ELECTRONIC AUCTIONS IN THE METALLURGICAL INDUSTRY: RESULTS AND SPECIFICS

Vojtěch KLÉZL

VSB-Technical University of Ostrava, Ostrava, Czech Republic, EU, vojtech.klezl@vsb.cz

Abstract

The topic of this paper is the electronic reverse auctions with focus on the companies in metallurgical industry. In the introduction part, theoretical information about auctions is provided, along with current researches in this field. The practical part of the paper focuses on the analysis of the results of e-auctions conducted by metallurgical companies. The results of the auctions are then compared with e-auctions done by companies in other sectors. Statistical method ANOVA is used for the analysis. In the conclusion part, the author focuses on the specifics of the metallurgical industry and their possible influence on the results of the e-auctions.

Keywords: electronic auctions, ANOVA, metallurgical industry, procurement

1. INTRODUCTION

The process of procurement has undergone many changes in recent years. Both private and public sectors have started to benefit from various new methods and trends, which use information technology as its base. This change of the traditional means of purchase is called e-procurement. Perhaps the most used method of e-procurement is the electronic auctions (e-auctions). E-auctions bring companies and public institutions price savings and other significant benefits.

Carter et al. [1] defines e-auctions as 'an online, real-time auction between a buying organization and two or more invited suppliers, where suppliers can submit multiple bids during the time period of the auction, and where some degree of visibility exists among suppliers regarding the actions of their competitors.'

Many companies operating on the Czech market have started using e-auctions, albeit with different results. The results are determined by many factors such as the number of suppliers on the market, general situation on the market and category of the procured goods. The goal of this paper is to determine, if the results of e-auctions conducted by companies in the metallurgical industry differ from companies of other industries.

2. E-AUCTIONS ON THE BUSINESS MARKET

A lot of companies on the business to business market are now using electronic auctions as a method of procurement. Mabert and Skeels [4] claim e-auctions are intended mainly for the purchase of non-strategic products ('B' and 'C' products, using the terminology of ABC analysis). It is due to the fact that the current supplier is not always the winner of e-auctions and changes of suppliers are quite common in repeated e-auctions. Companies can afford the changes of suppliers of the B and C products, but they focus more on building the long-term relationship with the selected supplier of A (strategic) products.

2.1 Benefits of e-auctions

Many authors focus on the benefits of e-auctions. Manoochechri and Lindsy [5] list:

- financial savings (usually around 15% of the initial price for first-time purchases, maximum values even more than 70%, depending on other specifics of the auction);
- increased market efficiency - e-auctions provide to buyers and sellers an open environment where they can compare the true value of their products;

- improved procurement process efficiency includes the time savings for both the buyers and sellers;
- access to a larger supplier base - companies are not limited to the suppliers they already know, they can choose an open auction, where newer and previously unknown companies can also compete.

Soudry [9] names another significant benefit of e-auctions: transparency of the whole procurement process. Every action within the auction is automatically recorded which helps in reducing the unfair or corruptive behavior. This is, however more beneficial for the public sector, as the pressure for more clear public contracts and procurement arose in recent years.

2.2 Measuring the success of e-auctions

The question is how we can determine, if the e-auction was successful or not. Most authors (Manoochechri and Lindsy [5]; Janke and Kubačka [2]) agree, that the most common approach is the comparison of the final costs of the product with and without e-auction. The reason for this is the availability of data: researches usually know just the result and factors included in the auction (the type of auctioned product, number of competing suppliers, and type of e-auction used etc.), so calculating the financial savings is the easiest way of getting comparable results. Examining if other benefits were gained from an auction would require gaining access to qualitative data directly from the buyers about their experiences with e-auctions.

The other problem is definition of the savings itself: how to measure the savings in costs, when the final price is affected by the auction? How to determine what the price would be without the auction? There are multiple ways of calculating the savings. However, two approaches are by far the most used: savings based on the estimated price and savings based on the initial price.

