“The efficiency of electronic public procurement system in Ukraine”

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THE EFFICIENCY OF ELECTRONIC PUBLIC PROCUREMENT SYSTEM IN UKRAINE

Abstract

Public procurement has been the subject of research for a long time in the work of scientists from both the economically developed countries and those undergoing the transformation of public finances. Their research comes from different points of view, namely from the essence of the definition, the process of their conduct, the problems of the legislative framework to their effective implementation. In addition, the issue of electronic public procurement, which can greatly enhance the transparency of this process and reduce the level of corruption inherent in this area in all countries without any exception, is becoming increasingly relevant in recent times.

Based on the conducted analysis, the article proposes the definition of the term of public procurement, defines the principles of public procurement as a controlled subject in the electronic environment of their conduct, and systematizes the basic indicators characterizing the effectiveness of public procurement. Based on the Granger causality method, an analysis of efficiency was performed and the basic indicators determining the level of savings in the public procurement system were determined. It is established that the use of Granger causality in changing the amount of savings in the system of public procurement gives only a quantitative characteristic. For a more complete picture quantitative analysis is supplemented with qualitative parameters.

Keywords public procurement, efficiency, e-procurement system, public finance

JEL Classification D60, E60, H41, H83

INTRODUCTION

In Ukraine, increasing the efficient use and spending of public funds and financial resources is an important issue for modern economic development, in order to ensure equilibrium and stable development of the national economy. The state acts as one of the main participants in the economic process as a consumer of goods, works and services. Public procurement is an important element in the system of factors of the world trade development and improvement.

This issue is extremely important for countries with a transitory economy, such as Ukraine, and for those with a high level of economic development. High interest in the problems of public procurement in general and their modern form (electronic public procurement) is primarily due to the fact they are aimed at satisfying the needs of society through public finances. Such operations are often accompanied by a certain risk of corruption by civil servants.

1. LITERATURE REVIEW

Public procurement aimed at satisfying the needs of society through public finances is accompanied by a risk of corruption by public officials. This is confirmed by a large number of publications devoted to this issue, with

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public procurement research taking place from different perspectives and in different countries, both in highly developed countries and in countries that are in the beginning of the study of public finance reform in general and public procurement in particular. From the point of view of their implementation and the transparency of its stages, it is worth mentioning the work by Naidoo, Naidoo, and Ambe (2018), which analyzes the level of legislative provision of the principles of Open Contracting in the public procurement sector and notes the need to improve national legislation in this area. Amann and Essig (2015), Bolton (2016) analyze public procurement in terms of their use as a driver of innovation in the country. Similar studies from Germany have been done by Czarnitzki, Hünermund, and Moshgbar (2018), Sitar (2011), Saarela, Niinikoski, Muhos, and Isoherranen (2018). These authors investigate public procurement in the context of the expediency of firms participating in providing the relevant services. They also analyze each stage of electronic public procurement, their benefits and disadvantages. A significant amount of research is devoted to the evaluation of the effectiveness of the whole system of public procurement.

Fourie (2015) analyzes the problem of public procurement from the perspective of ethical behavior and the problems of corruption formation in this area. This issue is also being explored by UN experts, in particular in the Supplement to the 2011 Annual Statistical Report on United Nations Procurement (2012), where a number of publications focus on public procurement issues from different perspectives: transparency, fight against corruption, the role of technology in this process, etc.

Electronic purchases are the most attractive area for activities in the market of public procurement of developed countries, which is caused by the prevalence of using an electronic commerce.

Public procurement is a significant link in the relationship between government institutions and business entities. Using the electronic procurement system allows for controlling the stages of bidding, preventing the misuse of budget funds, and ensuring competition in the public procurement market (Martin-Ortega, 2018). The peculiarity of this system is the availability of monitoring the market participants' performance, which enables the efficient use of funds by customers and the implementation of proposals from the party to the tender.

For Ukraine, this issue is extremely relevant, as the level of corruption in the country is extremely high, which significantly reduces business confidence in cooperation with the state, especially considering the transformational processes taking place in public finances. Dmytryshyn, Zhovnovach, Levchenko, Malakhovskyi, and Gonchar (2018) emphasize that the public procurement reform is part of the reform of the public finance sector, and the sustainability of economic growth depends on the public procurement effectiveness. In addition, they analyzed the effectiveness of electronic procurement using the traditional method for financial analysis and concluded that the negative consequences of the introduction of the ProZorro system were made. According to the authors of the current article, this is due to the fact that the analysis period covered the stage when the ProZorro system just started to work.

