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Bidder Asymmetry in Infrastructure Procurement:

Are There Any Fringe Bidders?

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Abstract

Asymmetric auctions are among the most rapidly growing areas in the auction literature. The potential benefits from improved auction efficiency are expected to be enormous in public procurement auctions related to official development projects. Entrant bidders are considered a key to enhance competition in an auction and break potential collusive arrangements among incumbent bidders. Asymmetric auction theory predicts that weak (fringe) bidders would bid more aggressively when they are faced with a strong (incumbent) opponent. Using official development assistance procurement data, this paper finds that in the major infrastructure sectors, entrants submitted systematically aggressive bids in the presence of an incumbent bidder. The findings also show that a high concentration of incumbents in an auction would harm auction efficiency, raising procurement costs. The results suggest that auctioneers should encourage fringe bidders to actively participate in the bidding process while maintaining the quality of the projects. This is conducive to enhancing competitive circumstances in public procurements and improving allocative efficiency.

This paper—a product of the Economics Unit, Finance, Economics and Urban Development Department—is part of a larger effort in the department to understand and investigate efficiency and effectiveness in public infrastructure procurement. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at aiimi@worldbank.org.

BIDDER ASYMMETRY IN INFRASTRUCTURE PROCUREMENT: ARE THERE ANY FRINGE BIDDERS?

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I. INTRODUCTION

Asymmetric auctions are among the most rapidly growing areas in the auction literature. Although the traditional symmetric framework has been attractive for analyzing the general bidding behavior in a tractable manner, it is not always applicable in practice because bidders are usually heterogeneous in various dimensions. The existence of weak bidders—also referred to as fringe or entrant bidders—is particularly important from the competition policy point of view. They are expected to augment the competition effect and break potential collusive arrangements among strong bidders—referred to as incumbent bidders.

The current paper attempts to apply the basic asymmetric auction theory to actual procurement data from official development assistance (ODA) projects of two aid donors. In the context of infrastructure development assistance, the question of how fringe bidders behave under competitive circumstances is of particular interest for several reasons. First, there is always a concern about the limited competition especially in large-scale infrastructure procurements (Estache and Iimi, 2008a). Our data reveal that the average number of firms participating in an auction is about six in road and water-related procurement auctions. In the electricity sector, many contracts attracted only two or three bidders. Hence, it is an even more fundamental question whether or not fringe bidders exist in these procurement markets.

Closely related to this, second, high market concentration in some segments of infrastructure has been a cause for considerable policy concern (e.g., NOA, 2007). In the repeated game circumstances, incumbent bidders may desire to build a reputation of being an aggressive bidder, which helps deter fringe bidders from entering the market. It is a challenging task for auctioneers to invite new entrants to the competitive bidding, while maintaining fair competition environment between incumbent and fringe bidders (e.g., Klemperer, 2002). But is there any strong or incumbent bidder in the infrastructure project markets?

Third, it is *intuitively* acceptable that different types of bidders—e.g., dominant and weak, or foreign and domestic—are involved in the procurement process for public infrastructure projects. They presumably have different preferences and cost (dis)advantages to implement infrastructure projects given their distinct experiential, technical, administrative and financial backgrounds. One of the evident consequences of the existing bidder heterogeneity is joint bidding practices, which are commonly observed in ODA projects (Estache and Iimi, 2008b). About 25–30 percent of total bidders rely on the joint bidding strategy. Without bidder asymmetry it seems unclear why firms are motivated to form a bidding coalition.[1] Moreover, it is shown that local firms submit systematically low bids in particular in the road and water sectors. However, to our best knowledge, there is no formal analysis addressing the question of the existence and behavior of fringe bidders in this area.

Fourth, the fact that different types of bidders coexist can potentially result in an inefficient allocation of the object. Under an experimental setting, Andreoni, *et al*. (2007) show that even if bidders are ex ante symmetric, the asymmetry in the bidders' knowledge about their rivals' types raises procurement costs (in our context). Bidder heterogeneity and knowledge asymmetry about bidders' types are almost indistinguishable in practice. In ODA procurement auctions, there is no consensus on the question of who is the incumbent (or entrant), and it is also plausible that some firms well know who their rivals are and others do not.

Fifth, the size of contracts in infrastructure projects is usually large. In theory, as the potential reward increases, firms are more motivated to collude with each other. Collusion may easily translate into corruption. If a corrupt agent has large manipulation power, bribery makes it more difficult for the truly efficient bidder to secure a win (Burguet and Che, 2004). The alleged notion that a considerable amount of public resources including foreign aid might be lost due to poor governance has been among the most serious concerns in the donor

[1] This assumes the conventional independent private value paradigm. See Estache and Iimi (2008b) for further details.

community (Olken, 2005; Auriol, 2006). The unpredicted entry of fringe bidders has an important role to play in mitigating collusive and corrupt incidences.

Because of the size, finally, there is the high potential for efficiency gains by encouraging competition at the auction level. Our companion paper (Estache and Iimi, 2008a) shows that total benefits to developing countries could amount to 8.2 percent of annual investment requirements in infrastructure, if the optimal level of competition is achieved. Importantly, public investment resources are limited in the developing world.

