Economic aspects of public procurement parameters in tertiary education sector

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Abstract: *Public procurement is a very important area of competitiveness development of the countries. Significant public sector financial resources are allocated through public procurement. Over the last decade, there has been a growing demand for an investigation of the efficiency of public procurement processes. In the research studies, analyses focusing on methodological aspects, efficiency assessment models, economic and transaction costs and other economic parameters in relation to public procurement have begun to appear gradually. Their importance has increased in the recent period, especially in the era associated with a lack of financial resources in the economic and social spheres. A correct determination of the mechanisms ensuring the implementation of transparent competition is able to allow improvement of competitive environment. Such aspects prompt this study, which is aimed at examination of the selected parameters of public procurement in the tertiary education sector and their impact on the final cost of the public procurement contract. There are no such sectoral analyses within the national environments, making it difficult to create an international comparative basis. The aim of the paper is to investigate the impact of the selected public procurement parameters on the final price. These parameters are subcontractor participation, European funds funding, usage of electronic auction, type of procured item, and procurement procedure. Besides these ones, public procurement processes also influence the final price. Approximately, a share of 95 % from the expected price is reflected in the final price, whilst a mean regression coefficient of the number of offers reaches a level of -17499.07 in the year 2017. The outcome of the analysis can help the procurers to identify the behavior of public procurement and to confirm or disprove the significance of the parameters that are examined using the quantitative methods. The results of this analysis are beneficial for national policymakers as well as national and international benchmarking.*

Keywords: *procurement, tertiary education sector, subcontractor, electronic auction, procurement procedure, regression analysis.*

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Introduction

Public procurement is one of the important and sensitive areas of the economy. Its processes as well as the determinants are currently the subject of many debates, both nationally and internationally. Public procurement has a significant impact on the operation of the public sector and on its efficiency in particular. Its economic importance has an increasing tendency mainly in the post crisis period, when there is a noticeable lack of resources in most spheres of social and economic life. Ensuring the efficiency of public procurement processes is very complex and it is related to the systemic complexity, whilst it is a part of public policy (Androniceanu, 2017; Potůček, 2017). Public procurement is also an important factor in competition. This competition generally supports quality, efficiency and productivity, while reducing the likelihood of corruption or cartel agreements among enterprises. A larger number of competitors put downward pressure on costs with a complementary improvement in quality, while the existence of the entity's monopoly position has the opposite effect on cost and quality. The size of competition is limited by a number of factors. One of the main factors is the sector, which public procurement is conducted in. For sector with a high cost to enter the industry, public procurement may provide better contractual terms than a lower price.

In the case of sectors with small entry barriers, it is possible to achieve a significant reduction in the price of the goods or service in question if it is provided through public procurement. From these aspects, it is very interesting to examine the determinants of the efficiency of public procurement also from the point of view of the specificities and characteristics of individual sectors. From a point of view of a volume of public funds, civil engineering is a major sector in this view. For the period from the year 2009 to the year 2017, a civil engineering sector covers seven billion euro. The second sector in this ranking is an agriculture and forestry sector with over 1.6 billion euro spent over the same period. The third one is informatics and communications worth 1.1 billion euro. In the terms of a number of the involved public tenders, the order is opposite. The highest number of contracts is found in the agricultural and forestry sector with 4,481 contracts, the second one is the civil engineering sector with 2065 contracts and third one is the technical services sector with 437 contracts.

A high-quality database is essential for efficient public procurement processes too. The authors Chvalkovská and Skuhrovec (2010), who investigate public procurement processes in the public institutions of the Czech Republic, point to this. Their aim is to analyse the potential of electronic government tools to assess the expenditure of the public institutions in the country. A good database is important not only from a point of view of carrying out national analyses related to quantification of economic aspects, development of methodologies and models to evaluate efficiency, but also to create a platform for the implementation of national and international benchmarking. Optimum access to public procurement data increase the efficiency of public control over public institution spending. At the

present time, sufficient management of the public procurement provided by the Office for Public Procurement of the Slovak Republic is provided in the country. Nevertheless, the Slovak Republic is one of the countries with a low number of offers, suspicions of no transparency and corruption in public procurement. This fact is also the primary motivation to carry out research in this field. From a point of view of sectorial differentiation, focus is laid on a tertiary education sector, which research studies aimed at the efficiency of research and development are missing from.

The whole analysis demonstrates a quite large heterogeneity in the data set. Its outcome underscores this issue. Because it is a quite comprehensive view of the data related to public procurement, the regression models are executed for the individual examined factors separately. An initial analysis declares the finding that all the variables examine are statistically significant: subcontractor participation, European funds funding, electronic auction, purchase type, and procurement procedure. Due to the characteristics of the data, the individual years are separately investigated, allowing us to determine, whose year regression coefficients can be considered statistically significant within the observed period. The output of the regression coefficient analysis has the same trend over the explored period, the models of the separate years can be considered to be statistically significant. This is also the reason to compare them through the information criteria. The outcome of this comparison reveals a gradual improvement of the regression models throughout the whole observed period as their values decrease towards the final explored year 2017.

Many national and international studies declare the problem of involving a small number of participants in the procurement process, which results in a low level of competitiveness. Similarly, the purchase type and the procurement procedure influence the final price of the order. This analysis also points to the impact of electronic auction on a final price reduction. It is consistent with the results of Kvasnička et al. (2015) too who declare the impact of the various public procurement procedures on final price. According to their findings, the inefficiency of public procurement due to the use of different procedures is considerable.

