Bidder Behaviour in Swedish Simultaneous Procurement Auctions

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Abstract

Given no capacity constraints and the same set of competitors one would expect the same identity of the bidder having the lowest cost to complete all contracts simultaneously auctioned. Results based on bid level data from Swedish procurement auctions of internal cleaning service contracts suggests otherwise. The same bidder is found on simultaneous auctioned contracts although this bidder has not submitted the lowest bid on all contracts. A possible explanation is that bidders submit aggressive bids on some contracts in order to be given other contracts with less aggressive bids and thereby maximizing the total profit.

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1. Introduction

This paper provides an empirical test of the hypothesis that a bidder that wins at least one contract within a simultaneous procurement auction with an aggressive bid increases the probability to win another contract with a less aggressive bid (i.e. not the lowest submitted bid).

As in the rest of the European Union (EU), public contracts in Sweden are auctioned by the means of single and multiunit first-price sealed bid auctions. It is the law governing these procurements that makes the feature of the simultaneous procurement auctions described above possible.[1] Contracts can be given according to two award criteria, the lowest bid or the bid motivated to be the economically most advantageous bid with respect to certain criteria. It is observed in Swedish procurement auctions that bidders mix aggressive bids with less aggressive bids on contracts auctioned within the same procurement. In procurements of non-complex contracts and given that there are no capacity constraints and the same set of bidders it is reasonable to expect the same identity on the bidder having the lowest cost to complete all the contracts. However, given the two award criteria, a mixing of bids could be profit maximizing (higher profit on contracts won at a less aggressive bid) and risk reducing (aggressive bids on some contracts increases the probability of getting at least one contract). This strategy is relevant given the assumption that the contracting entity finds it beneficial to contract one or a few bidders. If the probability to get a contract at the economically most advantageous bid is higher if the same bidder is awarded at least one other contract auctioned simultaneously at a low bid, the competition situation is affected and the resulting allocation could be inefficient. As such, this study has clear policy implications for the bidders, as well as the agents in the local government who evaluate the bids.

The data used in this study originate from procurements of internal cleaning service contracts on the local government level in Sweden during the period 1992 to 1998. The data consists of 5,303 bids placed on 663 contracts. A logistic regression is used to estimate the determinants of the probability of winning a contract.

[1] See the Public Procurement Act in Sweden, LOU (1992:1528).

From previous empirical studies on procurement auctions we have knowledge about among other things the impact of collusion. Examples may for example be found in an application on spectrum auctions in the U.S by Cramton and Schwartz (2002) and highway construction procurements in the U.S, by Gupta (2001). Furthermore, Bajari, McMillan, and Tadelis (2003) provide an empirical paper on the use of auctions versus negotiations in procurements of construction works in the U.S, and in another paper Gupta (2002) studies competition and bidder interaction using the same highway construction data as in Gupta (2001). The effect of the winner's curse and competition on bids concerning highway work, maintenance, and road paving in the U.S, are analyzed in Hong and Shum (2002). Bidding behaviour using electricity procurement data from England and Wales is studied by Wolfram (1998). This is also the topic in Jofre-Bonet and Pesendorfer (2000) but in a repeated highway procurement auction in the U.S. In a paper on U.S. procurement auctions of oil and gas leases Hendricks, Pinkse, and Porter (2003) provide evidence of bidders taking the winner's curse into account when placing their bids. Data from these procurements are also used by Hendricks and Porter in a series of studies of asymmetric information (1994, 1993, 1988, and 1987) as well as joint bidding (1992). The current paper is, to my notice, the first to study the effect on bidder strategies from the two award criteria applied in procurement auctions within the EU. Lundberg (2005) empirically analyses differences in winning bids due to the two award criterions with the same data as in the current paper and finds that winning bids on lowest bid offered contracts are significantly lower than contracts awarded under the economically most advantageous bid criterion.

The remainder of this paper is organized as follows. The next section gives a presentation of the institutional setting surrounding Swedish procurement auctions and a brief presentation of the theory underlying the empirical analysis. The following two sections describe the data and the empirical model followed by a presentation and discussion of the results. Finally, a concluding section ends the paper.

