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Influence of tender type on seller participation

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Abstract

When announcing a tender, the buyer decides on its setting, which includes its type. In practice, the most widespread types of tenders are sealed bids and English reverse auctions. The two types have different settings and thus affect the seller behaviour in the tender. One of these is the participation in the entry round. It is possible to assume that the seller participation in the entering round of English reverse auctions, in which sellers receive some market information, is higher than that in sealed bids, in which sellers gain no market information.

The aim of the paper is to verify the above-mentioned assumption of seller participation in the entering round of sealed bids and English reverse auctions. The research was carried out on a sample of 1077 sealed bids and 3083 English reverse auctions. The result of statistical testing using the Mann–Whitney test is that the type of tender has an effect on the seller participation in the entering round at the 5% level of significance. A comparison of average seller participation in the entering round in sealed bids and English reverse auctions confirms the above-mentioned assumption.

Keywords

English reverse auction, eProcurement, eSourcing, Mann–Whitney test, sealed bids

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1. Introduction

According to Sollish and Semanik (2012), the selection of a supplier is a key task of a company's purchasing department. It is usually carried out as a tender. The results of research on electronic purchasing show accelerated digitization in the purchasing area in 2018 and 2019 (BME-Barometer, 2019). Purchasers discover electronic tenders and use them to negotiate with sellers. With the spread of the application of electronic tenders, which, for purchasers, are a new method of selecting suppliers, the study of seller behaviour comes into focus.

In practice, according to Fiala (2012), the most widespread types of tenders are sealed bids and English reverse auctions. These types of tenders usually differ in the number of rounds, the information published during the rounds, the way in which sellers' bids are submitted and the direction in which the price moves (Fiala, 2012).

Due to the specific course of each type of tender, described in chapter 2, it is possible to expect the behaviour of sellers to differ for different tender types, like sealed bids and English reverse auctions. From the comparison of the characteristics of the tender types, it is possible to make an assumption regarding the seller participation in the entering round of sealed bids and English reverse auctions.

The aim of the paper is to verify the assumption that the seller participation in the entering round of English reverse auctions is higher than the seller participation in the entering round of sealed bids. The statistical testing proposed in chapter 3 will be performed on data from realized tenders that match the defined conditions for the research. An evaluation of the seller participation in the entering round for sealed bids and English reverse auctions will be an output of the paper.

The added value of this paper is the verification of the derived assumption of seller participation in the entering round of sealed bids and English reverse auctions. The seller participation in the entering round has an impact on the number of bids that a purchaser receives from sellers and, in the case of English reverse auctions, on the level of competition in the auction round.

2. Characteristics of the selected tender types

The characteristics of sealed bids and English reverse auctions will be described in separate subchapters. Taking these characteristics into consideration, an assumption about seller behaviour regarding participation in the entering round will be derived.

2.1 Characteristics of sealed bids

Sealed bids are static closed auctions of the first price with a falling price. They are a one-round tender with an entering round (Fiala, 2012). For sealed bids, the bidding secret maintained by the buyer is specific (Schneider, 2014). During the tender, the sellers do not have any information on the number of sellers invited to participate by the buyer, the number of sellers participating in the tender, the number of submitted bids or the amount of individual bids. The sellers participating in sealed bids do not include competing bids in their decision making on their own bid (Rieck, Drozak and Grawert, 2015). For purchasers, it follows that, even if only one seller takes part in the tender, they will not receive a different bid from a particular seller than this seller would have entered in the case of the participation of other sellers (Chvoj, 2013). The seller with the lowest bid wins.

