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Effect of competition among suppliers on public procurement efficiency

Abstract. Electronic reverse auctions (eRA) have grown popular in the procurement communities recently. This trend is expected to continue as its benefits have been proved by the results in the companies across many fields. Their results depend on the actual market conditions while the literature emphasises the importance of the number of bidders in eRA for its result. In the paper, we present the evidence of the impact of competition among suppliers bidding within eRA on the efficiency of the tender, assessed via savings calculated as a difference between the Initial price and the Contract price. For this purpose, the method of correlation and regression analysis on the public procurement data provided by Electronic Contracting System has been applied. Moreover, we provide an analysis focused on a distinction between the savings caused by higher competition in goods and services, where our expectations of higher savings in services have been confirmed.

Keywords: Procurement; Competition; Electronic Reverse Auction; Savings; Slovak Republic

JEL Classification: H57; D44; Q55

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Вплив конкуренції між постачальниками на ефективність державних закупівель

Анотація. Електронні реверсивні аукціони (ЕРА) набувають усе більшої популярності. Ця тенденція, як очікується, буде тривати й надалі, оскільки їх переваги були підтвержені результатами в компаніях у багатьох галузях. Їхні результати залежать від реальних умов, у той час як у літературі підкреслюється важливість кількості учасників аукціону, що впливає на його результат. У статті наводяться дані про вплив конкуренції між учасниками ЕРА, які подають конкурентні заявки, на ефективність закупівлі, що розраховується як різниця між початковою ціною та ціною контракту. Для цього був застосований метод кореляційно-регресійного аналізу даних державних закупівель, отриманих через Електронну контрактну систему. Крім того, ми наводимо аналіз, спрямований на виявлення відмінності в економії на товарах і послугах, яка обумовлена більш високою конкуренцією, що підтверджує наше припущення щодо більш високої економії в сфері послуг.

Ключові слова: закупівля; електронний реверсивний аукціон; економія; Словацька Республіка.

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Влияние конкуренции между поставщиками на эффективность государственных закупок

Аннотация. Электронные реверсивные аукционы (ЭРА) в настоящее время становятся все более популярны. Данная тенденция, как ожидается, будет продолжаться и в дальнейшем, поскольку их преимущества были подтверждены результатами в компаниях во многих отраслях. Их результаты зависят от реальных рыночных условий, в то время как в литературе, как правило, подчеркивается важность количества участников аукциона, которая влияет на его результат. В статье приводятся данные о влиянии конкуренции между участниками ЭРА, подающими конкурентные заявки, на эффективность закупки, рассчитываемой как разница между начальной ценой и ценой контракта. Для этого был применен метод корреляционно-регрессионного анализа данных государственных закупок, полученных через Электронную контрактную систему. Кроме того, в статье мы приводим анализ, направленный на определение разницы в экономии на товарах и услугах, которая обусловлена более высокой конкуренцией, что подтверждает наше предположение относительно более высокой экономии в сфере услуг.

Ключевые слова: закупка; электронный реверсивный аукцион; экономия; Словацкая Республика.

1. Introduction and Brief Literature Review

Development of new technologies, and especially of those which are information and communication based, has affected all fields of industry in the developed countries [18]. A wide range of innovative solutions has been implemented and it has affected almost all aspects of doing business [2; 6; 9; 23] lea-

ding to the improvement of internal processes [4; 21-22]. Due to the increased efficiency, the application of information-communication technologies (ICT) in processes has become very popular both in private and public sectors [12; 19-20]. Thus, with such a change, there is natural to find electronic solutions to various problems in almost every field, including the pro-

curement within supply chains [10]. ICT-based solutions play an important role in achieving the goals of procurement teams, enabling on-time supplies with an efficient quality-price ratio, regardless of the type of product (goods or services) procured and the negotiation method chosen, e.g. sealed bid tender, electronic auction or even pre-commercial procurement (PCP) and innovative partnership for highly innovative products.

A few forms of e-sourcing have been developed. One of the most recognised and popular among them is the electronic reverse auction (eRA) which is regarded today to be one of the most powerful negotiation mechanisms within electronic procurement. The rate of its use and popularity has been rising since its first application. This trend is expected to continue [3; 7; 15]. The eRA is described as an electronic sourcing method that builds a competitive and dynamic environment in which a number of suppliers compete against each other in real time to win a business [1]. Since the entire process is put into online environment, this method supports principles of transparency and speed if compared to traditional purchase methods [17].