As for the last observed year 2017, a mean value of the regression coefficients of the number of offers stands at a level of -17499.07 for all the involved parameters.

The most extreme values for the expected price are found in the years 2016 with the procurement procedure variable involved in the regression model reaching a minimum value of 0.53 and in the year 2009 with the same variable involved peaking at a maximum value of 1.24. Disregarding of the observed categorical variable – the subcontractor participation, the European funds funding, the electronic auction, the purchase type, and the procurement procedure – the expected price is a significant component of the final price and has a very high share at 95% in the year 2017. In the previous years 2015 and 2016 this share is lower considerably. An increase of the number of offers causes a decrease in the final price. This influence is confirmed by all the models regardless the additional variable included in the modelling process.

1. Literature review

Public procurement represents a very important field of economy of every individual country. The European Union public bodies spend about 14 % of gross domestic product per year on public procurement. It is more than 1.9 trillion EUR. These orders are considerably important to increase competitiveness for the reason of their extent. Significant financial sources are allocated within the public sector via public procurement. Its importance increases especially when there are instances related to a lack of financial sources in many economic and social spheres. One of the main goals of every public procurer is to increase the its efficiency and to guarantee the efficient usage of public sources. This requests general setting of processes and procedures in a field of public procurement.

Many national as well as foreign specialists deal with the efficient setting of public procurement processes. They evaluate and analyse the data available from the past and the outcome of the analyses enable them to make recommendations for the economic policy. Their aim is also to increase the sector efficiency as a whole. In the eightieth years of the twentieth century, the authors of the various foreign research studies dedicated their research to the topic of appropriate determination of the public procurement processes and its efficiency for the numerous types of goods and services. In many research studies, this efficiency is assessed by the final purchase price (Kuhlman and Johnson, 1983; Brannman, 1987; Rose-Akerman, 1999; Gupta, 2002), while an important expectation to reduce costs as well as final price for the public sector is a sufficient level of competition within the market and competition within the public procurement. This is tricky in many European countries. According to the latest statistics, there were up to 27 % of announcements for public procurement with only one participant in the European Union from the year 2006 to the year 2016. The highest values are recorded in new member states.

The influence of competitiveness on the final price or saving in purchase is studied by many researchers (Gómez-Lobo & Szymanski 2001, Ilke et al. 2012). The results of these studies confirm that the knowledge of the public procurement processes increases the efficiency of usage of the sources and, therefore, it brings higher savings. In the last ten years, demands to explore this efficiency have increased and in the research done, the analyses focused on methodological aspects, the efficiency evaluation models, economic and transactional costs and other economic parameters related to public procurement have appeared (Fiorentino, 2006; Danger, 2008; Bandiera, 2008; Tynkkynen et al., 2013; Kohler et al., 2015; Grzeszczyk & Czajkowski, 2017).

An effort how to dealt with the issues of the public procurement processes is visible in the Czech Republic too. As a proof of it, there are numerous research studies done in this field. Many dissemination directions come from the structure of their research areas. One group of experts focuses on the efficiency of public procurement as a specific process of the public sector, whereas the other experts assess these processes in a conceptual way on a macroeconomic level and study in

detail their influence on the sectorial efficiency. One of the most influential study within the Czech Republic environment is done by Pavel (2011). The author searches for a convenient tool to analyse the public procurement market transparency in the Czech Republic during the period from the year 2001 to the year 2005. In his studies, the author states that the market transparency in the Czech Republic is not sufficient enough as open competitions do not cover even one third of the market and a current system of under-limit public procurement must be modified. Then, Pavel (2011) also studies the efficiency of the control systems in the Czech Republic.

The results demonstrate that there is an insufficient efficiency of these control systems. This correlates with the findings of the analysis by Nemec et al. (2008), who explore performance and efficiency of public administration authorities in the Czech Republic and the Slovak Republic. Their results point at negative findings, which inefficient systems of public services, obstacles in implementation of benchmarking in the Czech Republic and Slovak Republic and its incorrect and irregular usage belong among. A macroeconomic aspect is also evident in the study of the authors Chvalkovská and Skuhrovec (2010), who analyse the potential of electronic services as e-government tools for evaluation of expenditures efficiency of public institutions in the Czech Republic. They apply the transparency index as well as the composite indices, although they strongly criticise an insufficient data availability too. An optimal access to data related to public procurement will increase the efficiency of public control regarding expenditures of the public institutions. Transparency is also studied by the authors Ochrana and Pavel (2013), who investigate economic parameters of a set of 175 contracts. Except for that, they also study a resistance to corruption, openness, efficiency of the administration procedure and the process of a creation of convenient evaluation criteria to choose the best offer. The authors point at low competencies of the administrator not being able to use the so-called non price criteria more often. A similar analysis is done by Man et al. (2015). The data come from the collection of public procurement in the Czech Republic from the contracts in the year 2013. The authors study over-limit as well as under-limit public procurement orders with an aim to reveal dependency of the price differences of the particular type of public procurement. This aspect is studied carefully by Bandiera et al. (2008) and by the other authors in their works too.