2.2 Characteristics of English reverse auctions

An English reverse auction is a dynamic open auction of the first price with a falling price. It is usually a two-round auction and consists of an entering round and an auction round (Fiala, 2012). Sellers who are interested in participating in the tender will enter a bid in the entering round. In the auction round, the buyer publishes additional information about the seller's position, such as the order of the seller's bid, the current lowest price and so on (Fiala, 2012). In an English reverse auction, the buyer does not need to defend the bidding secret. The seller has the opportunity to reduce the bid during the auction round (LiCalzi, Milone and Pellizzari, 2010). The amount of the initial bid therefore defines the seller's maximum price at which the demanded products will be delivered (Chvoj, 2013). The seller's motivation to reduce the initial bid is caused by the competitive pressure created by the information published in the auction round (Rieck, Drozak and Grawert, 2015). The last submitted bid is always valid, regardless of whether it was submitted in the entering or

in the auction round (Maschler, Solan and Zamir, 2013). The seller with the lowest bid is the winner.

2.3 Assumption of sellers' participation in the entering round

In the case of sealed bids, it is possible to assume that only the sellers who are interested in winning the tender participate (Rieck, Drozak and Grawert, 2015). Sellers will not receive any other benefit from participating in the tender.

In the auction round of an English reverse auction, sellers can change the bid entered in the entering round according to the information published on their position. The publication of market information in the auction round may also motivate those sellers who do not intend to win the tender to participate, for example for market research (Rieck, Drozak and Grawert, 2015).

From the characteristics of sealed bids and English reverse auctions, it is possible to deduce an assumption about the seller participation in the tender: if only sellers who are interested in winning participate in sealed bids, while sellers with other interests participate in English reverse auctions, then the seller participation in the entering round of English reverse auctions is higher than the seller participation in the entering round of sealed bids. The seller participation in the entering round is given by the share of sellers who submitted a bid in the entering round and the number of invited sellers in the tender.

3. Methodology of the research

The aim of the research is to find out whether there is a statistically significant difference in the seller participation in the entering round between sealed bids and English reverse auctions. The reason for the research is based on the assumption mentioned in chapter 2.3.

The null hypothesis (H0) states that "The type of tender does not affect the seller participation in the entering round at the 5% level of significance". The alternative hypothesis (H1) is: "The type of tender has an effect on the seller participation in the entering round at the 5% level of significance".

The seller participation could be influenced, among other things, by the number of participants invited to the tender (a higher number of invited sellers could mean a higher number participating sellers). To limit this influence, the input to the research will be the average seller participation in a tender, ASP_i , calculated as follows:

$$ASP_i = \frac{PS_{ERi}}{IP_i}, \quad (1)$$

where PS_{ERi} is the number of participating sellers in the entering round of a tender and IP is the number of sellers invited to the tender by the purchaser.

The null hypothesis will test whether the distribution of the average seller participation of one data set is not stochastically greater than another one. It is possible to expect that the data set of the average seller participation is not normally distributed, so the use of the Mann–Whitney nonparametric two-tailed test is more secure (Black, 2009).

Before the application of the Mann–Whitney test, the outliers in the data sets will be removed to reduce the measurement errors and data export errors. To identify outliers, the 1.5 IQR method will be performed (Jarošová and Noskievičová, 2015).

To test the hypothesis, the input data will gradually be processed in the following steps:

1. calculating the average seller participation in a tender in both data sets;
2. removing outliers from both data sets through the use of the 1.5 IQR method;
3. performing the Mann–Whitney test for data sets adjusted for outliers.

The result of the statistical testing is the result of the Mann–Whitney nonparametric test, respectively p-values. If the calculated p-value is higher than the specified significance level of 5% (0.05), the null hypothesis will not be rejected. Then, the assumption of the seller participation in the entering round for sealed bids and English reverse auctions will not be confirmed. Otherwise, the null hypothesis will be rejected and an alternative hypothesis will be accepted. In such a case, the values of the average seller participation in the entering round for sealed bids and English reverse auctions will be compared and the result of the comparison will be evaluated with regard to the above-mentioned assumption.

For the calculations performed in the research, MS Excel will be used. The statistical test and figures will use SPSS.