Krytenko and Danshyna (2015) associate the control over the use of public funds in the implementation of public procurement with the public financial control. The authors believe it can help identify the quality of using state funds, deficiencies and offenses in public procurement, and outline ways to improve their use efficiency.

In order to effectively monitor the efficiency of using public resources in the field of public procurement, it is necessary to determine the essence of the concept of public procurement. However, in Ukraine in 2016, there were significant changes in the system of public procurement. On February 17, 2016, the President of Ukraine signed the new Law of Ukraine "On Public Procurement", which came into force on August 1, 2016 and became mandatory for all public sector customers. The main change was the transfer to the electronic platform of the entire system of public procurement, which was carried out exclusively in electronic form.

The Law of Ukraine "On Public Procurement" (2016) defines public procurement as a procurement of goods, works and services at the request of the state to meet public needs.

As for the international practice of the English-speaking countries, the term "procurement" is

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used to identify the procurement mechanism. Procurement is a set of methods that allow the client to meet the needs of a bidding campaign with the help of competitive bidding as much as possible (Tkachenko, 2018). A deep study on the nature of public procurement from different perspectives was carried out by Lloyd and McCue (2004), Pinks (2009), Smotritskaya (2009), Yuditsky (2010), Olefir (2012), Flynn and Davis (2014), Nijboer, Senden, and Telgen (2017), Rolfstam (2015).

2. AIMS

Evaluating the effectiveness of electronic public procurement system in Ukraine, given that the period of introduction of the system of electronic public procurement is insignificant, but since its introduction considerable savings of the state's financial resources were expected.

In this study, public procurement can be defined as a system of ordering goods (works, services) on a competitive basis, which provides for the implementation of certain conditions among bidders in order to ensure the efficiency and maximum savings of cash for their customer – the state.

Public procurement, according to the Law "On Public Procurement", is carried out based on the following principles: fair competition among participants; maximum economy and efficiency; openness and transparency at all stages of procurement; non-discrimination of participants; objective and unbiased evaluation of tender offers; preventing corruption and abuse.

In international practice, procurement is subject to the principle that budget funds cannot go beyond the country as a result of agreements with foreign companies. Rejection of this principle is possible only in the foreseeable cases, which are clearly regulated by the legal systems of most countries of the world.

In Ukraine, the open bidding procedure is based on the principle of openness and equal (non-discriminatory) access to the procurement of all participants, which implies the mandatory holding of an electronic auction in the electronic procurement system. Electronic public procurement is carried out in compliance with a number of principles (see Table 1).

Table 1. Principles of public procurement as a controlled subject in an electronic environment

Principle	Subject of control
Equal turn	Procurement documentation must contain the following details: • quantitative characteristics of the procurement subject; • any restrictions on the parameters of the subject of the contract, which follow from the specifications; • information that will be available to tenderers during an electronic auction; • information on the process of electronic auction; • the conditions under which the tenderers will be able to offer a new price; • information on the electronic equipment used, the mechanisms and specifications for its connection
Prohibition of discrimination	All business entities that submitted valid applications must be simultaneously invited to participate in an electronic auction with an indication of the date and time using the electronic tools in accordance with the instructions set out in the invitation
Identification	The invitation to take part in the electronic auction must contain the result of the full evaluation of each bidder according to his application, but does not contain data on the applications of other tenderers
Objectivity	The electronic auction takes place in successive stages. The auction should not start earlier than two business days after the date on which the invitation was sent
Informative value	At each stage of an electronic auction, the customer must immediately provide all tenderers with information that is sufficient to enable the participants to find out their relative rating at any time. The customer can declare the number of participants at each stage of the auction
Transparency	The invitation should indicate the mathematical formula to be used in the electronic auction to determine the automatic rating

Ukraine has introduced a system of electronic procurement and an electronic system of appeal, which aims at increasing competition in public procurement field and promoting the procurement transparency. Changing the format of tender procurement involves the exchange of documents and information on the Internet, the disclosure of all offers of participants after the completion of the auction in open bidding. This reform was held under the requirements of the EU project "Harmonization of public procurement in Ukraine with EU standards", and as a result was a system of cooperation between business, government and the public. This change has increased the efficiency of the procurement system for all parties, and

has created a model of electronic procurement with the participation of the customer (the state) and the supplier.