The key question is how the authorities can promote competition in the public procurement procedure for infrastructure investment. Obviously, it is not a good idea to compromise the prequalification requirements so that many firms without sufficient responsiveness would be allowed to participate in the bidding process. When some prequalification criteria are loosened, the winning bid will certainly decline, but a serious quality concern must be left behind.[2] As well documented in ADB (2006), it is important to exclude inadequately qualified competitors from submitting unrealistically low bids, while keeping encouraging local firms to participate in the competition, for instance, through forming joint ventures. This remains a difficult task, and therefore, it is essential to understand how weak bidders behave in competitive bidding provided that bidders are likely asymmetric—i.e., either strong or weak.

Asymmetric auction theory predicts that a weaker (fringe) bidder tends to bid more aggressively in the presence of a strong (incumbent) bidder. Maskin and Riley (2002) shows that if a weak bidder faces a strong bidder rather than another weak bidder, he responds with a more aggressive bid distribution in the sense of stochastic dominance. Symmetrically, if a strong bidder faces a weak bidder rather than another strong bidder, he will respond with a less aggressive bid distribution. This proposition can explain the possible difference in bidding behavior if two types of bidders exist in an auction.

[2] Joint bidding practices are another possibility to invite more firms to public procurement auctions (Estache and Iimi, 2008b).

Empirically, De Silva, *et al*. (2002; 2003), investigating the case of Oklahoma State's auction market for road construction projects, finds that new entrants actually bid more aggressively than incumbents did, especially in the lower tail of the bid distribution. Of particular note, in their analysis only 70 entrant bids are identified out of about 2,800 bids. Moreover, a single firm bided 218 projects and a single firm was awarded with 59 contracts. These facts may characterize road construction auctions as a typical repeated game involving a closed set of a few incumbent bidders.

On the other hand, the prediction that weak bidders tender aggressive bids may raise a concern about the winner's curse (e.g., Klemperer, 1998). Executing agencies (i.e., auctioneers) will be faced with great difficulties when contractors of infrastructure projects go bankrupt or attempt to undergo renegotiation, because they are trapped in a classic hold up problem.[3] Theoretically, it is shown that a "high bid and broke winner" phenomenon is difficult to avoid (Zheng, 2001), and in reality such a problem is not rare.

The current paper aims at identifying incumbent bidders somehow and estimating the impact of their presence in an auction on the equilibrium bid function. The remaining sections are organized as follows: Section II provides an overview of market concentration and the existence of potential fringe firms and entrant bidders in our ODA procurement data. Section III establishes an empirical model and describes our data. Section IV summarizes the main regression results and discusses several policy implications.

II. Market Concentration and Fringe Bidders in Infrastructure Procurements

Our data initially cover 211 procurement auctions for 69 infrastructure projects in 29 developing countries from 1997 to 2007. When the fact that any single firm can possibly

[3] The more valuable the contract is, the difficult it is to terminate the existing contract. This is typical in large-scale national development projects.

participate in more than one auction is ignored, in total 1,656 "firms" who solely or jointly participated are identified in these procurement auctions. With joint bidding practices accounted for, in total 862 "bidders" were involved in the competition process.

Importantly, some firms are repeatedly participating in a series of procurement auctions in developing countries. Some are domestic companies, and others are multinational enterprises. This phenomenon is related to a market concentration question. Our sample reveals that one firm obtained seven road contracts solely or jointly (Table 1). In the water sector, one firm was awarded six public contracts related to ODA projects, though the market concentration looks relatively moderate compared with the other sectors. In the electricity sector where our sample data are quite limited, six firms won three or more contracts each.

Table 1. Concentration of Contract Awards

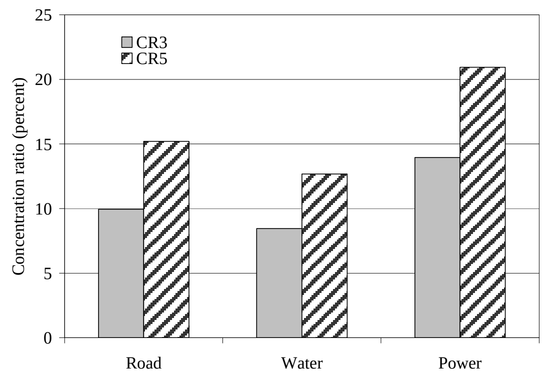
No. of	Number of firms		
wins	Road	Water	Power
1	74	79	43
2	17	21	11
3	11	5	4
4	2		1
5	3		1
6		1	
7	1		

Source: Author's calculation.

Figure 1 shows the conventional concentration ratio of the top three or five firms in each sector (in terms of the number of contracts awarded). While the water sector is least concentrated, the electricity sector is most concentrated. The concentration ratios of the top five firms are 13 percent and 22 percent in water and power project procurements. The ratio is about 15 percent in the road sector. These figures may not be significantly high, though they risk being underestimated; the data are by no means comprehensive in terms of coverage of sample countries, periods and projects. Moreover, the identification of the same firm may not be perfect (see Estache and Iimi (2008a; 2008b) for details).