Since the time the eRA was applied, there has been a discussion about the ways to increase savings and the aspects that affect this process. Generally, they are dependent on market conditions. Hence, if the conditions are favourable, the outcome of the auction will be positive too. We can also assume other impacts due to the literature based on previous research. Many authors emphasise that the number of bidders participating in the auction is a crude indicator of supplier interest. In other words, the higher the number of suppliers is, the better [11; 13-14]. The importance of this factor raises significantly within the procurement process due to the auction, as in tenders, where each participant has the chance to submit only one bid and does not have information about the number of competing suppliers, this variable is not so important, however at the auction the price is dynamically pushed down through the competition of the individual suppliers whose aim is to outbid competitors. Some authors [16] argue that one supplier leads to poor outcomes; there are only mixed outcomes if there are two suppliers, whereas the best savings are attributed to a higher number of bidders. But we can also find opposite opinions. Some [3] provide evidence about auctions with only two suppliers, noting also that in such cases there is a high risk of loss of anonymity and a possibility that individual suppliers will recognise themselves. Most studies argue that at least three to five suppliers are required for successful auctions [3; 15] and the auction theory is in line with these statements [7; 25]. Others [24] provide a general statement that the auction should not be carried out if the number of suppliers is small.

2. Methodology

2.1 Research goals

Based on the previous findings, we have decided to support the evidence provision on the impact of competition among suppliers taking part within electronic reverse auctions on the savings which are calculated as the difference between the Initial price and the Contract price resulting from the tender. Our expectation says that, the higher the rate of competition is, the higher the percentage of savings calculated by using the Initial price and the Contract price should be. In contrast to the existing studies, we attempt to provide evidence on a recent sample from 2015 of public procurement data on commonly traded goods/services. According to the objectives of the research, we have formulated our own working hypothesis:

Working hypothesis 1: Higher competition among suppliers leads to higher savings within electronic reverse auction.

Moreover, as we possess the data of two different product categories - goods and services, we have analysed whether this distinction does have an impact on the latter relationship.

2.2 Data used

Our analysis is based on data provided by the Electronic Contracting System (ECS) in Slovakia. The ECS is a state-controlled centralised marketplace which can be used by different

public bodies in order to procure products meeting specific criteria and price levels, while rights and obligations of these subjects are described in Slovak National Act on Public Procurement using electronic reverse auction mechanism for price negotiation.

Before giving the main description of data, it is necessary to explain specific aspects of the database in use - the ECS, where the «common products» (goods or services) are procured. By this special category of products, the National Act understands the products which:

- 1) are not produced or provided on specific «tailor-made» needs;
- 2) are sold in the form without major modifications of features;
- 3) are used to satisfy operational needs;
- 4) are consumable.

It should be mentioned that not only products are standardised but also agreements used for all procurements. We regard all of these attributes to be very beneficial for the purpose of our research, because the commonness of products ensures that there should be high competition within every tender and procurers do not have many options to hinder it. The planned analysis will be performed using the indicators presented in Table 1.

Tab. 1: Description of variables

| Name of variable | Description |
|------------------------|---|
| ID of procurement case | Each procurement case has specific ID number to enable its identification |
| Date of contract | Date when the contract between procurer and supplier was concluded |
| Number of competitors | Number describing how many competitors gave at least one bid within eRA |
| Number of bids | Number describing how many bids were received within eRA by all competitors |
| Initial price | The first bid in eRA in EUR |
| Savings | Relative savings (in %) comparing Initial and Contract (final) price |

Source: Authors' elaboration

2.3 Model specification

To achieve our objective, we will use the following linear regression model based on the panel data described in the previous section:

$$SAV_i = \beta_0 + \beta_1 IP_i + \beta_2 CLS_i + \beta_3 CLB_i, \tag{1}$$

where:

SAV_i - the value of Savings (in %) based on the result of eRA;

IP_i - the Initial price, so the first offer, within the eRA auction in EUR;

CLS_i - the value of Competition level based on number of suppliers;

CLB_i - the value of Competition level based on number of bids.

