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The importance of evaluation of economic determinants in public procurement processes in Slovakia in 2010–2016

Abstract
Research background: Public procurement is designed to efficiently spend public sector financial resources. This should lead to savings in public funds. Domestic and foreign studies point to the fact that sufficient competition on the supply side is the condition for achieving those savings. Slovakia currently belongs to a group of countries with low competition on the supply side of the tender. Every year, about 10,000 tenders will be made in Slovakia for 5 billion Eur. However, contracting authorities have difficulty with establishing the estimated contract value and defining non-discriminatory criteria. On the other hand, contractors lack the expertise to prepare tenders, specifications are often tailored to specific

bidders or products, and the price criterion has a negative impact on the quality of the goods and services purchased.

Purpose of the article: The aim of the study was to investigate the impact of selected efficiency determinants on savings in public procurement in Slovakia in 2010–2016. The number of bids, the subcontractor's participation, the narrower competition and the impact of the narrower competition and the expected price on the number of bids have been examined.

Methods: The survey sample consisted of 800 randomly selected public procurement contracts from different sectors in 2010–2016. The contracts were split on the basis of the median estimate of the above-limit (409 contracts) and below-limit (391 contracts) contracts; the divestment value was the estimated price of 400,000 Euro (without the tax).

Findings & Value added: The number of offers positively influences the creation of savings in public procurement, an average of 5-6%. The impact of a narrow competition was significant, which led to a decrease in savings of 3-4% compared to the open competition if the sample was 800 contracts and over 400,000 Euro (without the tax). For below-limit orders, this determinant was shown to be statistically insignificant. The size of the contract did not affect the number of successful candidates. Also, the negative impact of narrower competition on the number of tenders was demonstrated. These findings are in line with the presented research studies. In the future, we plan to perform sectoral analyses to verify the validity of the hypotheses under review based on the results of our research.

Introduction

Public procurement (PP) is a very important and sensitive area of the economy. Public procurement processes and their determinants are currently the subject of many debates, not only at the national but also at the international level. Through public procurement, a considerable amount of funds is allocated from the state budget and municipal budget. This public procurement significantly affects the efficiency of the functioning of the public sector. Public procurement involves the transfer of funds from the public to the private sector, and this process should be accompanied by savings. Their importance is growing especially in the post-crisis period, when there is a considerable lack of resources in many spheres of economic and social life. Ensuring process efficiency through public procurement is a complex process. Public procurement is a part of public policy, characterized by systemic complexity (Potůček, 2005). Public procurement is a closely related factor of competition. The competition promotes quality, efficiency, and productivity while reducing the likelihood of corruption or cartels among entrepreneurial subjects. A higher number of competing entities puts pressure on cost reductions and quality improvements, while the existence of a monopoly position can support price increases while lowering quality (Androniceanu, 2017). From the retrospective point of view, there are no implemented regulatory or deregulation mechanisms (depending on the nature of the market), which is reflected in many negative public goods.

Some authors call for new public policy tools to monitor its effectiveness and efficiency. Public procurement processes as a part of public policy have a significant strategic potential for companies (Potůček *et al*., 2008). Many research and professional studies focus on various aspects of the PP. Their focus is heterogeneous, determined by the set goals as well as by the studied processes. Most often they are dominated by economic and legal issues that affect each other. The legal view of PP was also dominated by older research studies by Czech and Slovak authors (e.g. Šedivý *et al*., 1996; Tillmann, 1995; Pelc, 1996; Jurčík, 2008; Zemanovičová *et al*., 2010; Špinerová, 2014 and others). Due to the financial and economic crisis and its consequences, the economic parameters of the PP and the related consecutives have been examined first (Becerra-Alonso *et al*., 2016). Active in this issue is also the author Ochrana in his works (2008ab, 2010), Mlčoch (1996), Pavel (2007; 2008ab; 2009abc), Beblavý and Sičáková-Beblavá (2006), Halásková (2015), Halásková and Halásková (2015), Bandiera (2008), Danger (2008), Fiorentino (2006) and others. The economic platform in their studies consists of methodological aspects, evaluation methods for process evaluation, the economics of transaction costs, etc.