Changing the legislative framework has led to significant changes in the classification of public procurement, the direct submission of documentation, bidding and lodging a complaint with the appeal body. Thus, there was a need to characterize the field of public procurement, and to analyze the transparency of the process after the reform of public procurement.

Law "On Public Procurement" moved the bidding for the authorized electronic platforms to the Authorized Agency information and telecommunication system, which is part of the e-procurement system and ensure registration of person automatic placement, receive and impart information and documents on the procurement, use of services with an automatic exchange of information accessed through the Internet. Web portal was authorized by Order of the Ministry of Economic Development No. 473 dated March 18, 2016, as an organ that defined information and telecommunications system ProZorro on the Internet: www.prozorro.gov.ua. Order No. 1398 as from August 23, 2016 determined that the state company ProZorro is responsible for the portal operation. Thus, the procurement takes place in the electronic system ProZorro, thus abolishing the holding of paper tenders.

Public procurement in accordance with clause 1 of Article 2 of the Law of Ukraine "On Public Procurement" in the ProZorro system can be divided into two groups:

- auxiliary, that is, those purchases, the expected value of which is less than UAH 200 thousand for goods and services and UAH 1.5 million for works, and for customers who carry out activities in certain spheres of management less than UAH 1 million for goods and services and UAH 5 mln for jobs;

- the thresholds are considered, respectively, if the expected value of the purchase equals or exceeds UAH 200 thousand and UAH 1.5 mln for works, and for customers who carry out activities in certain spheres of economy equals or exceeds UAH 1 mln for goods and services and UAH 5 mln for works (Zvonova, 2012).

At the same time, over-threshold purchases are divided into the following types:

- open auction (this is the main type in the field of procurement);

- competitive dialog; and

- negotiation procedure.

The main features of public procurement procedures are given in Gorbatyuk (2016):

- in the announcement about the procurement procedure, information about the size of the minimum step of the price reduction during the electronic auction in percentages or units and the mathematical formula that will be used in conducting an electronic auction to determine the indicators of other evaluation criteria is necessarily indicated;

- the date and time of the tender opening, and the date and time of the electronic auction are determined by the electronic procurement system automatically on the day of the announcement by the customer of the announcement of the conduct of the open tender procedure on the website of the Authorized Agency;

- the tender documentation must contain, in particular:

1) the draft contract of purchase with obligatory indication of the order of changes in its terms; and

2) description of the method of valuation by the criterion «price» should contain information on the inclusion of value added tax;

- changes made by the customer to the tender documentation, placed and displayed in the electronic procurement system in the form of a new edition of the tender documentation, in addition to the original version of the tender documentation.

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In 2017 the "competitive dialog" procedure was technically implemented in the electronic procurement system. This procedure allows customers to purchase, in particular, legal, advisory, software development, etc., in cases where there are difficulties in defining requirements for such items of purchase and the need to negotiate with participants in order to determine the required technical characteristics.

According to available data in the electronic procurement system in the reporting year, the proportion of unpublished purchases is 11.9 %, canceled is 2.8 %. The total expected value of such purchases amounted to over UAH 200 billion.

The main reasons for the cancellation of a bid or its recognition as not occurring in the reporting year, are, according to most customers, the impossibility of eliminating violations, the lack of further needs, the submission of less than two tender offers and reduction of expenses, as well as the presence of errors of any nature either systemic or then in the documentation. Savings in procurement, which successfully completed in the reported year, account for 8.19 %, which in absolute terms makes UAH 27.09 billion.

In 2017, the biggest savings were made in purchasing construction and repairs, oil products, fuel, electricity and other energy sources, as well as medical equipment, pharmaceuticals and the purchase of personal hygiene products. 30,304 entities were recognized the winners in the procurement procedures conducted during the reporting period. The most active participants who won the largest number of lots were BADM-B Ltd. with 3,664 lots, Ukrainian paper – 2,810, Kyivoblenergo – 2,653, Alliance Evolution LLC – 2,408, and Epicenter-K won 1,669 lots.

According to the results of procurement procedures, 99.84% of contracts were concluded with domestic business entities, and 0.16% with foreign suppliers.