3.1 Cleaning from outliers

Outlier values in a data set can be identified by following the 1.5 IQR rule (Moore, 2010), which is used when assembling a box plot. Outliers are in the range

$$(-\infty; x_{25} - 1,5IQR) \cup (x_{75} + 1,5IQR; \infty), \quad (2)$$

where x_{25} is the lower quartile, x_{75} is the upper quartile and IQR is the interquartile range of the upper and lower quartiles.

Removing outliers increases the significance of the statistical testing to which the values are subjected. The remaining values, belonging to the interval between $x_{25} - 1,5IQR$ and $x_{75} + 1,5IQR$, enter the next statistical test.

3.2 Mann–Whitney test

The Mann–Whitney test tests the agreement of the probability distribution for two unpaired continuous data sets of values. This is a nonparametric test, so the data sets of values may not correspond to the Gaussian normal distribution (Marques de Sá, 2007).

The ascending values of both data sets create a so-called mixed selection. All the values of the mixed selection receive the order in which they occur. If the values match, all the arithmetic means receive their order. The orders assigned to the values for each of the two original data sets of values are summed. The result is the values R_1 and R_2 , for which the following applies:

$$R_1 + R_2 = \frac{(n_1+n_2)(n_1+n_2+1)}{2}, \quad (3)$$

where R_1 is the sum of the order in the first data set, R_2 is the sum of the order in the second data set, n_1 is the number of values in the first data set and n_2 is the number of values in the second data set.

The test criterion U , which is compared with the table values for the Mann–Whitney test, is the lower value of the test statistics (U_1 ; U_2) for each of the sets. The test statistics are calculated according to the following formulas:

$$U_1 = n_1 \cdot n_2 + \frac{n_1 \cdot (n_1 + 1)}{2} - R_1, \quad (4)$$

$$U_2 = n_1 \cdot n_2 + \frac{n_2 \cdot (n_2 + 1)}{2} - R_2, \quad (5)$$

where U_1 is the test statistics of the first data set, U_2 is the test statistics of the second data set, n_1 is the number of values in the first data set, n_2 is the number of values in the second data set, R_1 is the sum of the order in the first data set and R_2 is the sum of the order in the second data set.

The tabular value for the Mann–Whitney test is valid at the 5% significance level for the number of values in the first data set n_1 and the number of values in the second data set n_2 . The null hypothesis of the agreement of the probability distribution of the two sets is accepted if the value of the test criterion U is higher than the table value for the Mann–Whitney test. Otherwise, when the value of test criterion U is lower than the table value for the Mann–Whitney test, the null hypothesis is rejected.

3.3 Conditions of the analysed data

The analysed data have to come from realized purchasing via selected tender types. The purchases were carried out in the private sector.

To test the seller participation between different tender types, the analysed data must be comparable. The input data must meet the following conditions to enter the statistical testing:

- the input data come from sealed bids (with one entering round) and English reverse auctions (with one entering and one auction round);
- the mentioned tenders could also contain one control or evaluation round, in which, however, the sellers were not allowed to change the submitted offers;
- the starting or estimated price has not been published for the tender (the publication of the starting or estimated price could affect the sellers when entering the initial bid);
- at least three sellers took part in the tender;
- the tender contains a valid and complete offer of the seller;
- the winning seller was selected on the basis of the lowest total bid price;
- other criteria than the total price of the tender did not enter the evaluation;
- the bid unit was the real currency;
- the buyer did not interfere in the submitted bids of the seller;
- all the bids in the auction only decreased.

The above-mentioned conditions are applied to the received data set from the provider of an eSourcing tool. Further criteria, like the purchasing volume, purchaser branch and location, repeated purchases or product category, will not be part of the research.

3.4 Input data for the research

The data sets of seller participation used for the analysis come from the specialized software for electronic tenders PROebiz. PROebiz was developed by NAR marketing s.r.o. based in Ostrava in the Czech Republic.

The database of tenders from version "PROebiz 3" is the data source. This version was used from January 2008 to July 2015. The input data come from the "sealed bids" module or the "ERMMA" (English Reverse Multiitem Multicriteria Auction) module, that is, the English reverse auction.