Many studies examine the effectiveness of PP processes in relation to the competitive environment. Older research studies (e.g. Gilley & Karels, 1981; Szymanski, 1996; Domberger, 1995; Bajari & Tadelis, 2001; Brown & Potoski, 2003; Androniceanu & Ohanyan, 2016) examined the impact of the competitive structure on price and quality. Their analyses are applied in various sectors using quantitative methods and offer a wide range of results. Their unification is considerably difficult due to the heterogeneous process examined (a comprehensive overview of foreign research studies focusing on the aspect of competition is the subject of the following chapter). According to the European Commission, the level of competition on the supply side can be judged by the number of tenderers in the public procurement, resp. by the number of tenders submitted (European Commission, 2011). The European Commission evaluates in its study the efficiency of public procurement in the number of tenders, which is based on the assumption that a greater number of tenderers will allow to award a contract to a good tenderer at a more advantageous price (European Commission, 2011). Transparency in public procurement, therefore, needs to be ensured (Vlach & Ursíny, 2007). In recent years, legislation has been drastically modified in Slovakia by the introduction of electronic auctions, which has contributed to the increase of transparency in PP processes. Nevertheless, the situation in evaluating the effectiveness of PP processes is not satisfactory. This is also affected by the systemic complexity of PP processes as

well as by insufficient regulatory measures in the area of public policy (Androniceanu & Dragulanescu, 2012).

The above-mentioned consequent facts encouraged us to carry out our own research study aimed at identifying the impact of selected efficiency determinants on savings in public procurement in various sectors in 2010–2016 in Slovakia.

Theoretical background

As already mentioned in the survey of research studies, recent attention has been paid to examining the impact of competition on savings in PP. The subject of many research and professional studies is the study of determinants influencing the difference, resp. the ratio between the final and estimated cost of the contract. In Tab. 1 is a list of selected public procurement studies with an emphasis on the impact of the "number of tenders" factor.

On the basis of the studies analyzed, the positive impact of competition on the creation of savings in public procurement can be confirmed. This effect may vary depending on the sector under investigation. For sectors that are associated with high entry costs, it is not possible to provide a sufficient competitive environment that could lead to greater savings in public procurement (Shrestha & Pradhananga, 2010). For example, in the case of electricity and gas in the Czech Republic, the average price drop was only 1% with each of the other bidders. The contract terms of the contract (Soudek & Skurhovec, 2013) were pronounced more significantly. Hanak and Muchová (2015), who examined 256 construction and transport infrastructure contracts in the Czech Republic in 2014–2015, also point to differences. Zachar and Dančíková (2012) prepared an analysis of the public procurement of Slovak hospitals in 2009–2012, finding that 54.6% of tenders submitted only one candidate. For comparison, in other non-health sectors, the tenders were only one bidder — with only one bid being over 40% lower than for hospitals. On the other hand, the share of procurement with 5 or more bidders was almost 18% in the non-medical sector, while in hospital tenders it was only slightly more than 6%. The average number of offers in hospital tenders is 1.7. In the other sectors of the economy of the Slovak Republic, the average over the same period was less than 3 tender offers. This means that the public health sector is exposed to lower competition among suppliers, which may be due to a narrowly specified subject matter. In the Czech Republic, competition among suppliers in the medical field is twice higher.

A number of determinants can be affected by many factors, such as participation by a subcontractor, type of public procurement procedure, drawing on EU funds, participation of SMEs, use of electronic auction, industry type, time factor, and others which may affect positively or negatively the resulting procurement may affect the resulting savings of public resources in public procurement. Millet *et al.* (2004) consider the use of e-auction as important to ensure greater competition on the supply side. According to the authors, the optimal number of offers would be 5 — 6. With more offers, there is no such price drop as would be desirable. However, if e-auction is linked to excessive transaction costs, small and medium-sized enterprises will be excluded, which negatively affects the competitive environment (Krasnokutskaya & Seim, 2011).