In 2017, according to the analysis of data collected in the electronic procurement system, goods were the most frequently purchased. Thus, the share of goods was 64.16% by number and 51.91% at their expected value in the total amount of all purchases. The share of work on the number amounted to 13.85%, while the expected cost of works is almost 34% of all purchases in the electronic system.

In the year under review, the number of successfully completed procedures increased by 34%, and the amount of these procedures by 64% compared to the last year. The possible explanation for this is the increase in funding for customer needs. In 2017, among completed procurement procedures, customers often used open bidding, which is 55% in relative terms.

About 53 thousand or 30.3% of purchases did not take place. Their expected value was UAH 121.9 billion. At the same time, 6.8% or almost 12 thousand procedures were canceled with the total expected value of UAH 89.3 billion. These figures indicate an inadequate level of professionalism and awareness of customers regarding the norms of the current legislation, the lack of interest of the business in bidding. The most money saved in the monetary equivalent is the open tender procedure with the publication in English UAH 12.4 billion, followed by open tenders UAH 7.9 billion, negotiation procedure (for defense purposes) UAH 499 million.

An important part in the electronic procurement system is taken by the secondary procurement. Their surplus amount was 767,072 lots (85%) out of 903,005 successfully completed purchases: 21% of pre-purchase procurement, and 64% of reports on contracts entered into in the total amount of all auctions in the electronic procurement system. In the reporting year, the number of reports on concluded contracts increased by almost 4.5 times compared with 2016: from 128,643 to 576,083 reports.

A significant increase in the number of sub-procurement is due to the fact that the norm in the Law on compulsory reporting appeared in 2016 and the largest number of customers began to perform it from August 1. At the same time, in the reporting year, other customers and state, communal, state-owned enterprises, their subsidiaries, economic partnerships or associations that were not customers in the understanding of the Law came into the electronic procurement

system (in 2017, the number increased by 6,880 customers in tentative purchases compared to 2016).

The vast majority of reports on concluded contracts consist of purchases of construction works, repairs and construction materials, utilities, in particular, natural gas and natural gas transportation services through main and distribution pipelines, electric energy and electricity supply services, steam and hot water supply services water (heat supply services), water supply and sewage services, as well as postal services, as well as purchases of food, beverages, tobacco and related products. Their total number was 35% of the total number of reports placed in the electronic system, and the total cost amount to 66%.

The Antimonopoly Committee of Ukraine is the body for appeals against complaints about violations of legislation in the field of public procurement. The Antimonopoly Committee of Ukraine found violations both on the part of customers, and on the part of the bidders, including typical violations, inherent in the majority of customers and participants.

The Antimonopoly Committee identifies the following most common mistakes by participants while preparing proposals:

- an improperly executed bank guarantees: the absence of mandatory guarantee requirements specified in the documentation, reference in the unconditional guarantee to the agreement, which establishes the terms of the guarantee (without the provision of the contract itself);
- failure to provide annexes to contracts (similar agreements, contracts for the confirmation of material and technical base, etc.), in the event that such applications are defined by the agreements, as integral parts;
- not contesting the terms of the documentation regarding the impossibility of fulfilling certain conditions of the documentation;
- reporting (if required by the customer) not for the reporting period (calendar year), but for the quarter/six months (interim reporting).
- The most common violations by the customers during the bidding process include:
- discriminatory approach in terms of rejecting tender bids of some participants and admitting to an auction/determination by the winner of the participants who also do not meet the requirements of the documentation (more frequent instances of a selective approach in the presence of the same violations of the participants);
- cancellation of the bidding even if the Board obliges to cancel only the decision on determining the winner (with the right to pass to the assessment of the next participant);
- the establishment of discriminatory terms of the documentation – establishes technical (or qualification) requirements for participants, which can be performed by a limited circle of business entities.

Generalizing performance indicators of the Permanent Administrative Board for 2017 are complaints filed for a total of UAH 90.58 billion. It is obliged to eliminate the violation for the total amount of UAH 37.38 billion.

3. METHODOLOGY

The above data does not give a general idea of the effectiveness of public procurement, so we will conduct a study of savings in public procurement, which will analyze the effectiveness of the electronic system of public procurement and identify the reasons for its improvement. Table 2 presents the key indicators that can be used for efficiency analysis. The indicators are divided into two groups – the performance indicators of government procurement by customers, the activity of the procurement participants, and the probability of conducting procedures.