2. Stylized facts regarding Swedish procurement auctions and bidder behaviour

Swedish local governments use sealed bid auctions in line with the first-price sealed bid auction to allocate internal cleaning service contracts. The bidders submit sealed bids that are opened and evaluated at a predetermined date. The winner is paid in accordance with her bid. The phrase "in line with" is used since there are two award criteria that may be applied. The contract can go to the lowest bidder or to some other but the lowest bidder motivated to be the economically most advantageous bid with respect to price, and for example, quality, service, and maintenance. Although the evaluations criteria are known to the bidders prior to the bids are placed, the weight attached to each criteria is unknown.[2] The bids are pure price bids and it is not possible to separate the bid into a price and quality share. The contracts are well defined and the bidder has information about the internal cleaning frequency, square meter to be cleaned, and the cleaning products to use before the bids are placed. Therefore it is reasonable to assume that the bidders know their cost to complete the contract with certainty. However, the uncertainty about the award rule could affect the bidders' behaviour. Results provided in Lundberg (2005) show that the award rule affects the winning bids. Under the economically most advantageous award rule winning bids are significantly higher than winning bids on contracts allocated according to the lowest bid rule. This becomes even more interesting if the auction format is taken into consideration. The contracts can namely be auctioned in single or multiunit (simultaneous) auctions and the latter format adds another dimension to the uncertainty regarding the award rule. Under the simultaneous format there is no combinatorial bidding and one bid cannot be conditional on other bids in the same procurement. The bids are therefore supposed to be simultaneously submitted independently of each other.

In the case of internal cleaning service contracts procured by local governments on the municipality level, it is observed that bidders mix aggressive bids on some contracts with higher bids on the other contracts simultaneously auctioned in the same procurement. This might seem a bit strange. If a bidding firm has the lowest cost to complete one contract it is likely to have the lowest cost to complete the other

[2] This situation is valid for the procurements in the present paper.

contracts as well.[3] On the other hand, there could be a restriction on how many contracts the firm can handle given that it has a capacity constraint leading to less aggressive bidding on some contracts according to some internal predetermined ranking. If the bidder is awarded such a contract it is worth the extra effort to accomplish it, due to the higher profit. However, the capacity constraint for an internal cleaning service contract would be an access to cleaners which, due to a labour market characterized of unemployment, seem unlikely. Therefore, it is argued here that if the contracting entity finds it beneficial to contract one or a few firms on a number of contracts, *B*, within the procurement, then aggressive bids on at least one contract could be the an opportunity for a bidder to be given all the contracts (or at least more than one). Consequently, placing higher bids on the other contracts can thereby increase the total profit, compared to a scenario with aggressive bids on all contracts. Given this argument a bidder *i*, where $i = 1,...,n$, strategically submits aggressive bids in accordance with the standard first price sealed bid auction (b_i), on at least one contract and higher bids than that, ($b_i' > b_i$) on other contracts auctioned simultaneously in order to maximize the expected profit.[4] Both bids are assumed to correspond to the same quality and cost to complete the contract ($c_i = c_i'$). The cost is assumed to be private. If there is a mix of award rules within the procurement, a mix of bids based on this assumption could increase the probability to win at least one of the contracts and thus give higher profit on contracts won with a b_i'-bid. Assume that bidder *i* can submit b_i'-bids on a subset *K* ($K \subset B$) of the total set of contracts *B* in combination with b_i-bids on another subset *F* ($F \subseteq B, F \neq \varnothing$) of the total set of contracts *B*. Bidder *i* may as an alternative choose to submit b_i-bids on the total set of contracts ($F \cap K = \varnothing, F \cup K = B$). Given that bidder i is assigned all the contracts that she has placed a bid on, the expected profit from mixing aggressive and less aggressive bids is;

[3] This presumes that the bidders face the same set of competitors on all contracts within the same procurement.

[4] See, for example, Vickrey (1961), Laffont, Ossard, and Voung (1995), Laffont (1997), Krishna (2002), and Milgrom (2004) for theoretical presentations of the first price sealed bid auction.

$$E_1[\pi_i] = \sum_{j \in F} (b_{ij} - c_{ij}) + \sum_{j \in K} (b'_{ij} - c'_{ij}) \quad \text{for } \forall j \in B, F \subseteq B, \text{and } K \subset B \tag{1}$$

Under the same assumption the expected profit from submitting bids according to the bidding strategy given by the first-price sealed bid auction the expected profit to bidder *i* is;

$$E_2[\pi_i] = \sum_{j \in B} (b_{ij} - c_{ij}) \quad \text{for } \forall j \in B \tag{2}$$

Since $b'_i > b_i$ and $c_i = c'_i$ the expected profit according to expression (1) is higher than the expected profit according to expression (2)

$$E_1[\pi_i] > E_2[\pi_i] \tag{3}$$

The bidder also has to decide which contract to bid aggressively and less aggressively on based on, her belief about the award rule. However, this is not modelled here because it is not necessary for testing the hypothesis.