Nonetheless, it seems evident that there are a number of firms that can be characterized as fringe (weak) bidders in these markets. Notably, this contrasts strikingly with the concessionbased infrastructure market.[4] According to the PPI database, the top 10 percent largest firms—defined by the number of transactions that each company obtained—were awarded about half of the public private partnership (PPP) contracts in infrastructure over the world. In the water industry, for instance, a multinational French water service operator, Veolia Environnement (former Vivendi Environnement, or Compagnie Générale des Eaux), was awarded 51 contracts, and another French company, SUEZ (former Lyonnaise des Eaux), won 50 transactions (Iimi, 2007).[5]

Figure 1. Concentration Ratio in Infrastructure Procurement Markets



Source: Author's calculation.

It is debatable how to identify fringe (or incumbent) bidders in empirical works. One popular approach is to rely on some auction outcome measures, such as the number of wins. The potential problem is that the outcomes are endogenously generated. In addition, it implicitly assumes that the nature of being a particular type of bidder, like fringe bidders, would translate into such observable outcomes. For example, one might think that fringe incumbents would be unlikely to obtain the object. The current paper follows De Silva, *et al*. (2002; 2003) and reinforces their definition; they define entrants as firms who did not bid in the first half of the sample period, and use data from the second half for their main analysis.

[4] Benitez and Estache (2005), computing the market concentration indices in the infrastructure service markets, show that the electricity distribution, fixed-line telecommunications and water distribution markets are over-concentrated.

[5] Also see Foster (2005).

This is not a perfect solution, and especially its great disadvantage is that half observations are discarded. However, the idea is at least feasible and not inconsistent with theory.

We define incumbent (strong) bidders as firms who obtained one or more contracts in the same sector during the first period: 1997–2002. This period covers about 20 percent of our entire sample data.[6] If a bidder is composed of multiple firms, it is defined as incumbent when at least one of the member firms has been awarded one or more contracts. Then, this definition is applied to the rest of the sample period: 2003-2007. We identify a total of 386 fringe bidders in the second half of our sample period. This accounts for about 70 percent of total bidders. Approximately two third of fringe bidders are faced with an incumbent bidder in auctions for road and electricity project auctions. One third of entrants competed with incumbents for water contracts (Table 2). Table 3 presents some companies classified as an incumbent or constituting a consortium classified as an incumbent based on our working definition. Some of them somewhat represent real incumbent firms that practitioners can agree on. But it is clearly affected by our country selection, and thus this classification cannot be generalized beyond the analysis in the current paper.

Table 2. Our Working Classification of Incumbent and Fringe Bidders: 2003-2007

	Roads	Water	Electricity
Number of auctions	45	60	33
Number of bidders	188	236	99
Of which, incumbent bidders	62	39	36
Of which, fringe bidders	126	197	63
Of which, bidders facing incumbents	71	66	38

Source: Author’s calculation.

[6] We intended to use the minimum amount of observations to identify the types of bidders; otherwise, no robust estimate of the entrant or incumbent effects in question could be obtained because of our limited sample.

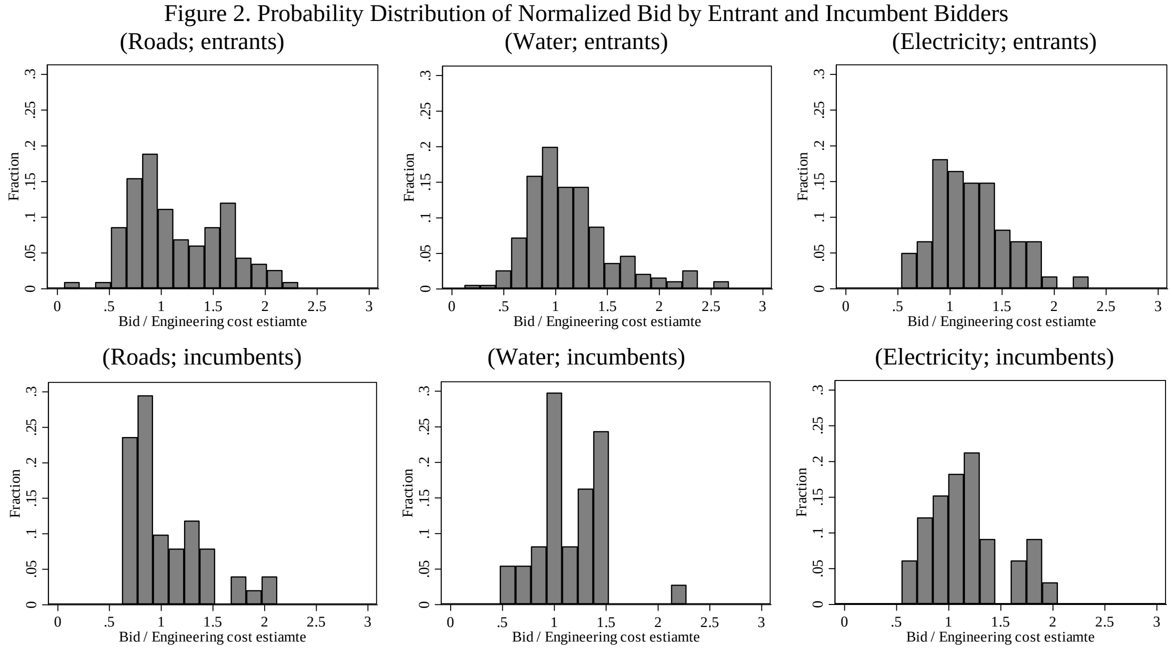
Table 3. Selected Companies Classified as "Incumbent Bidders"