Several non-governmental organisations as Transparency International Slovakia point out the inefficiency of public administration in the Slovak Republic and in the Czech Republic too. Is it admitted to some level also by governmental structures, but there is no available and working methodology for optimisation and evaluation of public procurement efficiency. Knowledge of external environment is essential in order to secure efficient public procurement processes (Organisation for Economic Co-operation and Development Publishing, 2009). The European Union member countries follow the European Commission directives that define principles and procedures of public procurement (Directive 2014/23/EU of the European Parliament and of the Council of 26 February 2014 on the award of

concession contracts, 2014; Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC, 2014; Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC, 2014; Directive 2014/55/EU of the European Parliament and of the Council of 16 April 2014 on electronic invoicing in public procurement, 2014). These directives are integrated into the national legal system of every member state. In the Slovak Republic, public procurement follows its own act 343 of the year 2015 (Zákon 343 z 18. novembra 2015 o verejnom obstarávaní a o zmene a doplnení niektorých zákonov – časová verzia predpisu účinná od 1. 1. 2019 do 31. 12. 2019, 2015).

Even though, one of the public procurement principles is a principle of efficiency and efficacy, neither act nor the corresponding legal acts, or methodology at a national level or a European level, define methodology for its evaluation. This raises a necessity to create a platform of multidimensional economic analyses that are differentiated form a sectoral angle of view. The outcome of such activities is able to reveal elementary determinants of efficiency as well as their causal relationships. Such consequential facts bring an examination which is a content of the analysis and therefore, the aim of the paper is to investigate the impacts of the selected public procurement parameters on the final price of an order. These parameters are subcontractor participation, European funds funding, usage of electronic auction, type of procured item, and procurement procedure. Besides these ones, public procurement processes also influence the final price.

In the context of this research, some studies specifically focus on sustainable procurement policy and the development of the tools to assist policy implementation (Brammer & Walker, 2011). For instance, so-called green procurement meaning public procurement of green products has been encouraged through legislation, providing information and dismantling barriers (Thomson & Jackson, 2007). A tool to support green procurement has been developed for municipalities in Germany (Günther & Scheibe, 2006), while a case study from California of the United States of America develops a priority setting tool for greener state government purchasing (Swanson et al., 2005), which considers purchasing volume, environmental impacts, potential for improvement and institutional factors such as existing state policies and upcoming contract renewals. Legal issues have also been considered, including the acceptance of green contract award criteria in public procurement (Kunzlik, 2003).

The project Effective Institutions was carried out in the Czech Republic in order to make environment more efficient (Systémová podpora efektivního řízení institucí terciárního vzdělávání a výzkumných a vývojových organizací, 2013). The aim of the project is to support and to develop effective management principles, especially supportive economic and administrative processes in tertiary education institutions and research and development institutions. The reasons for the realisation of this project are clearly aimed at strengthening the competitiveness of

the public institutions at a national level and a European level too. A part of the project is an implementation of the process analyses at the selected seventeen universities and research and development centres in the Czech Republic. The process analyses reflect many applied approaches which there are based on, but they are associated with a number of the specific points as well. The specific focus is aimed at the selected processes of administration and development of the fundamental resources of the public procurement parameters. The analysis concerns their assessment through maturity model established on capability maturity model. According to it, the determined processes are the ones not implemented processes in an institution, the ones implemented ad hoc, the ones standardised in an institution, the ones involving the assessment criteria, and the ones continuously optimised and permanent.

2. Data and methodology

The main methodological approach applied in the analysis is the sensitivity analysis in a form of the regression analysis.

2.1 Data

The input data is created by database consisting of the 2409 records. Each record is represented by the individual contract based on the public procurement. The observed period lasts from the year 2009 to the year 2017. All the records come from a tertiary education area from the database of the Central Register of Contracts (Centrálny register zmluv) of the Government Office of the Slovak Republic.

Limitation of the data lies in the availability of the particular attributes of the explored contracts coming from the public procurement. This unavailability is caused by unread ability of the particular parts of the contracts.

The eighteen universities of the Slovak Republic are involved in the research, which Alexander Dubček University of Trenčín in Trenčín (Trenčianska univerzita Alexandra Dubčeka v Trenčíne), the Catholic University in Ružomberok (Katolícka univerzita v Ružomberku), the Comenius University in Bratislava (Univerzita Komenského v Bratislave), the Constantine the Philosopher University in Nitra (Univerzita Konštantína Filozofa v Nitre), the János Selye University (Univerzita Jánosa Selyeho), the Matej Bel University in Banská Bystrica (Univerzita Mateja Bela v Banskej Bystrici), the Pavol Jozef Šafárik University in Košice (Univerzita Pavla Jozefa Šafárika v Košiciach), the Slovak University of Agriculture in Nitra (Slovenská poľnohospodárska univerzita v Nitre), the Slovak University of Technology in Bratislava (Slovenská technická univerzita v Bratislave), the Technical University in Zvolen (Technická univerzita vo Zvolene), the Technical University of Košice (Technická univerzita v Košiciach), the University of Economics in Bratislava (Ekonomická univerzita v Bratislave), the University of Prešov in Prešov (Prešovská univerzita v Prešove), the University of Saint Cyril and Methodius of Trnava (Univerzita svätého Cyrila a Metoda v

Trnave), the University of Trnava in Trnava (Trnavská univerzita v Trnave), the University of Veterinary Medicine and Pharmacy in Košice (Univerzita veterinárskeho lekárstva a farmácie v Košiciach), and the University of Žilina in Žilina (Žilinská univerzita v Žiline) belong among. The list is sorted in an alphabetical order according the English names. All of them are public schools of tertiary education.

