with the identities of the losing bidders for each auction, and so we should be able to address this shortcoming in future work.

Second, although our reduced form estimation provides some very interesting insights, to obtain more concrete results in terms of the differences between incumbents and entrants, we need to recover their cost distributions through estimating the structural model in Maskin and Riley (2000a). As a way forward, previous studies, such as Guerre et al. (2000) and Flambard and Perrigne (2006), employ nonparametric methods to recover the distributions of the bidder's type parameters.

Finally, because auctions where entrants have more experience completely coincide with those for a larger size (greater than 2,000kW and 20,000V), the different results for the two different groups of auctions with/without entrant experience may merely reflect the difference in the auction type, not in the experience of the entrants. To see how entrant bidding behavior actually changes with experience, we need to estimate a structural model that explicitly takes into account the bidder's learning process.

¹ Under general assumptions, Cantillon (2008) has shown that the auctioneer's expected revenue becomes lower as bidders become more asymmetric. Accordingly, serious asymmetry may imply greater potential to improve competition through a preferential policy.

² We commonly observe examples of price-preference policies like this in the real world, including the recent spectrum auctions held by the Federal Communications Commission that employed various discriminatory policies in the spirit of affirmative action.

³ Because the auctions for electric power supply contracts in Japan only began after liberalization, neither the incumbents nor the entrants had experience of auction processes. Therefore, our incumbents are incumbents only in terms of the electric power supply business, not the auctions. However, while both the incumbents and entrants were new to auctions when they started, it is likely that the former already had some information about the auctioneers as they had dealt with them previously. Similarly, entrants could learn about incumbents before they entered the market because the historical prices of the incumbents were publicly available.

⁴ In 2009, 34.0 percent of incumbent electricity generation was from nuclear power, with 58.31 percent from thermal power and 7.37 percent from hydropower. In contrast, less than 0.2 percent of entrant electricity generation was from hydropower with the remainder provided by thermal power.

⁵ Transmission fees typically range from 0.57 to 3.42 *yen/kWh*, with a fixed fee ranging from 346.50 to 656.25 *yen/kW*, depending on the area, time, and voltage.

⁶ Self-generation is not included.

- ⁷ Since November 2007, the Environmental-Conscious Contract Law has been enforced in Japan. This law clarifies the public sector's responsibility to take into account not only economic concerns, but also the reduction of greenhouse gas emissions when it signs a contract. Specifically, contracts concerning the purchase of electricity and official vehicles, as well as service contracts, such as those with energy service companies (ESCO) and architects, are subject to the law. Under the law, public agencies began to set numerical targets, such as a maximum CO_2 emission coefficient, as a qualification for participating in auctions.
- ⁸ The Japanese fiscal year starts in April. Hereafter, we use "year" to denote the fiscal year unless otherwise noted.
- ⁹ Gilley and Karels (1981) show that one of the basic qualitative predictions in the common value paradigm is that "greater number of competitors on a tract will lower the optimal bid of the firm" (in higher value auctions for oil tracts). This is because if a bid wins against a relatively large number of competitors, it is more likely that the object has been overvalued and, as a result, firms must take a more pessimistic view of winning bids when more competitors enter. However, Pinkse and Tan (2002) show that strategic behavior can cause bids to increase or decrease in the number of opponents under both the private and common value paradigms. Gilley and Karels (1981) themselves also show that the above prediction does not always hold when the number of bidders is very small. Therefore, we cannot conclude that the auctions here can be modeled using the private value paradigm based on only this result. Recent studies introduce selection tests for common and private value auctions (see, for example, Haile et al. (2003)).
- ¹⁰ Because we would like to observe the differences in incumbent and entrant bidding behavior for the same auction, it is appropriate to focus on observations with similar characteristics. When the load factor is low, there appears to be some significant factors that prevent incumbents from winning auctions when there is an entrant as a rival. Therefore, even after controlling for the independent variables, it would seem that incumbents and entrants are not in the same situation for auctions with low load factors. Similarly, when the load factor is high, there appear to be some significant factors that prevent entrants from participating in the auction. For this reason, we use only observations of auctions with a load range between 40 and 60% for the quantile regressions.
- ¹¹ The results for the remaining quantiles are also available upon request.

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