An interesting study is also the one by Pavel (2008a, 2009a), concluding that narrower competition affects the price drop negatively, and that it is smaller by 11.6-19.8% compared to the open competition. For Slovakia, a similar study was carried out in 2009, when Pavel (2009a) supplemented the subcontractor's share of the monitored variables as well. The author of the study concludes that, in the area of transport infrastructure in Slovakia, the subcontractor reduces savings by an average of 11.6%.

Also, the narrowly specified subject of the contract and the too stringent demands on the contractor reduce the number of entities that can participate in the procurement process (Pavel, 2009b). In the case of Czech transport infrastructure, the impact of the size of the contract on the number of tenders was not demonstrated. This is influenced, for example, by a narrower competition that reduces the number of bids by 2.6 (Pavel, 2009c).

Research methodology

The aim of this paper is to identify the impact of selected efficiency determinants on savings in public procurement. Specifically, they are determinants such as the number of bids, subcontractor participation, and narrower competition. Subsequently, the impact of the narrower competition and the expected price on the number of offers is also examined. The sample consists of 800 randomly selected public procurement contracts from different sectors in 2010–2016. The contracts were split on the basis of the median estimate of the over-limit (409 contracts) and below-limit (391 contracts), the divestment value being the estimated price of 400,000 Euro without tax. The basic characteristics of the analyzed data sample are shown in Tab. 2.

Table 2 shows that most of the public procurement was conducted with only one candidate and up to 36.37% of the contracts. In the below-limit

contacts, it was 35.06% and in the above-limit 37.63%. Two bidders made a bid in 20.25% of cases. We find that up to 56.62% of all procurement took place with one or two bids. This fact also applies to over-limit and below-limit contracts.

Another factor examined is the involvement of the subcontractor. We can see that up to 82.38% will go without the subcontractor. Differences also exist in below-limit and above-limit contracts. When above-limit contracts, the subcontractor's participation is in 25.24% of cases when below-limit contracts it is only 9.54% of cases. Open public procurement is used in 73.38% of cases. It is also clear that there are differences in below-limit and above-limit orders, because in above-limit ones closed proceedings are 35.19%, while with below-limit ones it is only 17.53%.

The variable to be explained is the ratio of the final and the estimated price. If this ratio is less than one, it means that public procurement has saved public funds and has resulted in a better (lower) price than expected. If this ratio is greater than one, it means that the final price was higher than expected, which we can call an overpayment. A ratio equal to one means that it was purchased at the same price as the price assumed. Public procurement should aim to achieve savings and, in the case of a ratio equal to or above one, we can call this procurement as inefficient. Of course, account must also be taken of the possibility that the estimated price was incorrectly estimated and was underestimated at the beginning of the procurement process, and it was not possible to obtain specific goods or services at such a low price. Table 3 shows the resulting savings or over-delivery by public procurement.

From Table 3, we can see that in both cases the public procurement leads to greater savings than overpayment. In contracts, below 400,000 Euro, it is in 60.1% of cases, and in orders above 400,000 Euro it happens in 59.2% of cases. Excess in both samples occurs in approximately 30% of cases and no change in the final and predicted price occurs in about 10% of cases. Therefore, we can assert that in the analysis of overpayments, savings, and unchanged cost, we do not have significant differences with respect to samples broken down on the median of the predicted price.

Analysis and results

The analytical part was divided into three coherent units that made up separate sections. From the process point of view, besides testing the savings in the PP process, we were also interested in quantifying the impacts of the

individual determinants of the efficiency of PP on saving creation, as well as on the number of offers.