The dependent variable is represented by the final price. There are the two types of the independent variables encompassed in the analysis, that is, numerical and categorical. The two numerical variables are the number of offers and the expected price. The remaining five variables are categorical, while the three of them are binary variables. These are the subcontractor participation, the funding, and the electronic auction. The first variable expresses whether subcontractor is included in the fulfilling of contract. The second one states whether contract funding comes from the funds of the European Union too. The latter one demonstrates a presence of the electronic auction for each procurement. The remaining two categorical variables are the purchase type and the procurement procedure. The purchase type divides all the records into the four categories, where construction work, goods, service, and work are in the right place. There are the six categories of the procurement procedure, which the six ones are applied found in the analysed data set of. These are direct negotiated procedure, negotiated procedure with publication, competitive dialogue, narrower competition, and public competition (Ministerstvo spravodlivosti Slovenskej republiky, 2015). A standard five-per-cent significance level is set to determine statistical significance of the regressor. There is also to note that a minor number of the procurements from the whole data set are assigned by not available values in a case of some independent variables. The legend for the whole analysis is as stated in the following table.

Table 1. The categorical variables options legend

Variable	Option	Description
subcontractor participation	0	no participation of subcontractors
subcontractor participation	1	participation of one or more subcontractors
funding	0	no funding provided by the funds of the European Union
funding	1	funding provided by the funds of the European Union too
electronic auction	0	no usage of electronic auction
electronic auction	1	usage of electronic auction
purchase type	0	construction work as procured item
purchase type	1	goods as procured item
purchase type	2	service as procured item
purchase type	3	work as procured item
procurement procedure	0	direct negotiated procedure
procurement procedure	1	negotiated procedure with publication

Variable	Option	Description
procurement procedure	2	competitive dialogue
procurement procedure	3	narrower competition
procurement procedure	4	public competition

(*Source:* own elaboration by the authors)

2.2 Methodology

The linear regression based on an ordinary least squares approach is employed for the analysis. Each year is represented by the separate regression model in order to get a clearer view of an influence development of the independent variables. Because it is impossible to construct a panel data set, an individual approach from a time angle of view is selected to interpret dependence between the given variables. All the regression models include the expected price and the number of offers. Successively, the third regressor is one of the remaining independent variables mentioned in the previous section of the paper. For the whole analysis, a five-per-cent significance level is applied to determine whether the independent variable bears statistically significant regression coefficient or it should be declared as statistically insignificant.

The equation of the regression model looks like as follows:

$$FP = O + EP + CV$$

where the involved variables mean:
- FP – the final price;
- O – the number of offers;
- EP – the expected price;
- CV – the categorical variable.

The categorical variables are listed in Table 1.

For comparison of statistical significance of the regression models, the Akaike information criterion and the Schwarz bayesian information criterion are applied [**Error! Reference source not found.**].

3. Analysis

The analysis can be divided into the five parts according to the individual categorical variable involved in the regression model – subcontractor participation, funding, electronic auction, purchase type, and procurement procedure.

3.1 The Subcontractor participation

The results for the regression models with the subcontractor participation variable are shown in the following table 2.

Table 2. Estimated coefficients for the regression models involving the subcontractor participation

year	number of offers		expected price		subcontractor participation		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
2009	3944.87	$8.7 . 10^{-1}$	1.14	$8.6 . 10^{-49}$	0	-170944.62	$1.4 . 10^{-1}$
					1	692731.93	$2.3 . 10^{-2}$
2010	-9669.12	$1.6 . 10^{-4}$	1.03	$9.1 . 10^{-201}$	0	15858.71	$2.5 . 10^{-1}$
					1	-172298.87	$2.3 . 10^{-4}$
2011	-17490.57	$3.9 . 10^{-3}$	0.76	$5.8 . 10^{-131}$	0	113547.26	$7.2 . 10^{-5}$
					1	308881.46	$7.1 . 10^{-4}$
2012	-13871.31	$2.1 . 10^{-10}$	1.00	0	0	22068.78	$1.8 . 10^{-2}$
					1	115799.74	$3.1 . 10^{-2}$
2013	-11423.79	$4.2 . 10^{-3}$	0.91	$1.2 . 10^{-289}$	0	38354.23	$1.4 . 10^{-2}$
					1	48168.67	$4.2 . 10^{-1}$
2014	-75490.34	$1.4 . 10^{-4}$	1.07	$4.1 . 10^{-88}$	0	188492.57	$2.4 . 10^{-2}$
					1	-324837.57	$5.6 . 10^{-2}$
2015	-83932.26	$3.5 . 10^{-3}$	1.01	$8.3 . 10^{-109}$	0	129054.11	$1.4 . 10^{-1}$
					1	599452.17	$4.0 . 10^{-3}$
2016	3679.77	$5.4 . 10^{-1}$	1.11	$5.8 . 10^{-81}$	0	-45176.26	$9.5 . 10^{-2}$
					1	-73414.99	$5.3 . 10^{-1}$
2017	-22443.33	$2.9 . 10^{-3}$	0.94	$2.5 . 10^{-26}$	0	52581.53	$8.2 . 10^{-2}$
					1	337503.07	$4.4 . 10^{-3}$

