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Impact of E-Auctions on Public Procurement Effectiveness

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Abstract. Effects of E-Auctions are in expert literature often demonstrated on data from the domain of public procurement. The paper tests for their impact on public procurement effectiveness in conditions of the Czech Republic and within tenders for construction works. Using quantitative methods are analysed also other factors that may influence its strength (openness of the procedures, types of procurement management, etc.).

Keywords: Competitive Effect, Construction Work, E-Auction, Public Procurement

1. Introduction

Significant portion of public funds is being allocated under the institute of public procurement. According to OECD (2007), in developed countries the share of public procurement to GDP ranges between 15–20%. It is therefore clear that effectiveness of this institute has a significant impact on the overall effectiveness of public expenditure. Within recent literature (e.g. Nemeč et al. (2005)) there often appears a claim that the way to increase effectiveness of this institute is via electronic auctions. Although the usually assumed impact on tendered prices is often rather high (20%) it lacks a support by empirical analyses.

This paper aims to analyse factors influencing effectiveness of public procurement using data on construction contracts in the Czech Republic and, in particular, to test the hypothesis of a positive impact of electronic auctions on tendered prices of public contracts.

2. The Current Level of Understanding

Effectiveness of the institute of public procurement depends on existence of a sufficient level of competition. This finding was identified within most empirical studies concerning with the number of submitted bids. Inversely proportional relationship, known as the competitive effect, is confirmed by many empirical studies (e.g. Tas et al. (2008) or Bandiera et al. (2008)). Most authors (e.g. Kuhlman – Johnson (1983) or Iimi (2006)), however, warn that impact of competitive effect is limited and gradually evaporate as the number of tender offers increases, i.e. the price is approaching its cost limit. Empirical studies such as Brannman, Klein & Weiss (1987) or MacDonald et al. (2002) determine exhaustion of the competitive effect at somewhere around 6 submitted bids, with certain variation among individual sectors.

Increased competitive pressure with a positive impact on price is often expected once the tender is processed through an electronic auction. Some studies point to a relatively high impact on the tendered prices. For example, Croom and Brandon – Jones (2005) have indentified 16% savings on such purchases as are food or building materials. Case studies carried out in Brazil, Romania and Mexico presented in Auriol (2006) point to savings of 20 percent or more. As these figures seems impressive and very efficient it also influence estimates and expectations of some international institutions; for example, EC (2004) expects the e-procurement implementation to bring 5% savings on public expenditures and 50–80% savings on transaction costs.

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The main problem with these studies and the related savings estimates is in their methodology. The studies are mostly based on miscellaneous surveys whose results are negatively biased by the structure of respondents. Principally, such questionnaires are completed mostly by subjects interested in the issue that consider computerisation of public procurement as a useful way to go. Application of more advanced quantitative methods is in these studies rather rare.

Studies that analyse impact of computerisation of public procurement and electronic auctions using larger data samples are considerably less frequent. In this respect may be mentioned the work of Singer et al. (2009), where estimated benefits (in terms of a reduction in tendered prices) related to the introduction of e-procurement in Chile are slightly below 3%. This number is very similar to results of the study by Metty et al. (2005) conducted on the Motorola data that put the respective value at 3.75%.

3. Formulation of Hypotheses and Their Theoretical Derivation

Based on the aforementioned theoretical examination it is possible to formulate the following hypotheses for a dataset analysis:

- HP1: With an increase in the number of submitted tender offers the final tendered price decreases.
- HP2: Any artificial restriction of competition results in higher prices.
- HP3: Use of an electronic auction results in lower tendered prices vis-à-vis "classic paper" procedures.
- HP4: Advance notice of public tender announcement reduces tendered prices.

The first of the formulated hypotheses is based on the aforementioned assumption that an increase in the number of bidders has a positive impact on the offered price. Two factors may participate in the price reduction:

- Higher number of bidders maximises the probability that one of them will turn out to be the most effective in implementation of the given contract, i.e. a company that is able to offer the lowest price.
- Growth in the number of bidders reduces likelihood of a collusive cartel formation.