Testing saving in the procurement process

A sample of both above-limit and below-limit contracts was subjected to statistical testing of the average value. This testing was performed in the R program using the Wilcoxon Signed-rank Test. Our ambition was to prove that in the sample, public procurement leads to savings — a change in the final price compared to the given price. The zero hypothesis of the mean values was rejected by both samples based on the p-value, so an alternative hypothesis is that the mean values of the files are not equal to either above-limit or below-limit contracts. The result indicates that public procurement can either bring savings or overpayment. We, therefore, use a one-sided test and formulate an alternative hypothesis directly by making savings in the public procurement. A positive result was obtained from both tests as well as the finding that savings are statistically significant in both above and below-limit contracts. The p-values as the test results are shown in Table 4.

We can also support the test results in Table 5, where we calculated the average absolute and relative savings for both above and below-limit contracts.

From Table 5, we can see that in both cases the public procurement leads to saving because the average value of the final price is smaller than the average predicted price for both samples. Average relative saving is greater for above-limit contracts and represents 12.73%. Average relative saving of below-limit contracts is 8.74%.

Quantification of the impacts of individual determinants of public procurement efficiency on savings

Using a second-order polynomial regression model, we model the ratio of the final and predicted prices depending on the number of bids, (no) subcontractors, and the type of competition (open, closed). The first part deals with the influence of factors on the whole set of divisions based on the reference value. The basic model has the form:

$$y = \beta_0 + \beta_1 \times x_1 + \beta_2 \times x_2 + \beta_3 \times x_3 + \beta_4 \times x_1^2, \qquad (1)$$

where: x_1 is the number of bids, x_2 is a subcontractor (yes / no) and x_3 is the type of procurement (open/closed).

The polynomial model, namely the square of the explanatory variable of the number of bids, has been chosen in order to quantify the long-term effect of this influence in addition to the influence of the given variable (whether it is a concave or convex growth/decrease — whether the growth or fall effect is gradually exhausted or not). Based on the outputs in Table 6, we can see that the subcontractor's impact is not statistically significant, so we removed the variable from the model and performed another regression without this variable. In total, we analyzed 6 models (3 models, all contracts together, below-limit and above-limit contracts with all variables and 3 models without subcontractor's variable participation). The results for all contracts, including the inclusion of the subcontractor, can be seen in Tables 6 and 7.

Since the influence of subcontracting is not statistically significant, we are compiling a new model without this variable, whose regression coefficients we interpret.

The regression results show that each additional offer causes the final price to drop as a perceived price on average by 5.24%. This means that with the increasing number of offers, the final price decreases, but this effect of additional bids is gradually exhausted, which in the regression function ensures the explanatory variable second power of the number of bids, which is expressed with a positive sign — a so-called convex drop. The existence of a closed competition, on the contrary, increases the final contract price by an average of 3.46%.

The results of the regression analysis performed for all orders together, the above-limit, and below-limit contracts, together with the partial effects of the variables on the explained variable, are summarized in Table 8.

On the whole, it has been confirmed that the number of tenders positively influences the creation of savings in public procurement, on average 5-6% growth. Insignificant statistics showed subcontractor participation. The impact of a narrow competition was significant, with a sample of 800 contracts and over 400,000 Eur without tax exceeding the savings of 3-4% compared to the open competition. For below-limit contracts, this determinant was shown to be statistically insignificant.

Quantification of the impact of individual determinants of public procurement efficiency on the number of tenders

Based on the analysis, it has been shown that the number of tenders, i.e. competition on the supply side, directly affects the size of the savings achieved. For this reason, the impact of the size of the estimated price and

the narrow competition on the number of bids was also analyzed. The model was again created in R and its result is in Table 9.

Based on the model, it can be concluded that in the case of the reviewed the estimated price did not have an impact on the resulting number of tenders in the public procurement. Thus, the size of the contract did not affect the number of successful candidates. Pavel (2009a) also came to this surprising conclusion in a study on the transport infrastructure of the Czech Republic. The model we are constructing is also confirmed by its further finding that narrow competition has a negative impact on the number of offers. In the case of Pavel, this was an average drop of 2.6, while the model we are building on the average says only about 0.8 offers.