(*Source:* own elaboration by the authors)

A majority of the estimated coefficients computed for the number of offers by a linear regression technique is negative or positive but with a considerably low absolute value. Only the two years – 2009 and 2016 – are represented with statistically insignificant regression coefficients. The expected price keeps relatively stable position of its regression coefficient with statistical significance throughout the whole observed period. The subcontractor participation bears the relatively high numerical influence on the final price and in a majority of cases with a positive sign. As it is seen, a participation of subcontractor raises absolute value of the regression coefficient in each year. The statistically insignificant cases are no subcontractor participation in the years 2009, 2010, and 2015, while the first one and the latter one are close to a significance threshold. The cases with subcontractor participation are statistically insignificant only the years 2013 and 2016.

3.2 The funding

The funding variable influences the regression coefficients in a way visualised in the successive table.

Table 3. Estimated coefficients for the regression models involving the funding

year	number of offers		expected price		funding		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
2009	-4179.89	$8.7 . 10^{-1}$	1.21	$1.3 . 10^{-53}$	0	-29107.39	$8.3 . 10^{-1}$
					1	-334183.42	$2.8 . 10^{-2}$
2010	-9144.83	$1.7 . 10^{-3}$	1.02	$2.8 . 10^{-195}$	0	13794.24	$4.8 . 10^{-1}$
					1	4461.60	$7.8 . 10^{-1}$
2011	-17145.68	$5.6 . 10^{-3}$	0.76	$1.0 . 10^{-130}$	0	92254.02	$2.0 . 10^{-2}$
					1	137744.80	$1.0 . 10^{-5}$

year	number of offers		expected price		funding		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
2012	-14391.12	$1.1 . 10^{-10}$	1.00	0	0	31954.55	$1.2 . 10^{-2}$
					1	19313.82	$6.6 . 10^{-2}$
2013	-11936.44	$3.2 . 10^{-3}$	0.91	$1.0 . 10^{-293}$	0	49220.70	$2.7 . 10^{-2}$
					1	33980.87	$4.6 . 10^{-2}$
2014	-45695.76	$8.1 . 10^{-5}$	1.03	$3.1 . 10^{-154}$	0	139524.88	$4.1 . 10^{-2}$
					1	77453.73	$1.6 . 10^{-1}$
2015	31420.53	$1.5 . 10^{-1}$	0.64	$6.6 . 10^{-73}$	0	-106860.69	$4.0 . 10^{-1}$
					1	249319.20	$2.5 . 10^{-2}$
2016	-51074.49	$4.3 . 10^{-2}$	0.54	$2.1 . 10^{-20}$	0	284141.82	$9.5 . 10^{-3}$
					1	630834.03	$3.7 . 10^{-4}$
2017	-15840.08	$2.0 . 10^{-7}$	0.95	$1.9 . 10^{-62}$	0	38890.72	$2.3 . 10^{-2}$
					1	44522.54	$1.5 . 10^{-1}$

(*Source:* own elaboration by the authors)

The number of offers influences the final price in a negative way. Only positive regression coefficient in the year 2015 is statistically insignificant. Again, only the cases of the two years are statistically insignificant – 2009 and 2015 as mentioned one. The expected price bears the statistically significant regression coefficients in each observed year. It decreases its influence on the final price throughout the examined period.

Except for the three cases – the both options in the year 2009 and a no funding case of the year 2015, all the values bear a positive sign. Therefore, it has a considerable positive influence on the final price. There is a widely held statistical significance among these values, a no funding case is significant in the years 2011, 2012, 2013, 2014, 2016, and 2017, whilst a European funds funding case is significant in the years 2009, 2011, 2013, 2015, and 2016. In the year 2012, the regression coefficient is only very little above a significance level and the years 2014 and 2017 are insignificant, but not very heavily.

3.3 The electronic auction
The electronic auction variable behaves in the regression models as it is demonstrated in the following table 4.

Table 4. Estimated coefficients for the regression models involving the electronic auction

year	number of offers		expected price		electronic auction		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
2009	2073.43	$9.4 . 10^{-1}$	1.19	$2.8 . 10^{-53}$	0	-133520.09	$2.9 . 10^{-1}$
					1	-310986.00	$3.2 . 10^{-1}$
2010	-8728.44	$8.6 . 10^{-4}$	1.02	$5.2 . 10^{-199}$	0	9254.32	$5.1 . 10^{-1}$
					1	-33204.48	$5.9 . 10^{-1}$
2011	-18560.71	$2.3 . 10^{-3}$	0.77	$1.0 . 10^{-131}$	0	134896.99	$5.0 . 10^{-6}$
					1	53700.20	$3.3 . 10^{-1}$
2012	-13621.85	$7.4 . 10^{-10}$	1.00	0	0	11288.41	$4.3 . 10^{-1}$
					1	27918.31	$5.0 . 10^{-3}$
2013	-11042.09	$5.8 . 10^{-3}$	0.91	$8.0 . 10^{-293}$	0	9699.92	$7.8 . 10^{-1}$
					1	40889.26	$9.2 . 10^{-3}$
2014	-69102.46	$8.5 . 10^{-4}$	1.04	$3.0 . 10^{-89}$	0	87422.48	$5.8 . 10^{-1}$
					1	152989.01	$7.5 . 10^{-2}$

year	number of offers		expected price		electronic auction		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
2015	-111771.07	$9.9 . 10^{-5}$	1.03	$1.1 . 10^{-123}$	0	-176919.10	$1.2 . 10^{-1}$
					1	305506.08	$1.1 . 10^{-3}$
2016	-41095.35	$1.6 . 10^{-1}$	0.54	$4.8 . 10^{-18}$	0	219662.16	$1.5 . 10^{-1}$
					1	453824.06	$5.9 . 10^{-4}$
2017	-15936.46	$2.1 . 10^{-7}$	0.95	$6.2 . 10^{-62}$	0	41124.30	$3.0 . 10^{-2}$
					1	37829.70	$6.1 . 10^{-2}$