The most widely used concept of causality in econometrics is Granger causality (Supplement to the 2011 Annual Statistical Report on United Nations Procurement, 2012). The basis for determining the causality is a well-known axiom that the future cannot affect the past.

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Table 2. Key indicators that characterize the efficiency of public procurement

No.	Indicator	Method of calculating the indicator
Indicators of efficiency of public procurement by customers		
1	Saving	Expected cost of purchase – Cost of a victorious offer (minimum bid)
2	Average percentage decrease in price	Savings / Expected cost of purchase Ч 100
Indicators of activity of participants in public procurement		
3	Average number of price offers from one participant	Number of offers / Number of participants
4	Average bid amount per participant	Final price of offers / Number of participants
Probability of procedures		
5	Probabilistic Indicators of Public Procurement Risk Assessment	Number of canceled procedures / Total number of procedures
6	The probability that the procurement procedure will not take place	Number of failed procedures / Total number of procedures
7	Probability of appeal of procurement procedure	Number of satisfied complaints / Total number of procedures
8	Probability of disqualification of the participant	The number of quotes of disqualified participants / total number of quotations

Granger considered this axiom in the informational aspect: in order to determine whether the variable x is the cause of the variable y, it is necessary to find out what part of the variance of the current value of the variable y can be explained by the past values of the variable itself and whether the addition of past values of the variable x can improve this explanation. The variable x is called the cause of y if x contributes to the forecast in terms of decreasing dispersion.

The following form of the model is as follows:

$$x_t = \sum_{j=1}^{p} a_j x_{t-j} + \sum_{j=1}^{p} b_j y_{t-j} + \varepsilon_t, \quad (1)$$

$$y_t = \sum_{j=1}^{p} c_j x_{t-j} + \sum_{j=1}^{p} d_j y_{t-j} + \xi_t. \quad (2)$$

The absence of causation from x to y means that for $C_j = 1, .., p$, that is, the past values of x do not affect y. The absence of causation from y to x means that for $b_j = 0$ and $j = 1, .., p$.

Thus, if x is the cause of y, then the lag coefficients for x in equation (2) must be significant. If this condition is satisfied only in one direction, then it is said that x is causal to Granger for y or that there is one-way causality from x to y. On the other hand, if y is the reason of x, then the lag coefficients for y in equation (1) must be significant. If the lag coefficients are significant in both cases, then there is a two-way causality or two-way feedback. If none of the sets of lag coefficients were statistically significant, then say that x and y are independent.

When the process is stationary, then the hypothesis of causation can be checked using F-statistics. The null hypothesis is that one variable is not the cause of the Granger for another variable. The length of the lag should be selected based on the most distant lag that can still help in forecasting.

In order to detect Granger causality in the current study, one can indicate the influence of a set of factors on the amount of savings in the public procurement system. The main prerequisite for the study of the causality of Granger is the steady state of the studied series, therefore, it is necessary to check its implementation.

For stationary analysis, the Augmented Dickey-Fuller test and the Phillips-Perron test are used (Bolton, 2016).

In the Dickey-Fuller test, the zero (alternative) hypothesis is the fact that the time series is non-stationary (stationary) and is described by one of three models:

$$\Delta x_t = \varphi x_{t-1} + \alpha + \beta t + \sum_{j=1}^{p-1} \theta_j \Delta x_{t-j} + \varepsilon_t, \quad t = p+1, \ldots T, \quad (3)$$

$$\Delta x_t = \varphi x_{t-1} + \alpha + \sum_{j=1}^{p-1} \theta_j \Delta x_{t-j} + \varepsilon_t, \quad t = p+1, \ldots T, \quad (4)$$

$$\Delta x_t = \varphi x_{t-1} + \sum_{j=1}^{p-1} \theta_j \Delta x_{t-j} + \varepsilon_t, \quad t = p+1, \ldots T, \quad (5)$$

ε_t means normally distributed random variables with zero mathematical expectations; φ, α, and β are estimated parameters.

The validity of the basic hypothesis is verified using statistics for the first regression model, which includes the free term and the linear trend.

The validity of the basic hypothesis is verified using statistics for the second regression model, which includes the free term. The least squares method evaluates the parameters of the model φ, α, βand calculates the t-statistic t_φ for testing the zero hypothesis φ = 0.