Conclusions

The state finances its activity from public sources, primarily from citizens in the form of taxes and levies. Many pieces of research and expert studies, evaluation reports, and other documents declare the considerable inefficiency of managing public resources. This requires the setting of appropriate regulatory processes with the implementation of various tools. PP is a process that has long been exposed to criticism in evaluating the effectiveness of public policies. It is related to overpriced contracts that are disadvantageous to public budgets, lower quality services, lower public confidence, unnecessary purchases, and etc. In spite of the existing rules, it is common for contracting authorities to have preferential interest in individual bidders. They create discriminatory conditions that reduce transparency. Another negative phenomenon is the abuse of sub-standard PP methods, the use of unfair practices related to the provision of information, Existence of corrupt practices significantly interferes with healthy competitive processes, resulting in considerable economic losses. Expert estimates declare up to 80% of the manipulated auctions, with a bribe amount between 10–15% of the total price of the contract (Ondráček, 2005). These facts are an important call for comprehensive analyses of the procurement system both horizontally and vertically (development and sectoral analyzes) that would be the basis of regulatory and evaluation mechanisms as well as a platform for national and international benchmarking.

The aim of our study was to investigate the impact of selected efficiency determinants on savings in public procurement in Slovakia in 2010–2016. 800 randomly selected procurement contracts from different sectors were analyzed.

The results of our analyses show interesting findings. The number of offers positively influences the creation of savings in public procurement, an average of 5–6%. Insignificant statistics showed subcontractor participation. The impact of a narrow competition was significant, which led to a decrease in savings of 3–4% compared to the open competition if the sample was 800 contracts and over 400,000 Eur (without the tax). For below-limit orders, this determinant was shown to be statistically insignificant. The results of our analyses have further shown that the number of tenders (bid-side competition) in the public procurement process directly affects the size of the savings achieved. For this reason, the impact of the size of the estimated price and the narrower the competition on the number of bids was also analyzed. The results show that the size of the contract did not affect the number of successful candidates. Also, the negative impact of narrow competition on the number of tenders was demonstrated.

These findings provide a valuable platform for follow-up research. In the future, we plan to perform sectoral analyzes to verify the validity of the hypotheses under review based on the results of our research. It will also be important to cooperate research teams with competent institutions to support the development of methodologies to detect discrimination and non-transparency in PP processes and to enable appropriate regulatory and stabilization mechanisms to be established in PP processes and public policy. This is the only way to achieve greater efficiency in the public sector.

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Annex

Table 1. Survey of studies focusing on the impact of the number of tenders on the resulting savings in public procurement

Author, Year	Sample	Results
Kulhman, Johnson (1983)	USA, Transport Infrastructure	Every other offer reduces the final price by an average of 2%
Gómez-Lobo, Szymanski (2001)	Great Britain	The second biggest offer came with the biggest savings, with an average reduction of the final price of 12-13%.
Gupta (2002)	Florida (USA), Transport Infrastructure, 1981-1986	For 2-8 bids, the average savings were 12-14%.
European Commision (2008)	EU countries, 13370 above-limit contracts from 2004-2007	The second offer reduces the price by 4.5%, the third and the fourth offer on average by 1.2%
Ilke, Rasim, Berdi (2012)	Turkey, 90089 tenders	Average number of bids 3.09, every other offer decreases the average price by 3.9%
Šípoš, Klátik (2013)	Slovakia, 6800 tenders in the amount of 3.9 billion Eur	The average number of offers in 2011 is 3.6, the biggest savings came when the second offer arrived
Soudek, Skurhovec (2013)	Czech Republic, electricity and natural gas	The impact of the number of applicants on average only 1% on the price drop
Grega, Nemec (2015)	Slovakia, 27000 tenders, 2009-2013	With each additional offer, savings are made on average by 2.63%. For projects funded by EU funds, the savings were on average 1.54%.
Pavel (2008)	Czech Republic, Transport Infrastructure, 2004-2009, 202 contracts	Every other offer reduces the ratio of the final and estimated bid prices by 3.27-4.4%
Pavel (2009)	Slovakia, Transport Infrastructure, 2005-2009, 100 contracts	For 2-5 offers, the fall in the final and estimated price ratio by 5-8%