(*Source:* own elaboration by the authors)

The absolute values of the estimated coefficient of the number of offers partially correlate with its values in the previous case of the funding variable involvement. A positive value is reached only in the year 2009. A statistically insignificant coefficients are assigned to the years 2009 and 2016. There is even higher correlation at a level of 0.7898 between the expected price coefficients of the electronic auction model and the funding model. Also, all the regression coefficients are statistically significant. The mathematical signs of the electronic auction variable are exactly the same with one exception of a no electronic auction case of the year 2010. As statistically significant, the regression coefficients of a no electronic auction case appear in the years 2011 and 2017, whilst the years 2015 and 2016 are slightly above a ten-per-cent significance level. If electronic auction is applied, the statistical significance is valid for the years 2012, 2013, 2015, and 2016, therewith the years 2014 and 2017 are very close to a five-per-cent significance level

3.4 The purchase type

There are four types of procured items in the data set. All the purchased stuff is divided into the four categories as stated in the section discussing the data applied in the analysis.

Table 5. Estimated coefficients for the regression models involving the purchase type

year	number of offers		expected price		purchase type		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
2009	6708.10	$7.5 . 10^{-1}$	0.98	$3.1 . 10^{-42}$	0	89413.30	$6.4 . 10^{-1}$
					1	-33652.53	$7.3 . 10^{-1}$
					2	-51843.39	$7.3 . 10^{-1}$
					3	6592004.07	$6.3 . 10^{-13}$
2010	-4373.09	$9.4 . 10^{-2}$	1.04	$8.0 . 10^{-199}$	0	-213614.07	$2.6 . 10^{-6}$
					1	2346.44	$8.7 . 10^{-1}$
					2	-18359.52	$4.5 . 10^{-1}$
2011	-4365.47	$4.5 . 10^{-1}$	0.83	$1.3 . 10^{-139}$	0	-37725.63	$6.1 . 10^{-1}$
					1	74377.51	$5.1 . 10^{-3}$
					2	12531.68	$7.5 . 10^{-1}$
					3	-2681793.49	$3.5 . 10^{-17}$
2012	-10602.88	$2.2 . 10^{-5}$	1.00	0	0	-73446.46	$5.9 . 10^{-2}$
					1	22999.01	$2.1 . 10^{-2}$
					2	-1588.77	$9.2 . 10^{-1}$
2013	-9065.79	$3.2 . 10^{-2}$	0.91	$1.4 . 10^{-290}$	0	-52877.39	$3.5 . 10^{-1}$
					1	35022.07	$3.4 . 10^{-2}$

year	number of offers		expected price		purchase type		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
					2	38495.98	$1.4 \cdot 10^{-1}$
2014	-35595.71	$2.0 \cdot 10^{-3}$	1.06	$5.5 \cdot 10^{-146}$	0	-416910.38	$6.6 \cdot 10^{-3}$
					1	75662.50	$1.6 \cdot 10^{-1}$
					2	72269.08	$3.4 \cdot 10^{-1}$
					3	90553.54	$4.4 \cdot 10^{-1}$
2015	27655.84	$2.2 \cdot 10^{-1}$	0.63	$1.0 \cdot 10^{-71}$	0	2187989.91	$7.5 \cdot 10^{-4}$
					1	253653.24	$1.9 \cdot 10^{-2}$
					2	-262518.04	$8.0 \cdot 10^{-2}$
					3	-16249.24	$9.3 \cdot 10^{-1}$
2016	-33391.83	$2.1 \cdot 10^{-1}$	0.54	$7.9 \cdot 10^{-20}$	0	100218.11	$8.3 \cdot 10^{-1}$
					1	441999.56	$3.6 \cdot 10^{-4}$
					2	247962.69	$8.0 \cdot 10^{-2}$
					3	4262.67	$9.8 \cdot 10^{-1}$
2017	-17130.00	$4.1 \cdot 10^{-6}$	0.95	$1.1 \cdot 10^{-59}$	0	51175.24	$7.7 \cdot 10^{-2}$
					1	36959.52	$7.7 \cdot 10^{-2}$
					2	40224.69	$7.0 \cdot 10^{-2}$
					3	108342.75	$2.1 \cdot 10^{-1}$

(*Source:* own elaboration by the authors)

A development of the regression coefficients for the permanent independent variables is very similar to the previous cases. The statistical significance of the number of offers appears in the years 2012, 2013, 2014, and 2017. On the other hand, the expected price is statistically significant throughout the whole observed period.