When creating the model, we needed to cope with the fact that the database also included the records of procurement cases where there was only 1 supplier. In such a case, the supplier had no motivation to change the price when no competitor occurs. As we did not want to remove these records, where there was only 1 bidding institution, we decided to adjust the variables describing the level of competition - (both the number of suppliers and the number of bids) by decreasing the original values by 1, which is the value of suppliers/bids.

New variables were calculated as:

$$CLS_i = \text{Number of competitors} - 1 \tag{2}$$

$$CLB_i = \text{Number of bids} - 1 \tag{3}$$

As previously stated, the impact of specification of the procured goods or services (quality, delivery and service conditions, etc.) should not be omitted. This parameter can influence the behaviour of both suppliers and procurers in either positive or negative way. However, when discussing the possibility to include this variable within the model, it is quite obvious that

we are not able to create an objective indicator as the quality of the specification of a procurement object lies tacitly within the sentences of the documentation (tender details, agreement proposal, technical specification, etc.). For this reason, we have decided to accept the fact that the specification of the procurement object will be embedded in its consecutive indicators measuring the level of competition. But, as we use the data describing the procurements of common goods and all procurements have to use the same contract template, it is possible to omit the impact of this issue.

2.4 Expectations

Before conducting the analysis, we decided to estimate the effect of each independent variable in the specified panel regression model. Firstly, there is an Initial price in the model, which represents the auction volume. As mentioned before, the theory says that the bigger the number of bidders is, the higher the savings should be, which can be considered a *positive relation*. Moreover, the *positive relation* is expected in two other variables. The level of competition based on the number of competing suppliers is SLS_i and the level of competition based on the number of bids proposed within the competition is CLB_i. The higher the competition is, the higher the movement within the eRA should be, which is supported by the previous studies devoted to the topic mentioned before.

Other expectation is related to the difference between savings when procuring goods and services. We assume that in the case of services, savings will be higher, which is caused by a higher number of suppliers in the electronic reverse auction. This emanates from the fact that the «auction fever» can be more intense when there are no accurate costs which create a bottom price. In other words, goods are usually set the minimal price, which is the bottom price for suppliers and they are not willing to bid lower. However, in the case of services, this bottom price is often subjective and depends on labour costs which can be variable. Thus, higher pressure on suppliers providing services can bring higher savings in the electronic reverse auction.

3. Data description

Our regression analysis was based on 8,842 records of procurement cases performed on the Electronic Contracting System called ECS in Slovakia, in June, July and August 2015. This database known as the Electronic Contracting System was launched in March 2015 and the first months of its application might have included many irregularities caused by the adoption of the new process.

Statistical data relevant to basic description is presented in the table below. As we can see from our sample (Table 2), there is a wide range of procurement cases when assessing it from the view of the initial price, whereas the mean price is 8,346.9. Among the variables, there are also those describing the number of competitors and the number of bids. The level of competition was in the maximum case very high, as the maximum value was 19 competitors and 543 bids in the auction. Overall, the mean level is 3.63 competitors per auction and 25.26 bids per auction, which indicates that the Electronic Contracting System is already established in Slovakia and recognised by both procurers and suppliers.

Before performing the regression analysis, there was a need to know if the values of variables were normally distributed, as we had been able to choose an appropriate statistical method. For this purpose, we applied the Kolmogorov-Smirnov test of normality. The result of test indicated that the data were not normally distributed.

Before conducting the main regression analysis, we performed a correlation analysis using the non-parametric Spearman correlation coefficient. We found a strong correlation between a few pairs of variables, such as Competition_level_SUPPLIERS and Savings_per, which indicated that our prediction about the strong relationship would be proved. High is also The level of correlation between Competition_level_BIDS and Savings_per was also high. The same was for the Competition_level_SUPPLIERS and Competition_level_BIDS variables.

4. Results

As mentioned before, the main method for our research with the goal to define the relations between the competition price and the contract price was a linear regression based on the panel data.

The model equation according to the result of regression analysis is (Table 3):

$$SAV_i = 4.165 - 3.383E^{-5}IP_i + 2.852CLS_i + 0.134CLB_i \quad (4)$$

The dependent variable was Savings and the independent variables were represented by Initial price and factors of competition. The values of the beta coefficients and the significance of concrete input factors are listed in the table below.