Sector	Company
Roads	China Road & Bridge Corporation
	Civil Engineering Construction Corporation No. 1
	Grinaker
	Plant Pool Limited
	Sable Transport Limited
	Shimizu
	Thang Long
Water and sewage	Constructora Cadena S.A. de C.V.
	Summit Grade Limited, Part
	Tianjin Machinery & Electric Equipment Import & Export Co. Ltd.
	Urbanizacion y Riego de Baja California S.A. de C.V.
Electricity	Mitsui & Co., Ltd
	Alstom
	China National Electric Wire & Cable Import & Export Corporation
	EnegroInvest D.D.
	Itochu
	Nissho Iwai Corporation

Source: Author's calculation.

Based on definition, the probability distribution functions of normalized bids are illustrated (Figure 2). Incumbent bidders appear more aggressive than fringe bidders do, in particular in road procurements. Incumbents seem to have a tendency to submit competitive bids in the electricity sector as well. Note that these figures are unconditional and just compare bid prices by entrant and incumbent firms. It is worth recalling that theory does *not* indicate how differently they bid. Rather, it predicts that weak bidders tend to be more aggressive only if they are faced with strong opponents (Maskin and Riley, 2002).

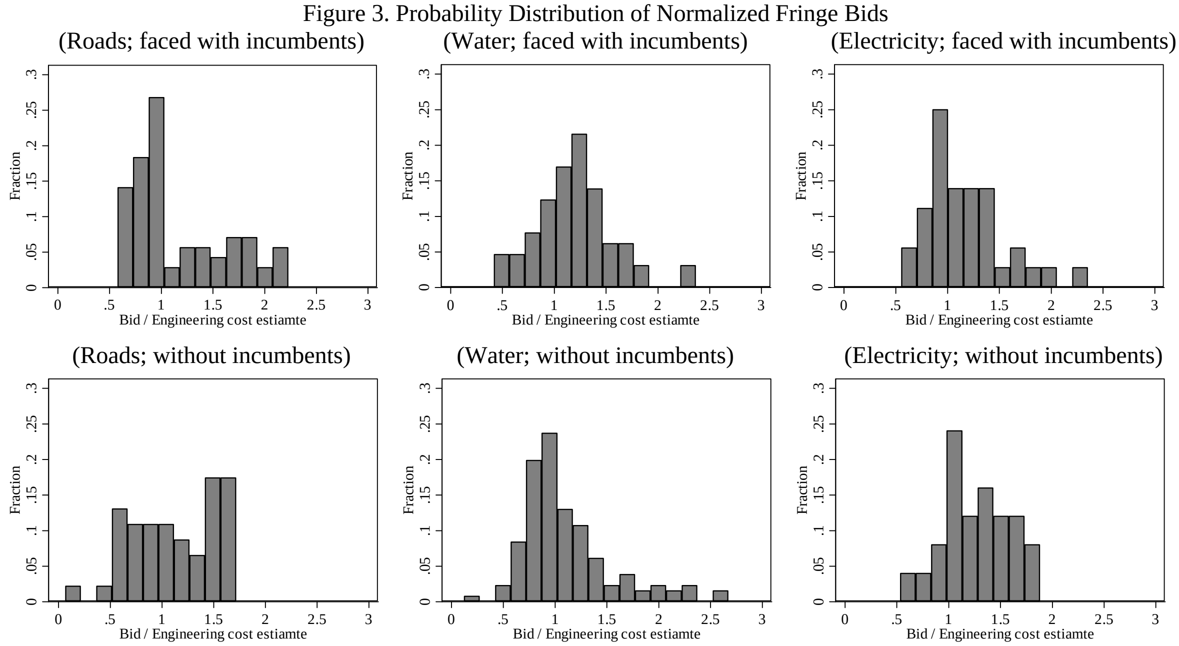
Figure 2. Probability Distribution of Normalized Bid by Entrant and Incumbent Bidders



Source: Author's calculation.

Our data are broadly supportive of the theoretical proposition. Figure 3 shows that the probability distributions of entrant bids only. While the distributions conditional on the existence of incumbent bidder(s) in an auction are shown in the upper charts, those conditional on the absence of incumbent(s) are shown in the lower charts. Except for the water sector, it seems that fringe bidders respond with aggressive bids when they compete against incumbent bidders in that auction. Especially in electricity procurement auctions, the probability distribution is concentrated on the left hand side, if one or more incumbents are present.