Savings based on estimated price are calculated as:

$$S_R = \frac{P_E - P_{BO}}{P_E} \quad (1)$$

where S_R is Relative savings, P_E is the Estimated price and P_{BO} is the Best offer received in the auction. Estimated price can be taken from previous procurement cases of the same product (regardless of the fact whether an e-auction was part of the process or not), or it can be assessed by experienced expert in the procurement field. The estimation can be either based on informative market survey, subjective expectations of the expert, or combination of these methods.

The other method of calculating the savings (based on initial price) can be calculated by a similar formula as (1), only the P_E (Estimated price) is substituted with P_I (Initial price). Initial price is the lowest offer, which was gathered from potential suppliers in the preparation round of the auction. The suppliers are usually asked to lower this price, if they want to qualify for the contract.

On average, savings based on the estimated price are a bit higher than savings based on initial price. It is because the estimated price is usually higher than the initial price - if the suppliers know about the auction, they are prepared to submit the lower prices in the preparation round. There is also one more difference between these methods: saving based on the estimated price can be in certain specific cases negative (for example if the market changed significantly since the last purchase, or if the current supplier is not part of the auction), while saving based on initial price can be either positive or zero (if the other suppliers weren't able to lower the initial lowest bid).

Janke and Kubačka [2] claim, for the same auction cases; these two savings are statistically dependent and highly correlated. Therefore, they bring very similar results. In this paper, the method using estimated price is used.

The other variable used in this paper also relates to success of the auction. It is the number of potential suppliers competing in the auction. Multiple authors (Prídavok and Delina [7]; Pavel and Sičáková-Beblavá [6]) found, that the number of competing suppliers correlate with the savings in auction. In other words, auctions with higher number of suppliers tend to have higher savings.

3. RESEARCH METHODOLOGY

The study is based on real data from e-auctions conducted by Czech and Slovak companies in 2011 and 2012. Sample size was 1261 e-auction cases by 21 companies. The companies were divided by their industry. Initially, 7 industries were chosen, but 2 industries had to be scratched and the auctions removed due to the low number of auctions in those industries (Food and Clothing industries). Therefore, there are 5 industries in the final sample (Metallurgy, Construction, Energy, Machinery and Manufacturing). Each auction in the sample is defined with several variables (e.g. date of the auction, listed items, number of suppliers competing, estimated price, best offer), so we were able to compute the savings for each case. Outlying cases and cases where there was a high probability of mistake in the input were deleted from the sample. The data were analyzed using statistical software IBM SPSS Statistics 21.

The goal was to test if the two most commonly tested variables in e-auctions (number of suppliers and savings based on estimated price) differ amongst the industries. Specifics analysis of the e-auction data based on industry was done through the Analysis of variance (ANOVA). To use the most common application of this method, two criteria have to be met: normal distribution of the data and homogeneity of variances. Kolmogorov-Smirnov test was conducted to test if the data was of normal distribution. The results (see Appendix 1) showed that both testing variables were not normally distributed. Therefore, the standard ANOVA could not be used. Non-parametric test had to be used instead.

3.1 Kruskal-Wallis ANOVA

The non-parametric equivalent of ANOVA is Kruskal-Wallis one-way analysis of variance (also known as Kruskal-Wallis ANOVA). It is a test that uses ranks instead of values. It is used for comparing more than two samples which originate from the same distribution. Generally, it is an extension of the Mann-Whiteny U test, which tests only 2 groups. The test statistic is given by:

$$K = (N\text{-}1)\frac{\sum_{i=1}^{g} n_i(\bar{r}_i\text{-}\bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(r_{ij}\text{-}\bar{r})^2} \quad (2)$$

where n_i is the number of observations in the group i, r_{ij} is the rank of observation j from group i, N is the total number of observations across all groups, and $\bar{r}$ is the average of all r_{ij}. The K value is then corrected of ties (this is usually a small difference). If the statistic is significant, then there is evidence of differences between the samples.

4. EXAMINING THE DIFFERENCES BETWEEN THE INDUSTRIES

The savings were measured using method mentioned in Chapter 2.2. The results were then divided by companies that conducted the auction and their industries. The average saving was 23.67% of the initial price, with standard deviation of 0.24. The other variable used in this paper is the number of potential suppliers competing in the auction. The mean was 11.94 suppliers with standard deviation of 12.34.