3. Data from Swedish procurement auctions

In order to test the hypothesis about bidder behaviour, field data from simultaneous Swedish procurement auctions of internal cleaning service contracts are used. The contracts are fixed priced, well defined, and not complex. The data originate from the period 1992 – 1998 and are rich on information about the bidders, contract specifics, procurement procedure, and municipality characteristics. All the 289 Swedish municipalities received a request asking them for documents concerning internal cleaning service procurements.[5] The response rate was 79.5 percent and about 22 percent of the respondents had actually procured internal cleaning services during the time frame. The rest had in-house production without procurement. It is a political decision in Sweden which type of services the local government should produce by

[5] The contract notice, technical specification, list of tenders, and decision protocol.

them selves and which to put up for competition. If an in-house bidder competes for the contract, this bidder should not be favoured in any way.

The data is organized in three levels; there are 50 procurements and 664 contracts on which 5,303 bids were placed. The number of simultaneously auctioned contracts varies between 2 and 74 and the bid level data will be used in the present paper. There are different contract types in the data for different premises, such as for example a school, a day care centre, a medical health care centre, or an office. Each of the premises (building type) is contracted separately. The contract period ranges from a couple of months up to four years. The variables used in the empirical analysis are categorised into procurement characteristics, the bidders, and municipality characteristics.

The causal variable is a dummy variable (*Advantage*) capturing the effect of a bidder winning at least one contract with a lowest bid on the probability that the same bidder will win another contract auctioned in the same procurement with an economically most advantageous bid. This dummy variable takes the value one if this is the case (that is, i wins with a b_i'-bid given that i has won another contract in the same procurement with a b_i-bid) and zero otherwise. Descriptive statistics show that 252 of the 664 contracts were assigned to a bidder according to the economically most advantageous award criterion, and who also was assigned a contract in accordance with the lowest bid criterion.

The procurement characteristics are the contract period and dummy variables for the contract type (the premises to be cleaned) where a school is the reference category. It is very common that the contracts specify a contract period and a prolongation period (usually one or two years). If everything runs smoothly during the contract period, the contract is automatically prolonged in accordance with the stipulated prolongation period. Since this is the expected outcome, the contract period variable is the sum of the contract and prolongation period. Variation in the number of contracts auctioned simultaneously is also considered. On average, 26 contracts were simultaneously auctioned. See Table 1 for descriptive statistics on the contract and prolongation period and number of contracts.

The bidders are heterogeneous. There are five national firms, the in-house production as well as a number of local firms that compete with each other. Instead of using firm specific dummy variables as in Bajari and Hortacsu (2003), the effect of bidder heterogeneity is captured by bidder type dummy variables. Three dummy variables are constructed, one that takes the value one if the bidder is one of the five national firms and another dummy variable that takes the value one if the bid is placed by the in-house production. Although each municipality has its own in-house production, these are all considered to belong to the same bidder category. The local firms are the reference category. Almost 30 percent of the bids were placed by a national firm and about 7 percent by the in-house production. In order to capture the effects of competition, the number of bidders is included in the analysis. It is reasonable to assume that the probability that bidder i wins is negatively affected by the number of bidders. This effect is assumed to be non linear. The average number of bidder per contract is approximately 8 (see Table 1 for more details). One contract attracted only one bidder. This case is excluded from the estimations.

The most obvious determinant if a bidding firm will become a winner is the bid it has placed. The theoretical prediction is a negative relationship between winning options and the bid level but since we have the two award criteria this is not self-evident. As displayed in Table 1, there is a high degree of variation in the bid variable. This is measured as the annual price per square meter to be cleaned in the 1994 price level.[6] Finally there is a dummy variable (*Previous winner*) that takes the value one if the bidder is a firm that has been contracted by the local government in one or more previous procurements. A previous winner placed approximately 23 percent of the bids. The in-house production is the most successful bidder in terms of contract won in relation to number of contracts bid on; it wins in 55 percent of the cases. See Table A1 in the appendix for more information about success ratio given bidder type.

The municipalities are characterized by the political characteristic, population density, and unemployment rate. These variables are assumed to measure differences in the bidding environment. The political characteristic (*Red*) is the share of seats in the

[6] The bids are normalized to a cleaning frequency corresponding to 260 days per year.

local council assigned to the social-democratic and left wing parties measured in percent. The population density is computed as the population divided by land area and the unemployment rate is the unemployment per capita in percent.