A total of 4160 tenders fulfil the above-mentioned conditions, and 1077 sealed bids and 3083 English reverse auctions enter the research. These were carried out by 152 companies, mainly from Central Europe, specifically the Czech Republic, Slovakia, Poland, Germany and Croatia.

4. Research results

The input data are divided into two data sets according to the type of tender. The purchasers invited on average of 15.49 sellers to the entering round of the sealed bids, in which, on average, 5.94 sellers participated. In the English reverse auctions, the purchasers invited on average 7.35 sellers to the entering round, and an average of 4.76 sellers participated.

From the number of participating sellers in the entering round and the number of invited sellers in it, the average seller participation is calculated. The basic statistics of the data sets of average seller participation are shown in Table 1-1.

Table 1-1 Statistics of the data sets for the average seller participation in a tender

| | Sealed bids | English reverse auction |
|--------------------|-------------|-------------------------|
| n | 1077 | 3083 |
| Mean | 62.98 % | 76.70 % |
| Median | 71.43 % | 83.33 % |
| Variance | 9.7 % | 6.7 % |
| Standard deviation | 31.17 % | 25.88 % |
| Skewness | -0.470 | -0.74 |
| Kurtosis | -1.166 | -0.733 |

From the statistics shown in Table 1-1, it is obvious that the seller participation in different tender types could be different. The comparison of the distribution of the average seller participation in the entering round of a tender shows the same conclusion for both data sets, as displayed in Figure 1-1.

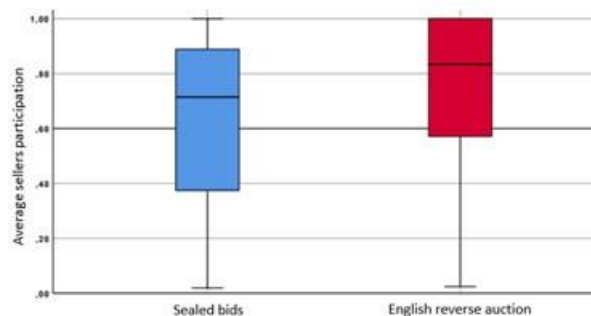


Figure 1-1 Box plots of data sets for the average seller participation in a tender

Both data sets are the input for the 1.5 IQR method to identify outliers. From the data sets adjusted for outliers, the test criterion U of the Mann–Whitney test will be calculated. Then, the tabular value for the comparison of the data sets will be found. The values of the input data and the results of the Mann–Whitney test are shown in Table 1-2.

Table 2-2 Results of the statistic tests

| | Sealed bids | English reverse auction |
|---|-------------|-------------------------|
| n | 1077 | 3083 |
| Identified outliers by 1,5IQR | 0 | 0 |
| n adjusted for outliers | 1077 | 3083 |
| Mann-Whitney test statistics U_1 | 1790452.00 | |
| Mann-Whitney test statistics U_2 | 6864428.00 | |
| Mann-Whitney tabular value for n_1, n_2 | 1209949.00 | |
| Mann-Whitney test: p-value | 0.000 | |

In the data sets, no outliers are identified using the 1.5 IQR method. The Mann–Whitney test statistics U_1 and U_2 are calculated for the data sets. The lower test statistic U_1 (1790452.00) is the test criterion U that is compared with the tabular value of the Mann–Whitney test for data sets with 1077 and 3083 samples at the 5% significance level (1209949.00). Because the value of test criterion U is lower than the Mann–Whitney table value for n_1 and n_2 , the null hypothesis can be rejected and the alternative hypothesis can be accepted: "The type of tender has an effect on the seller participation in the entering round at the 5% level of significance". This result is also supported by the p-value (0.000) of the Mann–Whitney test, which is lower than the 5% significance level (0.05).

According to the result of the Mann–Whitney test, it is possible to compare the mean value of the data sets (see Table 1-1) to decide which tender type has higher seller participation. Because the seller participation in the entering round is lower in sealed bids (62.98%) than in the English reverse auction (76.70%), the assumption (see chapter 2.3) that the seller participation in the entering round in the English reverse auction is higher than the seller participation in the entering round in sealed bids can be confirmed.