The absolute values of the regression coefficients for the purchase type variable are very various. Even though, they are disparities among the individual types of the procured items. Namely, construction work, goods, service, and work, ordered according to their number in the regression model change their influence throughout the observed period from the negative values to the positive values mainly. This introduces an issue of increasing impact on the explained variable, that is, the final price of the procured item. The statistical significance is seen for a construction work option in the years 2010, 2014, and 2015, whilst in the years 2012 and 2017, p-value stands only slightly above a significance level. An option of goods as procured item is statistically significant in the years 2011, 2012, 2013, 2015, and 2016, whilst only a slight step above a significance level is found in the year 2017 and the years 2014 and 2015 show not wholly unsuitable result. The third option of service as procured item is very slightly above a significance level in the years 2015, 2016, and 2017, whilst little demonstration of improvement of statistical significance is seen in the year 2013. Finally, a work option is not involved in the data set for the records of the years 2010, 2012, and 2013, but it is statistically significant in the years 2009 and 2011.

3.5 The procurement procedure

The section devoted to the procurement procedure variable is the most alternating from an angle of view of the separate options of the regressors. It is caused by a variety of the approaches that can be applied as the procurement process (table 6).

Table 6. Estimated coefficients for the regression models involving the procurement procedure

year	number of offers		expected price		procurement procedure		
	coefficient	p-value	coefficient	p-value	option	coefficient	p-value
2009	-1421.52	$9.6 . 10^{-1}$	1.24	$4.8 . 10^{-43}$	0	-155224.39	$5.8 . 10^{-1}$
					3	-771832.54	$2.0 . 10^{-2}$
					4	-137293.34	$3.4 . 10^{-1}$
2010	-9143.66	$1.4 . 10^{-3}$	1.02	$2.5 . 10^{-169}$	0	6348.90	$8.8 . 10^{-1}$
					3	-38220.50	$3.4 . 10^{-1}$
					4	10882.26	$5.1 . 10^{-1}$
2011	-16336.88	$1.0 . 10^{-2}$	0.76	$1.4 . 10^{-122}$	0	25640.76	$8.4 . 10^{-1}$
					3	281616.52	$2.0 . 10^{-7}$
					4	98615.33	$2.7 . 10^{-3}$
2012	-14048.24	$1.5 . 10^{-10}$	1.00	0	0	67578.97	$1.4 . 10^{-1}$
					3	35923.22	$3.8 . 10^{-1}$
					4	22671.17	$1.6 . 10^{-2}$
2013	-11006.36	$5.6 . 10^{-3}$	0.91	$6.0 . 10^{-291}$	0	46292.10	$3.3 . 10^{-1}$
					1	-2452.68	$9.9 . 10^{-1}$
					3	171720.88	$4.7 . 10^{-3}$
					4	33333.59	$3.7 . 10^{-2}$
2014	-45426.46	$8.3 . 10^{-5}$	1.03	$2.1 . 10^{-144}$	0	226402.96	$3.0 . 10^{-1}$
					1	147903.47	$2.2 . 10^{-2}$
					2	86108.10	$8.6 . 10^{-1}$
					3	223244.86	$2.9 . 10^{-1}$
					4	53937.37	$3.5 . 10^{-1}$
2015	35662.47	$9.7 . 10^{-2}$	0.62	$1.0 . 10^{-69}$	0	32134.84	$9.6 . 10^{-1}$
					1	-154729.96	$1.9 . 10^{-1}$
					2	-28196.26	$9.8 . 10^{-1}$
					3	1346213.19	$9.5 . 10^{-4}$
					4	307619.46	$9.9 . 10^{-3}$
2016	-36645.09	$1.9 . 10^{-1}$	0.53	$2.9 . 10^{-19}$	0	227269.64	$2.9 . 10^{-1}$
					1	80097.46	$5.6 . 10^{-1}$
					4	468128.10	$7.6 . 10^{-5}$
2017	-16145.49	$1.1 . 10^{-6}$	0.95	$2.2 . 10^{-60}$	1	42316.91	$4.1 . 10^{-2}$
					4	37351.20	$5.9 . 10^{-2}$

(*Source:* own elaboration by the authors)

The outcome of the regression models with a participation of the public procurement procedure type is not comprehensive because of lack of some options in the particular years of the explored period. All the possibilities are comprised only in the years 2014 and 2015. Even, in the last year 2017, only the two options are found among the contracts.

The number of offers has a negative influence on the final price. Surprisingly, there is a positive sign in front of the regression coefficient value in the year 2015. Its presence is difficultly readable. This year looks like specially because a narrower competition case of the bears a very high positive influence on the final price. It is the highest regression coefficient among all the involved ones. Also, a public competition case has the highest regression coefficient throughout the whole observed period in this year. Statistical significance of the number of offers can be considered to be suitable as the years 2010, 2011, 2012, 2013, 2014, and 2017 keep regression coefficient significant, whilst the year 2015 has p-value only slightly higher than a five-per-cent significance level.

The expected price behaves similarly as for the previously mentioned variables. All the regression coefficients are statistically significant. On the other hand, the procurement procedure seems not to be statistically significant generally. The direct negotiated procedure is over a statistical significance level in each year involved, the negotiated procedure with publication is significant in the years 2014 and 2017, the competitive dialogue in none of the only two years involved, the narrower competition in the years 2009, 2011, 2013, 2015, and 2017 and finally, the narrower competition in the years 2011, 2012, 2013, 2015, and 2016, whilst there is only a very slight overcome of a statistical significance level in the year 2017.