When comparing the results with our expectations, we can conclude that our predictions were correct as:

- Initial price - negative relation (-3.383E⁻⁵)
- Competition level based on the number of suppliers - positive relation (2.852)
- Competition level based on the number of bids - positive relation coefficient (0.134)

As expected, the effect of competition is positive. As can be seen from equation 4, each new competitor will mean that contract savings will increase for about approximately 2.852% and each bid will increase the savings by more than approximately 0.134%. On the other hand, the initial price has a negative impact on auction savings even if the opposite result is expected. However, it should be mentioned that this influence is very insignificant (-3.383E⁻⁵). In other words, the price movement in the electronic reverse auction is mostly related only to the level of competition and suppliers. This can be explained in following way - the effect of procurement attractiveness perceived by suppliers according to the value of procurement is automatically present in the competition level among the suppliers.

In order to find some differences between savings when procuring goods vs. services, we conducted the same analysis for both of them. As can be seen from Tables 4 and 5, the biggest difference is in the level of competition of suppliers (the number of suppliers taking part in the eRA) where, in the case of services, each supplier in the competition brings about approximately 3.5% of savings, whereas in the case of goods it is 2.7% (similar to the case of the whole sample). Other variables - the initial price and the competitive level on bids (the number of bids) did not show any obvious differences. These findings related to the number of suppliers emanate from the fact that the cost of goods is determined by their production cost and some other costs related to them (transport, package, etc.). However, the cost of services is often given by the variable costs depending mainly on the salary of employees or subcontractors, so their assessing is more complicated and subjective when comparing to the costs of goods. This leads to a situation when, in the case of services a higher pressure caused by a higher number of suppliers pushes suppliers' prices down if compared to goods, because services have no strict price bottom.

To summarize the effect of the independent variable on the dependent variable (savings in %), we have compiled a table of relations (Table 6). As mentioned, all the three variables have proved their significance in the analysis. And as expected, the level of competition and the number of bids are the factors increasing the savings, whereas the initial price has a negative impact on the savings.

Tab. 2: Description of variables

| | Range | Min | Max | Sum | Mean | Std. Dev | Var |
|-----------------------------|--------|-----|--------|--------------|---------|----------|---------------------|
| Competition_level_BIDS | 543 | 0 | 543 | 214,539 | 24.26 | 38.43 | 1,477.1 |
| Competition_level_SUPPLIERS | 19 | 0 | 19 | 23,284 | 2.63 | 2.621 | 6.871 |
| Savings_per | 150 | 50 | 100 | 129,543.9 | 14.651 | 18.475 | 341.3 |
| Initial_price | 361375 | 2.0 | 361377 | 73,802,002.5 | 8,346.9 | 26,207.6 | 6.868E ⁸ |
| Number_bids | 543 | 1 | 544 | 223,381 | 25.26 | 38.4 | 1,477.05 |
| Number_competitors | 19 | 1 | 20 | 32,126 | 3.63 | 2.6 | 6.87 |
| Object_of_contract | 1 | 1 | 2 | 16,631 | 1.88 | .324 | .105 |

Source: Authors' elaboration

Tab. 3: Coefficients of the model: the whole sample

| Model | Unst. Coef. | | Std. Coef. | T | Sig | 95.0% Conf. Interval for B | | Collinearity Statistics | |
|-----------------------------|-----------------------|-----------|------------|-------|-----|----------------------------|-------------|-------------------------|-----|
| | B | St. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| (Constant) | 4.165 | .229 | | 18.18 | .00 | 3.716 | 4.614 | | |
| Initial_price | -3.383E ⁻⁵ | .000 | -.048 | -5.6 | .00 | .000 | .000 | .996 | 1.0 |
| Competition_level_BIDS | .134 | .005 | .279 | 28.33 | .00 | .125 | .144 | .754 | 1.3 |
| Competition_level_SUPPLIERS | 2.852 | .070 | .405 | 41.02 | .00 | 2.716 | 2.989 | .752 | 1.3 |