Figure 3. Probability Distribution of Normalized Fringe Bids

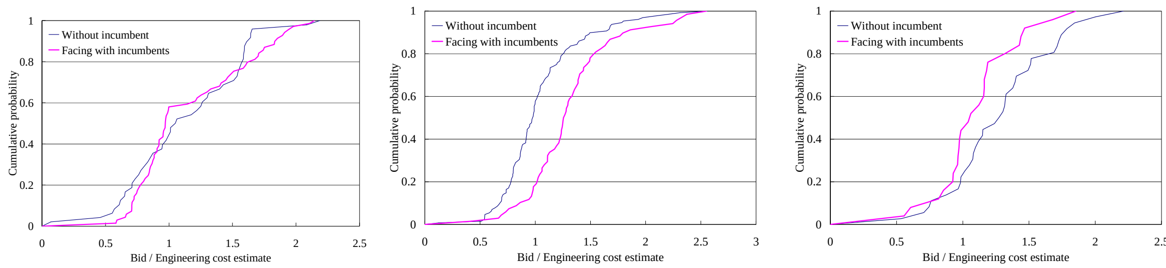


Source: Author’s calculation.

Figure 4 shows the cumulative probability distribution functions of entrant bids. The electricity sector exhibits the stochastic dominance of entrant bids in the presence of incumbent firms, as expected by Maskin and Riley (2002). In road procurements, entrant bids with incumbent rival’s presence may partly dominate those without incumbents, but it cannot be applied to the entire range of observed bids. The water sector looks inconsistent with theory; however, these comparisons are informal; there are many uncontrolled factors, some of which are accounted for in the following sections.

Figure 4. Cumulative Probability Distribution of Fringe Bids

(Roads) (Water) (Electricity)



Source: Author’s calculation.

III. The Empirical Model and Data

The empirical model is based on our companion paper (Estache and Iimi, 2008a). The following equilibrium bid function is estimated:

$$b_{it} = \alpha_1 D_{(Fringe)_i} + \alpha_2 D_{(Faced\ w\ incumbent)_{it}} + \alpha_3 ShrInc_t + \alpha_4 PastWin_i + X'_t\beta + \gamma \ln N_t + \varepsilon_{it}$$

b_{it} is i’s bid amount at auction t. The dependent variable includes both winning and losing bids, since the auction format adopted in ODA projects is a first-price sealed-bid auction. To save the degree of freedom, some of the explanatory variables, including a number of bidder nationality dummy variables, are excluded from our original model (Estache and Iimi, 2008a). Recall that our sample size is shrunken in order to define incumbent and entrant bidders. However, the contract-specific variables included in X_t are generally the same. N_t is the number of bidders participating in auction t, which is a key proxy to control for the degree of competition in an auction.

Following De Silva, *et al*. (2003), four variables are introduced to test the entrant bidding behavior predicted by asymmetric auction theory. First of all, $D_{(Fringe)}$ is set at one if bidder i is classified as an entrant; the dummy variable is expected to capture an unobserved characteristic of entrant bidders. Despite the presence of incumbent bidders, entrants may share certain common characteristics of cost parameters. For instance, in the highway construction case, De Silva *et al*. (2003) found that entrant bids are systematically low regardless of whether or not incumbent bidders are there. However, this may not always be the case if entrants are apparently inefficient and barely participate in the bidding competition.

Importantly, the entrant dummy is *not* our key parameter to be tested. Based on theory, it is the impact of the presence of incumbent firms on entrant aggressiveness, which is measured by another dummy variable denoted by $D_{(Faced\ w\ incumbent)}$. If it has a negative coefficient, it means that entrant bidders who are faced with incumbent rivals do respond aggressively, supporting the theoretical proposition.

We use two more variables related to the asymmetry across bidders. One is the number of contracts obtained by each bidder in the pre-period, i.e., 1997–2002. If a bidder is composed of more than one firm, all figures of the member firms are added up. This proxy is supposed to capture the potential differences in efficiencies across bidders (De Silva, *et al*., 2003). Firms with more prior-winning experience may be able to be presumed more efficient, whence continuing to submit low bids. Another is the share of incumbent bidders in each auction. This is additional to the existing literature but basically expected to play the same role as the measure of rivals' competitiveness, such as the past average winning ratio used by De Silva, *et al*. (2003). However, particular attention is paid to the extent to which presumably strong incumbents participate in each auction by using the incumbent concentration variable. The concern over anti-competitiveness will heighten, as the concentration of incumbent bidders increases in an auction.