Table 1. Descriptive statistics

Variable	*N*	Min	Max	Mean	Standard deviation
Bid	5,303	2.77	987.27	157.06	88.66
Number of bidders	664	1	18	7.98	3.74
Number of contracts	664	2	74	26.16	19.78
Contract period	664	0.50	4.00	2.11	0.66
Prolongation period	664	0	2.00	0.91	0.50
Red	50	21.0	66.0	45.93	12.39
Population density	50	8.75	2749.69	338.71	605.29
Unemployment rate	50	3.90	13.96	8.00	2.21

4. Empirical model

The previous discussion about bidder strategy boils down to the following hypothesis to be empirically tested; The probability that bidder i wins a contract based on the economically most advantageous award rule is higher, given that bidder i, is assigned at least one other contract in accordance with the lowest bid award rule auctioned simultaneously. This will be tested with a binary choice model, where $y_i = 1$ if the bidder is a winner and zero otherwise. This probability is estimated with a binary logit model

$$\begin{aligned} \Pr\left[y_i = 1 \middle| z_{ik}\right] &= \Lambda\left(\beta' z_{ik}\right) \\ &= \frac{\exp^{\beta' z_{ik}}}{1+\exp^{\beta' z_{ik}}} \end{aligned} \tag{4}$$

where β is a parameter vector and Λ is the logistic cumulative distribution. Contract specifications, characteristics of the bidding environment, bidder heterogeneity, and municipality characteristics as specified in the previous section are included in the z vector. The marginal effects are computed according to[7]

[7] See Greene (2000) and Lias (1994) for a description of binary choice models.

$$(5) \qquad \frac{\partial \Lambda(\beta' z_{ik})}{\partial z_{ik}} = \Lambda(\beta' z_{ik})(1 - \Lambda(\beta' z_{ik}))\beta$$

5. Results

Parameter estimates from the regression of expression (4) are presented in Table 2 below. The results suggest that the probability that a bidder will win a contract with an economically most advantageous bid is significantly higher if the bidder has won another contract in the same procurement to a lowest bid, and as such the hypothesis can not be rejected. When it comes to the procurement characteristics it is evident that the contract type is not relevant for the probability that a bidder wins a contract in comparison with school contracts. Results from a Wald test show that it is easier to win an office contract than a child-care centre contract, which in turn is easier to win than another contract. The test statistics are found in Table A2 in the Appendix. The number of contracts simultaneously auctioned matters; the odds of becoming a winner are higher the more contracts that are auctioned simultaneously.

The model further suggests that bidders are not equally likely to become a winner. Both national firms and the in-house production are significantly more likely to win a contract than the local firms. Moreover, from a Wald test (the $\chi^2(1)$ statistic is 147.80) it is evident that the in-house production is more likely to win compared to the national firms. There is a clear competitive effect concerning the likelihood of becoming a winner. The more bidders the harder this will be. Based on the fact that the parameter for number of bidder squared is positive and significant one may conclude that this effect is decreasing. The bid parameter has a significant negative effect on the probability of getting a contract. The lower the bid the more likely it is that the bidder will win a contract.

The model gives no evidence of the assumption that history matters; bidders who have been contracted by the same local government in previous procurements are equally likely to win a contract as any other bidder. Bidders' possibility to be awarded a contract is also significantly affected by the bidding environment. The municipality characteristic parameters are negative and significant.

Table 2. Results from maximum likelihood estimation. *N*=5,302

Variable	Logit model β	*t*-value	Fixed effect model β	*t*-value
Constant	0.57	0.94	-4.62	-9.57
Advantage	7.90	7.83	8.30	8.18
Procurement characteristics				
School	-	-	-	-
Child care centre	0.12	0.91	0.16	1.03
Medical health care centre	0.27	0.90	0.28	0.89
Office	0.18	1.01	0.03	0.14
Other	0.01	0.04	0.05	0.24
Contract period	0.41	5.21	0.74	4.99
Number of contracts	-0.02	-4.67	-	-
The bidders				
Local firms	-	-	-	-
National firms	1.20	9.54	1.37	10.79
In-house production	2.90	17.34	3.29	18.23
Bid	-0.00	-4.45	-0.00	-4.68
Number of bidders	-0.40	-4.83	-	-
Number of bidders squared	0.02	3.94	-	-
Previous winner	0.16	1.18	0.28	1.54
Municipality characteristics				
Red	-0.03	-4.20	-	-
Population density	-0.00	-1.92	-	-
Unemployment rate	-0.08	-2.27	-	-
$LogL$		-1371.38		-1329.92
$LogL_0$ (The constant only)		-2137.51		-2137.51
$\chi^2(16)$ / $\chi^2(38)$		1532.25		1645.41
McFadden information criterion[8]		0.36		0.38

The explanatory power of the model is good. The $\chi^2(16)$-value is well above the critical value and as such, the model cannot be rejected. The McFadden information criterion suggests the same conclusion. The estimated probability that a bidder will win a contract is approximately 0.14. The percentage of correct predictions is 91 (see Table 3).