Table 2. Basic characteristics of the sample

Factor		All contracts (%)	Below-limit contracts (%)	Above-limit contracts (%)
No. of offers	1	**36.37**	**35.06**	**37.63**
	2	20.25	22.42	18.20
	3	17.00	17.78	16.26
	4	9.00	8.76	9.22
	5	6.38	5.93	6.80
	6 and more	11.00	10.05	11.89
Participation of the subcontractor	yes	17.62	9.54	25.24
	no	**82.38**	**90.46**	**74.76**
Type of public procurement	open	**73.38**	**82.47**	**64.81**
	closed	26.62	17.53	35.19

Table 3. Resulting savings / overpayments in public procurement

Limit	All contracts (%)	Below-limit contracts (%)	Above-limit contracts (%)
Savings	59.6	60.1	59.2
Overpayment	30.6	29.9	31.3
Identical price	9.7	10.0	9.5

Table 4. Results of the Wilcoxon signed-rank test

Type of the test:	The null hypothesis	Alternative hypothesis	Below-limit contracts	Above-limit contracts
Double sided test	There are no differences in the submitted and the final price	There are differences in the submitted and the final price	2.2e-16 ***	2.2e-16 ***
One-sided test	There are no differences in the submitted and the final price	The introduction of public procurement leads to savings	2.2e-16 ***	2.2e-16 ***

Table 5. Average savings for above and below-limit contracts

Criterion	Below-limit contracts	Above-limit contracts
Average predicted price	121,484.5	26,768,880
Average value of the final price	110,867	23,361,827
Average absolute savings	10,616.99	3,407,053
Average relative saving	8.74 %	12.73 %

Table 6. Results of testing selected savings variables

Explained variable	Final price as % of the estimated price	
Explanatory variables	Estimated regression coefficient	Statistical significance
Constant	98.6735	< 2e-16 ***
Number of offers	-4.9969	7.03e-15 ***
Number of offers (second power)	0.1992	6.69e-06 ***
Participation of the subcontractor	3.5059	0.0580 .
Type of competition - narrow competition	3.7197	0.0223 *

Table 7. Results of testing selected savings variables (without subcontractor participation)

Explained variable	Final price as % of the estimated price	
Explanatory variables	Estimated regression coefficient	Statistical significance
Constant	102.1757	< 2e-16 ***
Number of offers	-5.2375	< 2e-16 ***
Number of offers (second power)	0.2096	1.9e-06 ***
Type of competition - narrow competition	3.4634	0.033 *

Table 8. Results of regression analysis for Slovakia for 2010–2016

Criterion	All contracts	Above-limit contracts	Below-limit contracts
Number of offers	800	409	391
Value of the contract	Unlimited	Above 400,000 Euro without tax	Below 400,000 Euro without tax
Impact of the number of bids	Growth savings on average by 5 %	Growth savings averaged by 5.64 %	Growth savings averaged by 5.87 %
The influence of the subcontractor	Statistically insignificant	Statistically insignificant	Statistically insignificant
The impact of narrow competition	Savings on average decreased by 3.7 %	Decrease in savings on average by 4.3 %	Statistically insignificant

Table 9. Results of testing selected variables on the number of bids

Explained variable	Number of offers	
Explanatory variables	Estimated regression coefficient	Statistical significance
Constant	2.5315e+00	< 2e-16 ***
Estimated price	8.1847e-10	0.2075
Type of competition - narrow competition	-8.1158e-01	1.822e-15 ***