Table 4 presents the summary statistics of the data used for our regression analysis. The data are comparable with the original one (see Estache and Iimi, 2008a) but cover only the period: 2003–2007. Of particular note, 67 percent of bidders are considered entrant in road procurements. In the water sector, this is as high as 83 percent. By contrast, the entrant ratio is lowest at 64 percent for the electricity projects. The share of incumbent bidders per auction is estimated at 32 percent in the road sector. The electricity sector has the similar level of incumbent bidders' presence (36 percent). In the water sector, however, the concentration of incumbent bidders is relatively low at 16 percent.

Based on our division of the sample period, bidders seem to have been awarded only a few contracts on average. The sample mean is 0.6 contracts in the road sector. This is the highest among the three sectors. The reason is simply that the total number of contracts in our pre-period is largest. The average numbers of past contracts are only 0.2 and 0.27 in the water and electricity sectors, respectively.

Table 4. Summary Statistics

	Obs.	Coef.	Std.Dev.	Min	Max
Roads					
Bid amount (million US$)	188	27.02	22.27	2.03	144.38
$D_{\text{(Fringe bidder)}}$	188	0.67	0.47	0	1
$D_{\text{(Fringe bidder facing incumbents)}}$	188	0.38	0.49	0	1
Share of incumbents in that auction	188	0.32	0.31	0	1
Number of contracts awarded	188	0.60	1.04	0	4
Number of bidders	188	6.63	3.75	2	16
Total road length (km)	188	43.27	60.89	3.50	427.00
Number of lanes	188	2.84	1.16	1	6
$D_{\text{(New roads)}}$	188	0.53	0.50	0	1
$D_{\text{(Rehabilitation work)}}$	188	0.37	0.48	0	1
Contract duration (month)	188	33.80	9.81	11.00	48.00
Water and sewage					
Bid amount (million US$)	236	15.95	26.61	0.33	276.66
$D_{\text{(Fringe bidder)}}$	236	0.83	0.37	0	1
$D_{\text{(Fringe bidder facing incumbents)}}$	236	0.28	0.45	0	1
Share of incumbents in that auction	236	0.16	0.24	0	1
Number of contracts awarded	236	0.22	0.68	0	4
Number of bidders	236	6.36	3.81	2	16
$D_{\text{(Water)}}$	236	0.27	0.44	0	1
$D_{\text{(Treatment plant)}}$	236	0.45	0.50	0	1
$D_{\text{(Network)}}$	236	0.60	0.49	0	1
Treatment capacity (million m3)	236	0.10	0.18	0	0.60
Total concrete tunnel length (km)	236	0.33	2.32	0	24.85
Total iron pipe length (km)	236	36.11	56.59	0	258.70
Contract duration (month)	236	26.11	13.03	3.00	72.00
Electricity					
Bid amount (million US$)	99	51.97	71.89	0.22	435.49
$D_{\text{(Fringe bidder)}}$	99	0.64	0.48	0	1
$D_{\text{(Fringe bidder facing incumbents)}}$	99	0.38	0.49	0	1
Share of incumbents in that auction	99	0.36	0.29	0	1
Number of contracts awarded	99	0.27	0.71	0	3
Number of bidders	99	4.71	2.38	2	12
$D_{\text{(Generator)}}$	99	0.26	0.44	0	1
$D_{\text{(Trans. lines)}}$	99	0.21	0.41	0	1
$D_{\text{(Substation)}}$	99	0.34	0.48	0	1
$D_{\text{(Civil work)}}$	99	0.68	0.47	0	1
Installed capacity (MW)	99	69.47	193.50	0	1,200
Number of generators	99	1.36	3.12	0	12
Transmission line capacity (kV)	99	32.03	94.52	0	500.00
Total transmission line length (km)	99	20.59	55.92	0	230.00
Contract duration (month)	99	27.28	12.19	3.00	48.00

Source: Author's calculation.

IV. Estimation Results

Tables 5 to 7 present our main regression results in the three sectors. The estimated parameters are not significantly different from those in Estache and Iimi (2008a), despite differences in their data coverage and specifications. Competition generally matters, though the coefficient associated with the number of bidders tends to be insignificant with data from the electricity sector. In addition, the larger the scale of the project, the higher the revealed equilibrium bids. For instance, a longer road work will cost more, as expected. If a treatment plant with larger water production capacity is constructed, the submitted bids will be higher systematically. The equilibrium bids also increase with electricity generation and transmission capacities.

The most important finding is that entrant bidders faced with incumbent bidder(s) have been found aggressive, regardless of sector. The coefficient of the dummy variables for entrant bids in the presence of incumbent bidder(s) is significant and negative in all sectors. The coefficient is estimated at -3.9 in road procurement auctions, meaning that a fringe bidder is predicted to respond with a 3.9 million U.S. dollar lower bid if he is competing against some incumbent bidders, holding everything else constant. The magnitude of the coefficient varies across sector. The coefficient tends to increase particularly in the electricity sector, partially because the contract amount is normally large in this sector. All coefficients are statistically different from zero, supporting the hypothesis that there are two types of bidders: incumbent (strong) and entrant (weak), and entrant bids are aggressive given the presence of incumbents.