Table 3. Actual and predicted values
(winner=1)

	Predicted		Total
Actual	0	1	
0	4,540	25	4,565
1	446	291	737
Total	4,986	316	5,302

[8] The McFadden information criterion is computed according to $1 - L / L_0$. See Greene (2000).

The marginal effects, computed according to expression (3), show a small but significant negative marginal effect of competition and positive (tiny) marginal effect of bid level. There is clear marginal effect on the probability of winning a contract from the advantage variable. See Table A3 in the appendix for all marginal effect estimates.

The correlation between the unemployment rate and the political situation (*Red*) is high (0.77), therefore two separate models have been estimated, with each of these variables. The results proved the model as it is specified above to be robust for the model specification.

In order to allow for municipal specific effect not included in the data, a fixed effects model is estimated. Since estimation of a logit model with fixed effects requires the observations to be adjacent, dummy variables for each of the municipalities are created. However, the inclusion of the fixed effects does not affect the parameter estimates. See Table 2 for presentation of the results.

6. Conclusions

This paper focuses attention on bidder behaviour within Swedish procurement auctions. The main issue has been to empirically evaluate the hypothesis that bidders mix aggressive bids (in accordance with the standard sealed bid first-price auction) and less aggressive bids than that on internal cleaning service contracts in order to maximize profits. The main reason for applying this bidding strategy is a belief that an aggressive bid on at least one contract increases the probability to win simultaneously auctioned contracts to a less aggressive bid. This belief is motivated by an assumption that if the contracting entity finds it beneficial to contract one or a few firms instead of a bundle of bidders then aggressive bids on some contracts could lead to getting other contracts within the same procurement to less aggressive bids. The profits from the latter are higher than from the former. The hypothesis is by an empirical analysis based on Swedish procurement data regarding internal cleaning service contracts concluded to be accurate. Conclusively, the award criterion rules did affect the bidding behaviour in these procurements. The data covers the 1992 to 1998 period and consists of 5,303 bids placed on 663 contracts.

The bidding behaviour described above accords with the law governing these auctions. Publicly auctioned contracts within the EU can be awarded to the lowest bidding firm or the firm that has placed a bid considered being the economically most advantageous one. This is a central part of the procurement within the EU with clear effects on the outcome, possibly resulting in inefficient contract allocations where more research is needed. A natural extension of the present paper is the inclusion of systematic bidding behaviour regarding which type of bid to place on which contract.

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Appendix

Table A1. Statistics on bidding behavior and success rate for national firms and in-house production.

	Number of placed bids		Number of wins		Success ratio
	#	%	#	%	
Firm 1	620	93.4	172	25.9	0.28
Firm 2	507	76.4	80	12.0	0.16
Firm 3	321	48.3	20	3.0	0.06
Firm 4	48	7.2	21	3.2	0.44
Firm 5	65	9.8	1	0.2	0.02
In-house	371	55.9	202	30.4	0.55
N					664

Table A2. Wald test. $\chi^2(1)$-statistic for contract categories.

	Child care centre	Medical health centre	Office	Other
Child care centre	-	3.13	7.60	9.46
Medical health centre	-	-	2.29	3.53
Office	-	-	-	6.94

Table A3. Marginal Effects.[9]
N=5,302

Variable	β	*t*-value
Constant	0.49	0.95
Advantage	0.93	142.04
Procurement characteristics		
School	-	-
Child care centre	0.01	0.90
Medical health care centre	0.03	0.82
Office	0.02	0.96
Other	0.01	0.04
Contract period	0.04	5.17
Number of contracts	-0.01	-4.64
The bidders		
Local firms	-	-
National firms	0.13	8.02
In-house production	0.53	14.86
Bid	-0.00	-4.51
Number of bidders	-0.03	-4.80
Number of bidders squared	0.00	3.92
Previous winner	0.01	1.14
Municipality characteristics		
Red	-0.00	-4.20
Population density	-0.00	-1.91
Unemployment rate	-0.01	-2.27

[9] The marginal effects for the dummy variables are $\Lambda(\beta' z_{ik})[1-\Lambda(\beta' z_{ik})]0$.