Source: Authors' elaboration

Tab. 4: Coefficients of the model: subsample «GOODS»

| Model | Unst. Coef. | | Std. Coef. | T | Sig | 95.0% Conf. Interval for B | | Collinearity Statistics | |
|-----------------------------|-----------------------|-----------|------------|-------|-----|----------------------------|-------------|-------------------------|-----|
| | B | St. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| (Constant) | 4.514 | .250 | | 18.04 | .00 | 4.023 | 5.004 | | |
| Initial_price | -4.458E ⁻⁵ | .000 | -.059 | -6.39 | .00 | .000 | .000 | .998 | 1.0 |
| Competition_level_BIDS | .134 | .005 | .291 | 27.78 | .00 | .125 | .144 | .779 | 1.3 |
| Competition_level_SUPPLIERS | 2.683 | .074 | .380 | 36.21 | .00 | 2.538 | 2.829 | .779 | 1.3 |

Source: Authors' elaboration

Tab. 5: Coefficients of the model: subsample «SERVICES»

| Model | Unst. Coef. | | Std. Coef. | T | Sig | 95.0% Conf. Interval for B | | Collinearity Statistics | |
|-----------------------------|-----------------------|-----------|------------|-------|-----|----------------------------|-------------|-------------------------|-----|
| | B | St. Error | Beta | | | Lower Bound | Upper Bound | Tolerance | VIF |
| (Constant) | 3.187 | .566 | | 5.63 | .00 | 2.076 | 4.298 | | |
| Initial_price | -2.461E ⁻⁵ | .000 | -.046 | -2.06 | .04 | .000 | .000 | .949 | 1.1 |
| Competition_level_BIDS | .196 | .029 | .252 | 6.74 | .00 | .139 | .253 | .337 | 3 |
| Competition_level_SUPPLIERS | 3.489 | .261 | .501 | 13.38 | .00 | 2.977 | 4.000 | .336 | 3 |

Source: Authors' elaboration

Tab. 6: Research findings

| | Findings | | The Relation with Contract Price | The Direction of Relation |
|-----------------------------|---------------------|-----------------------|----------------------------------|---------------------------|
| Initial_price | Coefficient | -3.383E ⁻⁵ | Significant | Negative |
| | T statistics value | -5.597 | | |
| | P probability value | .000 | | |
| Competition_level_BIDS | Coefficient | 0.134 | Significant | Positive |
| | T statistics value | 28,329 | | |
| | P probability value | .000 | | |
| Competition_level_SUPPLIERS | Coefficient | 2.852 | Significant | Positive |
| | T statistics value | 41.016 | | |
| | P probability value | .000 | | |

Source: Authors' elaboration

Finally, we have investigated the overall significance and the performance of the model. As we can see in the Table 7, the Coefficient of determination (R-squared) is at the level of 0.594, which means that almost 60% of savings is based on the three factors studied in this article. In other words, almost 60% of variability is described by the proposed model. Thus, we can see that the proposed model is statistically significant.

pressure on the suppliers to lower their prices down to the real market prices, which will lead to higher savings. Consequently, we have confirmed our expectations based on the previous studies conducted by [3; 15-16].

Nevertheless, our second expectation related to the initial price, when we expected that a higher initial price would lead to higher savings, did not prove to be true. However, with a higher initial price, the final savings were a bit lower and the effect of procurement attractiveness perceived by the suppliers according to the value of procurement was automatically present at the level of competition among the suppliers.

Finally, in order to find some differences between variables affecting the final saving between services and goods, we have found out that in the case of services an increase in the number of suppliers brings higher savings if compared to the case of goods.

However, for future research, it would be interesting to understand how stable this relationship is over time and what can be analysed further. Also, the impact of other procurement process settings on its result should be investigated more deeply [5; 8]. On the other hand, some questions will probably remain open due to limited access to the relevant data.

Tab. 7: Model Summary

| R | R Square | Adj. R ² | St. Error of the Est. | Change Statistics | | | | |
|------|----------|---------------------|-----------------------|-------------------|----------|-----|-------|---------------|
| | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| .594 | .353 | .352 | 14.866% | .353 | 1 605.25 | 3 | 8 838 | .00 |

Source: Authors' elaboration

5. Conclusions

The purpose of this paper was to verify the impact of competition among suppliers taking part within electronic reverse auctions on the saving in the Slovak public procurement environment. Based on the results obtained from the data generated by the Electronic Contacting System, we can say that the higher the number of suppliers and bids in the eRA is, the higher is the

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