3.6 Comparison of the regression models

A comparison is executed through the comparative criteria for the regression models, that is the Akaike information criterion and the Schwarz Bayesian information criterion. These tests are selected in order to confirm the interpretation value of the constructed regression models.

Table 7. Estimated coefficients for the regression models involving the procurement procedure

variable	year	Akaike information criterion	Schwarz Bayesian information criterion
Subcontractor Participation	2009	3107.04	3120.26
	2010	7905.01	7923.45
	2011	5974.80	5991.63
	2012	8576.48	8595.43
	2013	9473.19	9492.44
	2014	4118.69	4133.40
	2015	6281.97	6298.75
	2016	2204.22	2216.38
	2017	709.59	716.25
Funding	2009	2737.46	2752.52
	2010	7195.68	7217.21
	2011	5591.33	5611.12
	2012	8580.48	8603.22
	2013	9471.84	9498.79
	2014	6961.41	6989.26
	2015	11570.33	11601.72
	2016	3591.67	3608.45
	2017	1709.25	1720.27
Electronic auction	2009	3059.99	3078.51
	2010	7896.26	7918.38
	2011	5899.89	5923.46
	2012	8572.89	8595.63
	2013	9472.28	9495.38
	2014	6949.48	6973.84

variable	year	Akaike information criterion	Schwarz Bayesian information criterion
	2015	11568.04	11595.51
	2016	3596.11	3615.68
	2017	1712.39	1727.83
Purchase type	2009	3112.53	3125.75
	2010	7921.23	7939.67
	2011	5978.20	5995.03
	2012	8578.67	8597.62
	2013	9472.77	9492.02
	2014	6957.50	6974.90
	2015	11578.27	11597.89
	2016	3593.32	3607.30
	2017	1709.26	1720.28
Procurement procedure	2009	3116.04	3129.26
	2010	7920.95	7939.38
	2011	5977.28	5994.11
	2012	8578.22	8597.17
	2013	9472.37	9491.62
	2014	4158.80	4173.54
	2015	6214.45	6234.53
	2016	3249.98	3263.43
	2017	1709.27	1720.29

(*Source:* own elaboration by the authors)

As the previous table state, the values of the Akaike information criterion and the Schwarz bayesian information criterion are the lowest among all their values throughout the whole observed period for every one of the involved variables. This points to improving the ability of the regression models to model the final price of the public procurement in form of an explained variable. A quite visible worsening ability from the beginning of the explored period is ended approximately at a halfway. The model series with the subcontractor participation and the series with the procurement procedure peak in this way in the year 2013, whilst the remaining series with the funding, the electronic auction, and the purchase type in the year 2015. There is to note that this outcome is confirmed in unison for the both information criteria.

4. Discussion and conclusions

The whole analysis demonstrates a quite large heterogeneity in the data set. Its outcome underscores this issue. Because it is a quite comprehensive view of the data related to public procurement, the regression models are executed for the individual examined factors separately.

The initial analyses declare the finding that all the examined variables are statistically significant – the subcontractor participation, the European funds funding, the electronic auction, the purchase type, and the procurement procedure.

Due to the characteristics of the data, the individual years are separately investigated to allow to determine whose years the regression coefficients can be considered statistically significant within the explored period in. Regarding the tendency of a development of the regression coefficient, the models of the recent years can be considered to be statistically significant. This is also the reason to compare them through the information criteria. The outcome of this comparison reveals a gradual improvement of the regression models throughout the whole observed period as their values decrease towards the final explored year 2017.

Many national and international studies declare an issue of involving a small number of procurers in the public procurement process and of submission of a small number of bids, which results in a low level of competitiveness in public procurement. Similarly, the purchase type and the procurement procedure affect the final price. The outcome of the analysis point to the impact of the electronic auction on a decrease in the final price. This is also consistent with the results of Kvasnička et al. (2015), who declare the impact of the various procurement procedures on the final price. According to their findings, the inefficiency of the public procurement due to the usage of the different procedures is considerable.

As for the last observed year 2017, a mean value of the regression coefficient for the number of offers is at a level of -17499.07 for all the involved parameters. The most extreme values for the expected price are found in the years 2016 with the procurement procedure variable involved in the regression model reaching a minimum value of 0.53 and in the year 2009 with the same variable involved peaking a maximum value of 1.24. Regardless the categorical variable, the expected price is a significant component of the final price and it keeps a very high share of 95 % that is reflected into the final price in the year 2017. In the previous years 2015 and 2016, this share is considerably lower. An increase of the number of offers causes a decrease in the final price. This influence is confirmed by all the models regardless the additional variable included in the modelling process.

In an area of public procurement, it is a common practice that a specific organisational unit is entrusted with the administration of the public procurement contracts, which provides administrative services for all these contracts or the contracts with a contracted price above a certain level. However, this can be carried out also in a way of the consolidation of the potential purchases of the selected commodities for the entire institution.

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Conceptualization, Beata Gavurova; Data curation, Viliam Kovac; Formal analysis, Beata Gavurova and David Tucek; Methodology, David Tucek; Software, Viliam Kovac; Visualization, Viliam Kovac; Writing – original draft, Beata Gavurova and David Tucek.

Conflict of Interest Statement
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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