A policy implication of this is twofold. First, encouraging fringe bidders to participate in the bidding process might be conducive to reducing procurement costs in infrastructure projects.[7] As far as our data are concerned, the above provides the insight that a considerable

[7] There is an adverse effect predicted as the flip side of the same coin by asymmetric auction theory. Incumbent bidders are likely to respond less aggressively when they are faced with entrant bidders. This would mitigate the competition pressure in auctions, and the net impact will be ambiguous.

number of firms who can be characterized as fringe bidders. However, second, they tend to exhibit aggressive behavior in bidding. Normally several incumbent bidders are expected be present in a competition.[8] Then, the “low bid and broke winner” concern will emerge. It is important to establish a sound selection mechanism, e.g., prequalification and two-stage evaluation of prices and technical attributes, to exclude firms who are unlikely to deliver the reasonable quality of work.

Contrary to prior expectations, there is no statistically significant evidence that entrant bidders are less efficient or less inefficient than incumbents. In the electricity industry, entrants seem have the disadvantage, because one of the coefficients is significantly positive. This may be reasonable with the advanced technical nature required by the sector taken into account.

The number of contracts obtained by each bidder in the past has negative coefficients across sectors, meaning that firms who received prior procurement awards are likely to be efficient enough to submit low bids. In the last column model with water project procurement data, the coefficient turns out statistically significant. This is good news and bad news. It can be interpreted to mean that the past auctions achieved the efficient allocation. The contractors who had been selected were actually efficient as far as their bidding behavior in the subsequent period is considered. Bad news is this: the result suggests that past contractors are likely to be awarded repeatedly, making it difficult to invite new entrant bidders. However, once they decide to participate in the bidding process, they have a tendency toward aggressive bidding.

Finally, high concentration of incumbent bidders in an auction has an adverse effect on efficiency. The coefficient of the share of incumbents is consistently positive and very significant. This indicates the classical risk of anticompetitive behavior among market

[8] It is noteworthy that the relatively low market concentration of incumbent bidders measured by our measure of the share of incumbents in each auction is subject to our tentative incumbent definition assumed for the analytical work. However, as mentioned, it is open to discussion who is the incumbent.

dominants. It could be caused by explicit and implicit collusion; importantly, it may be realized in equilibrium given the rules of the game. To remove this anticompetitive effect associated with incumbents' dominance, again, it is important to promote active entrant participation in the auctions. Note that this effect is only associated with incumbent bidders. Conversely, the above-mentioned effect captured by the number past contracts is symmetric between incumbent and entrant firms.

In sum, some of the direct policy implications are as follows:

- A number of firms may be considered entrant or fringe bidders in infrastructure procurement auctions.
- They may or may not be efficient.
- However, they are expected to bid aggressively in the presence of incumbent bidders, whence promoting competition and possibly reducing procurement costs.
- When their aggressive behavior raises a concern about the "low ball" problem, auctioneers are required to follow a sound selection mechanism using the prequalification and/or two-stage evaluation procedures.
- High concentration of incumbent bidders in an auction also harms auction efficiency, raising procurement costs.
- From this perspective, again, it is important to encourage fringe bidders to actively participate in the bidding process and maintain competitive circumstances in public procurement auctions.

Table 5. Regression Results for Bids in Road Procurements

	(1)	(2)	(3)
Entrant bid dummy		3.62	7.17
		(4.27)	(4.55)
Dummy for entrant facing with incumbent(s)			-3.90 *
			(2.12)
Share of incumbent bidders in auction		22.38 ***	26.84 ***
		(5.16)	(5.92)
Number of contracts before 2002		-0.32	-0.64
		(1.94)	(1.98)
ln(*N*)	-10.37 ***	-4.77 *	-3.19
	(2.82)	(2.56)	(2.59)
Lot length (km)	0.14 ***	0.17 ***	0.18 ***
	(0.05)	(0.05)	(0.05)
Lot length^2 (km) 1/	0.31 ***	0.30 **	0.26 **
	(0.12)	(0.12)	(0.11)
Lane	-17.89 ***	-22.42 ***	-22.88 ***
	(4.37)	(4.71)	(4.59)
Lane^2	4.07 ***	4.61 ***	4.63 ***
	(0.65)	(0.65)	(0.64)
New roads	8.38 **	11.74 ***	12.09 ***
	(3.51)	(3.38)	(3.30)
Rehabilitation	0.47	4.53 *	4.96 **
	(2.83)	(2.49)	(2.47)
Contract duration	0.27	0.41 **	0.48 ***
	(0.17)	(0.16)	(0.16)
Donor 1	2.30	-3.18	-2.80
	(2.33)	(2.22)	(2.26)
Constant	34.54 ***	18.60 *	11.18
	(9.41)	(10.21)	(10.36)
Obs.	188	188	188
R-squared	0.680	0.727	0.730
F -statistics	90.15	68.21	65.71

1/ For presentation purposes, the coefficients are multiplied by 1,000.

Note: The dependent variable is the bidding amount. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

Source: Author's calculation.