5. Conclusion

The aim of the paper was to test the assumption about the seller participation in the entering round of a tender, derived from the characteristics of sealed bids and English reverse auctions. The assumption was that the seller participation in the entering round of English reverse auctions is higher than the seller participation in the entering round of sealed bids. The reason for this assumption is that sellers gain extra market information during the auction round in English reverse auctions, which is not part of sealed bids.

The research was carried out on the calculated average seller participation in realized sealed bids and English reverse auctions. Both data sets were input for

the statistical testing, performed with the Mann–Whitney test. The result shows that the seller participation in the entering round in sealed bids and in English reverse auctions is different. After comparison of the mean values of the seller participation in the entering round of sealed bids (62.98%) and English reverse auctions (76.70%), it was found that the seller participation in the entering round in English reverse auctions is higher than that in sealed bids. With these findings, it is possible to confirm the assumption that the seller participation in the entering round of English reverse auctions is higher than the seller participation in that of sealed bids.

The result of the research confirms the expected supplier behaviour regarding participation in tenders. Purchasers who organize a tender as an English reverse auction can expect higher seller participation than if they organize a tender as sealed bids. The profit for the purchaser is not the higher participation rate but the higher number of bids. Otherwise, the count of bids does not mean better price conditions for the purchaser in the entering round. The real price negotiation starts in the auction round, in which sellers obtain additional market information, like the position of their bid. At the same time, the sellers have an opportunity to reduce their bid. Thus, a higher number of bids in the entering round means a higher number of bids in the auction round, which could produce market competition.

An influence of the tender volume, product category or purchaser branch on the seller participation could be the next object of research, as well as the comparison of bids on price levels between different tenders.

References

- BLACK, K. (2009). *Business Statistics: Contemporary Decision Making – sixth edition*. Hoboken: John Wiley & Sons. 632-636.
- CHVOJ, M. (2013). *Pokročilá teorie her ve světě kolem nás*. Praha: Grada.
- FIALA, P. (2012). *Aukce: teorie a praxe*. Praha: Professional Publishing.
- JAROŠOVÁ, E., NOSKIEVIČOVÁ, D. (2015). *Pokročilejší metody statistické regulace procesu*. Praha: Grada.
- LICALZI, M., MILONE, L., PELLIZZARI P. (2010). *Progress in Artificial Economics*. Heidelberg: Springer Verlag Berlin Heidelberg.
- MASCHLER, M., SOLAN, E., SHMUEL, Z. (2013). *Game Theory*. Cambridge: Cambridge University Press, 2013.
- MARQUES de SÁ, J., P. (2007). *Applied Statistics Using SPSS, STATISTICA, MATLAB and R*. Heidelberg: Springer-Verlag Berlin. <https://doi.org/10.1007/978-3-540-71972-4>
- MOORE, D., S. (2010) *The Basic Practice of Statistics - fifth edition*. New York: W. H. Freeman and Company.
- RIECK, Ch., DROZAK, J., GRAWERT, G. (2015). *Spieltheorie im Einkauf - Auktionen in Theorie und Praxis*. Eschborn: Christian Rieck Verlag.
- SCHNEIDER, G. (2014). *Electronic commerce*. Stamford: Cengage Learning.
- SOLLISH, F., SEMANIK, J. (2012). *The procurement and Supply Manager's Desk Reference*. New Jersey: John Wiley & Sons, Inc. <https://doi.org/10.1002/9781119205098>

Additional sources

- BME (2019). *BME-Barometer Elektronische Beschaffung 2019*: „I.0-Welt aufräumen: Platz für Neues schaffen. [Online], accessed at 29.10.2019. Available from: < <https://www.bme.de/bme-barometer-elektronische-beschaffung-2019-10-welt-aufraeumen-platz-fuer-neues-schaffe/>>.