The second hypothesis assumes a negative impact on the tendered price resulting from a selection of other than open procurement procedures. The reason is that only open procedure represents process that does not limit the number of bidders while other types (restricted procedure, procedural negotiation, etc.) do. Analogous to the arguments stated in the hypothesis 1, artificial reduction in the number of bidders decreases the probability of identifying the most efficient firm for the given contract and also increases the likelihood of a corrupt or collusive behaviour. Moreover, unrestricted possibility to participate in the tender affects the information uncertainty of the bidders, who in turn adjust their pricing strategies accordingly.

Formulation of the third hypothesis is based on the assumption that an electronic auction increases competition by allowing bidders to respond to competing quotations, eliminating in the process information uncertainty on the bidders' side.

The fourth hypothesis operates with the assumption that once companies are given more time to prepare bids, their pricing will go down since they will have more time for detailed calculations and therefore they will cut down on asked risk margin due to the reduced level of uncertainty.

4. Model and Data

Source dataset used for the testing of all hypotheses are data on construction work public procurements published in the information subsystem "Information system of public procurement". Contracts were awarded in the period May 2006 – November 2010. So-called outliers were adjusted using methods of Hadi (1999) and Freedman et al. (1978).

Models estimated within this paper consider the following variables:

- $\log(\text{final price})$ – logarithm of the final, winning price of the public tender i ,
- $\log(\text{originally est. price})$ – logarithm of the originally estimated price of the public tender i ,
- number of bids – total numbers of bids received for the given public tender i ,
- price ratio – ratio between the final price and the originally estimated price of the public tender i .

The model further employs additional dummy variables to get an additional explanation of the behaviour of the final price, respectively the ratio between the final and the originally estimated price:

- *restricted procedure* is a dummy variable that takes the value of 1 in the case of a restricted procedure.
- *open procedure* is a dummy variable that takes the value of 1 in the case of an open procedure form.
- *advance notice* is a dummy variable that takes the value of 1 in the case of an advance notification of the public tender.
- *SOE contractor* is a dummy variable that takes the value of 1 in case the contractor is a state-owned enterprise (SOE).
- *e-auction* is a dummy variable that takes the value of 1 in the case of an e-auction implementation.
- *price 1 criterion* is a dummy variable that takes the value of 1 in case the only criterion for public procurement evaluation is the price.

The model also employs one control variable that should improve its validity:

- $\log(\text{popul})$ – logarithm of the population of a municipality where the public tender takes a place.

In its general specification, the model can be written in the following form:

$$y_i = \beta X_i' + D_i' + \varepsilon_i, \quad (1)$$

where X captures the vector of potential non-binary variables affecting the explained variable and D denotes a vector of binary dummy variables. This general form will be further applied on two basic models:

- Model (A) in which the explained variable is the *price ratio* and the main explanatory variable is the *number of bids*.
- Model (B) in which the explained variable is the *number of bids*.

Model A is used to test the validity of the above formulated hypotheses of a direct impact of analysed factors on tendered prices. Model B aims to verify possible indirect influence of the explanatory variables on the price via affecting the number of submitted bids.

All models were also subject to the so-called Ramsey RESET test that examines the model's validity and on a general level thus may reveal its wrong specification. Both models have been tested by White and Breusch–Pagan tests for heteroscedasticity which has been repeatedly confirmed by model A and rejected by model B. This problem has been addressed by application of the WLS (weighted least squares) and HC (heteroskedasticity correction) methods.

5. Empirical Results

Test results of the two estimated models are summarized in the tables 1 and 2. Table 1 presents outcomes of the model A, where the relationship between the *price ratio*, *number of bids* and other dummy variables has been addressed. Results repeatedly confirm statistically significant negative correlation between the number of bids and the ratio of originally estimated and final tendered prices. Each additional offer, on average, represents reduction in the price ratio by 2.5% of the expected price. The dummy variable of e-auction does not show up to be statistically significant.