4.1 Savings based on industries

Following hypotheses were set for comparing the savings based on industries:

H_o: there are no differences between the medians of the samples based on industries;

H_a: there is a statistically significant level of difference between the medians of at least two categories of industry.

Table 1 shows that the null hypothesis is rejected and therefore there are enough conclusions to assume differences between the median savings of at least two categories of industry. **Fig. 1** shows that median savings for the Metallurgical industry are in fact lowest of all the industries (median savings are 10.7%, as can be seen in the table in the Appendix 4). This suggests lower average savings than in other industries, which could be explained by different reasons.

Table 1 Hypothesis test summary for the savings compared to estimated price

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Savings compared to E is the same across categories of Industry.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

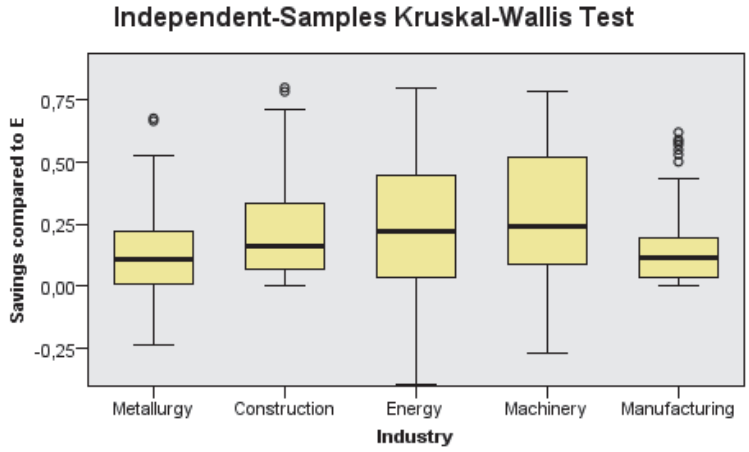

Fig. 1 Box-plots for the variable Savings compared to estimated price grouped by the variable Industry

4.2 Number of suppliers based on industries

For comparing the number of suppliers based on industry, following hypotheses were set:

H_o: there are no differences between the medians of the samples based on industries;

H_a: there is a statistically significant level of difference between the medians of at least two categories of industry.

It is clear from the **Table 2** that null hypothesis is rejected, and therefore hypotheses that at least two categories of industry tend to have different number of competing suppliers is accepted. From **Fig. 2**, we can see that the median for the metallurgical industry is second highest now (7.33 for metallurgy, the highest is 9.55 in energy industry - exact values can be seen in Appendix 5). This finding is in contrast with the finding in chapter 4.1: when there is lower savings, there also should be less competing suppliers. The reasons behind this anomaly may vary and are discussed later in the paper.

Table 2 Hypothesis test summary for the number of suppliers

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Number of the Participants is the same across categories of Industry.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

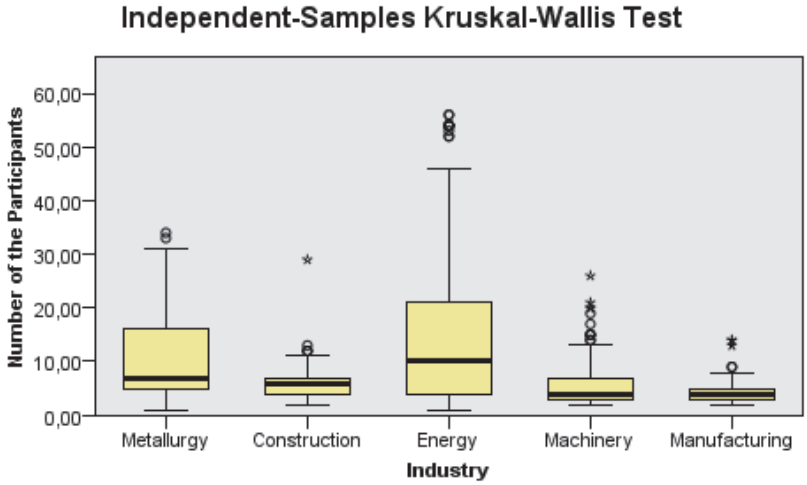

Fig. 2 Box-plots for the variable Number of the participants grouped by the variable industry