Table 6. Regression Results for Bids in Water Project Procurements

	OLS	OLS	OLS
Entrant bid dummy		-2.04	17.83
		(7.59)	(11.68)
Dummy for entrant facing with incumbent(s)			-22.52 **
			(9.92)
Share of incumbent bidders in auction		34.12 **	71.09 ***
		(14.11)	(25.94)
Number of contracts before 2002		-4.85	-8.36 **
		(3.09)	(3.81)
ln(*N*)	-11.82 **	-7.30 *	-5.57 *
	(4.85)	(3.80)	(3.46)
Water	6.56	10.11	14.52 *
	(6.68)	(7.38)	(8.44)
Treatment plant	-89.28 *	-78.63 *	-111.28 **
	(47.95)	(45.97)	(55.28)
Network	13.65	11.21	16.25
	(18.18)	(17.19)	(18.63)
ln(*Treatment capacity*)	9.42 **	8.51 *	11.29 **
	(4.62)	(4.40)	(5.20)
ln(*Tunnel network length*)	0.24	0.52	0.30
	(0.44)	(0.37)	(0.42)
ln(*Iron pipe network length*)	0.95 ***	1.00 ***	0.61 *
	(0.27)	(0.23)	(0.37)
Contract duration	0.29 *	0.40 **	0.28 *
	(0.18)	(0.19)	(0.16)
Donor 1	-2.41	-8.92	-7.54
	(6.97)	(8.43)	(7.79)
Constant	160.02 ***	141.89 **	158.52 ***
	(59.20)	(55.06)	(59.14)
Obs.	236	236	236
R-squared	0.360	0.400	0.422
F-statistics	15.39	14.05	11.25

Note: The dependent variable is the bidding amount. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.

Source: Author's calculation.

Table 7. Regression Results for Bids in Electricity Project Procurements

	OLS	OLS	OLS
Entrant bid dummy 1/		-0.05	1.69 ***
		(0.11)	(0.39)
Dummy for entrant facing with incumbent(s) 1/			-1.72 ***
			(0.39)
Share of incumbent bidders in auction 1/		0.59 *	2.53 ***
		(0.35)	(0.63)
Number of contracts before 2002		-6.36	-4.31
		(9.46)	(6.57)
ln(*N*)	-4.14	-6.12	53.16 **
	(12.77)	(12.80)	(20.11)
Turbine	83.39 *	69.29 *	32.21
	(42.64)	(36.07)	(22.77)
Trans. dist. lines	8.13	11.83	-35.48 **
	(15.40)	(14.81)	(15.40)
Substation	7.50	-2.95	20.04 **
	(10.34)	(10.06)	(9.02)
Civil work	81.10 ***	77.90 ***	94.46 ***
	(23.32)	(21.01)	(17.70)
Installed capacity	0.12 *	0.11 *	0.18 ***
	(0.06)	(0.06)	(0.04)
Number of turbines	1.62	1.43	8.25 ***
	(3.36)	(3.30)	(1.96)
Trans. line voltage	0.06 *	-0.02	0.19 ***
	(0.03)	(0.06)	(0.06)
Trans. line length	-0.12	-0.07	-0.28 ***
	(0.09)	(0.08)	(0.10)
Contract duration	1.45 **	1.18 **	2.40 ***
	(0.58)	(0.50)	(0.68)
Donor 1	17.52	1.71	-16.66
	(21.05)	(16.71)	(14.24)
Constant	-83.94 *	-68.70 *	-307.56 ***
	(45.14)	(40.53)	(69.57)
Obs.	99	99	99
R-squared	0.545	0.580	0.749
F -statistics	32.74	25.27	37.90

1/ For presentation purposes, the coefficients are divided by 100.
Note: The dependent variable is the bidding amount. The robust standard errors are shown in parentheses. *, ** and *** indicate the 10%, 5% and 1% significance levels, respectively.
Source: Author’s calculation.

V. CONCLUSION

Asymmetric auctions are among the most rapidly growing areas in the auction literature. The traditional symmetric framework is not always applicable in practice because bidders are usually heterogeneous.

In public procurement auctions related to official development projects, an alleged concern is that the competition pressures at the auctions might be relatively weak. The potential benefits from improved auction efficiency are expected to be enormous.

Entrant bidders are considered a key to enhance competition in an auction and break potential collusive arrangements among incumbent bidders. However, it is debatable whether or not fringe bidders exist in these infrastructure procurement markets. It may also be open to argument how to identify fringe (or incumbent) bidders in empirical works.

Asymmetric auction theory predicts that weak (fringe) bidders would bid more aggressively when they are faced with a strong (incumbent) opponent. Our ODA procurement data are supportive of this. It has been found that in the three infrastructure sectors, entrant bidders submitted systematically aggressive bids in the presence of incumbent bidders. It is also shown that high concentration of incumbents in an auction would be likely to harm auction efficiency, raising procurement costs.

The results suggest that auctioneers should encourage fringe bidders to actively participate in the bidding process while maintaining the quality of the projects to be delivered. It would be conducive to enhancing competitive circumstances in public procurement auctions and improving procurement efficiency.

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