	(I) OLS	(II) WLS	(III) HC	(IV) WLS	(V) HC
const	1.110 *** (0.004)	1.112 *** (0.004)	1.107 *** (0.004)	0.801 *** (0.040)	0.878 *** (0.039)
number of bids	- 0.026 *** (0.000)	- 0.026 *** (0.000)	- 0.025 *** (0.000)	- 0.022 *** (0.000)	- 0.023 *** (0.000)
log(originally est. price)				0.015 *** (0.002)	0.009 *** (0.002)
e-auction				0.007 (0.042)	-0.001 (0.013)
restricted procedure				0.091 *** (0.007)	0.093 *** (0.008)
open procedure				- 0.018 *** (0.005)	- 0.019 *** (0.005)
advance notice				- 0.043 ***	- 0.026 **

				(0.013)	(0.011)
SOE contractor				- 0.105 *** (0.009)	- 0.083 *** (0.010)
price 1 criterion				- 0.023 *** (0.004)	- 0.016 *** (0.003)
log(popul)				0.005 *** (0.000)	0.007 *** (0.000)
F test (<i>p</i> -value)	0.000	0.000	0.000	0.000	0.000
<i>Adj R</i> ²	0.133	0.212	0.089	0.265	0.136
number of observations	9,501	9,501	9,501	9.337	9,337

Table 1: Model A – dependent variable: *price ratio*

Notes: *** significance at the 99% level of significance, ** 95% level of significance, * 90% level of significance, Robust (HAC) standard deviations in parentheses. WLS model: data weighted using *number of bids* variable. Source: ISVZ, own calculations.

Table 2 concerns with the model B with *number of bids* as the dependent variable. Presented results show that *form of procedure* and a *level of awareness* are the most important regressors influencing the total number of bids. The total number of bids rises once an e-auction is implemented, price is the only evaluation criterion and an open procedure takes place. On the other hand, pre-announcement surprisingly reduces the total number of bids. This result is also striking in the light of model A's results where the variable *open procedure* is identified as a negative regressor of the final price, respectively of the price ratio.

	(I) OLS
const	6.298 *** (0.523)
log(originally est. price)	-0.095 *** (0.032)
e-auction	3.059 *** (0.599)
price 1 criterion	0.454 *** (0.055)
open procedure	1.891 *** (0.075)
restricted procedure	0.038 (0.053)
advance notice	-0.787 *** (0.178)
F test (<i>p</i> -value)	0.000
<i>Adj R</i> ²	0.100
number of observations	9,501

Table 2: Model B – dependent variable: *number of bids*

Notes: *** significance at the 99% level of significance, ** 95% level of significance, * 90% level of significance, Robust (HAC) standard deviations in parentheses. Source: ISVZ, own calculations.

6. Conclusions

Results of the analysis presented above allow us to confirm the validity of hypotheses 1 and 2. Existence of a relatively strong competitive effect has been verified when each additional bid represents on average a 2–3% reduction in the estimated price. Furthermore, negative impact of competition restrictions on price has been also confirmed (e.g. introduction of restricted procedures increases the prices by ca. 8–9%).

The introduction of electronic auctions tends to show rather indirect effect on prices erosion. Nevertheless, the procedure becomes more transparent for bidding subjects and as a result a larger number of participants enter the tender. Likewise, single price criterion applied for the final tender evaluation turns out to have indirect impact on the final price.

We can also confirm the validity of the hypothesis 4 as pre-advancement lowers the tendered prices. On the other hand it also has a negative impact on the number of submitted bids. This finding can be explained due to its use for large contracts tenders where only a small number of bidding participants is expected.

Remaining results include a negative relationship between the ratio of the final price, respectively price ratio, and a variable of the contracting authority being a state-owned enterprise. Based on the results one could infer that state-own enterprises reach a lower final price. This may be due to their stiffer financial constraints compared to "traditional" public contracting authorities. Bandiera et al. (2008) has reached a similar conclusion for Italy as well.

7. References

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