5. POSSIBLE REASONS FOR THE ANOMALY IN RESULTS

As it was proven in the chapter 4, e-auctions conducted by companies in the metallurgical sector carry certain anomaly within their results. While the number of suppliers competing in them is quite high, they actually have lower savings, which is against previous researches in this topic. There could be multiple reasons for this. The reasons can be either industry-specific or based on the use of e-auctions in the specific company.

5.1 Industry-specific reasons for the anomaly

According to Vilamová et al. [11], metallurgical industry is a very specific sector, which is currently undergoing certain changes in the marketing environment. One of the possible reasons for the anomaly in e-auctions results could be the geographical concentration of customers and suppliers. The same suppliers usually compete for the same contracts, so they know each other's possibilities and limits, concerning both price and other factors. Spáčil [10] claims, that nearly half of the customers on the metallurgical market are stressing price as the main factor of the purchase process. This leads to low margins and low bargaining space for the suppliers, who can't drive the price lower. The last industry-specific reason could be that prices on the metallurgical market are derived from prices on the commodity markets, and the suppliers have low influence on these prices.

5.2 Reasons based on the use of e-auctions

When it comes to the possible reasons based on the use of e-auctions by specific company; the first reason could be simply the amount of time the company is using e-auctions. According to Kaplan and Zrník [3], the longer one company uses e-auction, the lower are usually the savings, because the suppliers get used to competing in e-auctions and the price can't be lowered indefinitely. Therefore, each repeated auction usually

leads to lower savings. What this means is, that if the companies in the metallurgical industry use e-auctions longer than the companies in other industries, they would get lower savings regardless of the number of competing suppliers. The other factor influencing the savings is general settings of auctions (e. g. correct type of auction, time allocated for the auction, visibility of offers by other suppliers). Metallurgical companies possibly use wrong settings for their auctions, which leads to lower savings.

CONCLUSION

Electronic auctions are very modern and powerful tool in the procurement process. When used correctly, they can provide several benefits for the company. However, it is important to analyze the results of the auctions. The research presented in this paper proves certain anomaly in e-auction results by the metallurgical companies: they generally have lower savings, while having above average number of potential suppliers. Several reasons for this situation are provided in this paper, both related to specifics of the metallurgical industry and e-auctions used by specific companies. Importance of the proposed reasons could be a matter of further researches.

ACKNOWLEDGEMENTS

This paper is supported by Student Grant Competition of the Faculty of Economics, VSB***-Technical University of Ostrava; project's registration number is SP2014/126. All support is greatly acknowledged and appreciated.***

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APPENDIX

Appendix 1: Kolmogorov-Smirnov test of normality for the used variables

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Number of Participants	.239	1261	.000	.742	1261	.000
Savings compared to E	.076	1261	.000	.969	1261	.000

a. Lilliefors Significance Correction

Appendix 2: Descriptive statistics for the variable Savings compared to initial price

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Savings compared to E	1261	.236682	.2435349	.328	.069	-.554	.138
Valid N (listwise)	1261						

Appendix 3: Descriptive statistics for the variable Number of Participants

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Number of Participants	1261	11.94	12.324	1.719	.069	2.089	.138
Valid N (listwise)	1261						

Appendix 4: Median for the variable Savings by industry

Grouped Median

Industry	Savings compared to E
Metallurgy	.107045
Construction	.158160
Energy	.223291
Machinery	.242333
Manufacturing	.114645
Total	.196121

Appendix 5: Median for the variable Participants by industry

Grouped Median

Industry	Number of the Participants
Metallurgy	7.33
Construction	5.73
Energy	9.55
Machinery	4.62
Manufacturing	4.02
Total	6.47