The obtained value is compared with the critical level of the $t_{crit.}$. A hypothesis about the non-stationary time series is rejected if $t_\varphi < t_{crit.}$.

In the Phillips-Perron test (PP-test), the verification of the null hypothesis about the nonstationary of the time series x_t reduces to the hypothesis test φ = 0 based on the statistical model:

$$\Delta x_t = \phi x_{t-1} + \alpha + \beta t + u_t, t = 2, \ldots T, \qquad (6)$$

α, β are model parameters that can be 0;

$E|u_t|^\delta \le C < \infty$, for δ > 2 – mathematical expectation of a random variable u_t.

Unlike the Dickey-Fuller test, random components u_t can be autocorrelated, have different dispersions and do not necessarily correspond to normal distribution.

The PP test is based on t-statistics, corrected for possible autocorrelation and heteroscedasticity of the time series u_t.

4. RESULTS

Applying these tests to the studied time series made it possible to draw conclusions about their stationary (Table 3).

Thus, based on the results of the Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, stationary I (0) is an index of inflation, and the rest of the factors are non-stationary. Since the main condition of stationary is not fulfilled, it is necessary to make the conversion of these indicators to the stationary type.

Thus, we make the transformation from the levels of the series to their first differences and check them for stationarity (Czarnitzki, Hünermund, & Moshgbar, 2018; Lloyd & McCue, 2004).

The calculation of the first differences of the time series is carried out as follows:

$$\Delta x_t = x_t - x_{t-1}, t = 2, \ldots T. \qquad (7)$$

The received time series of the first differences will be checked for stationary using the above-mentioned tests.

On the basis of the results obtained, one can conclude that all of the time series were stationary in the first differences, so for the Granger test on causality the first differences of all-time series will be used, except for the price index, which is stationary, so it can be represented by help levels.

The Granger test will be done using the Eviews software. This tool makes it possible to study causality for different values of the lag. The first three quarters will be tested. The chosen number of lags is explained by the fact that the impact of indicators on the amount of savings in public procurement (at 5% level of significance) continues to disappear.

As already noted, the zero hypothesis of this test is the assertion that *x* is not a causal in Granger for *y* (x → y), and that *y* is not Granger causal for *x* (y → x). To reject a zero hypothesis at a 5% level of significance, it is necessary that the value of the probability *p* for the corresponding pair of indicators is within 0.05. Table 5 presents the causal analysis results.

As Table 5 shows, the following indicators influence population size, GDP, number of contracts, the number of suppliers, the number of failed procedures, and the revenue of the state budget, as measured by the savings in public procurements.

Using Granger causality of changing the amount of savings in the public procurement system

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Table 3. Results of stationary research on the volume of savings in public procurement and factors that may affect them

Indicator	*ADF* *H0*: I(1)			*PP* *H0*: I(1)			Conclusion
	N	*C*	*T, C*	*N*	*C*	*T, C*	
Savings, UAH thousand	–6.419	–6.421	–4.564	–4.437	–10.015	–3.541	I(1)
1 % level	–5.119	–7.006	–3.007	–4.583	–5.835	–2.886	
5 % level	–3.519	–4.773	–2.021	–3.321	–4.246	–1.996	
10 % level	–2.898	–3.878	–1.597	–2.801	–3.590	–1.599	
Population of Ukraine, people	–2.588	–2.705	–0.581	–2.573	–6.242	–0.344	I(1)
1% level	–4.583	–6.292	–2.886	–4.583	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.702	–1.599	–2.801	–3.590	–1.599	
GDP at actual prices, UAH mln	–4.453	–3.801	–3.460	–3.846	–3.272	–2.890	I(1)
1 % level	–4.803	–6.292	–2.937	–4.582	–5.835	–2.886	
5 % level	–3.403	–4.450	–2.006	–3.321	–4.247	–1.996	
10 % level	–2.842	–3.701	–1.598	–2.801	–3.591	–1.599	
Number of contracts, pieces	–2.195	–4.405	–1.797	–2.303	–1.437	–1.809	I(1)
1% level	–4.582	–6.292	–2.886	–4.583	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.701	–1.599	–2.801	–3.590	–1.599	
The amount of contracts, UAH bln	–3.011	–3.671	–2.926	–3.058	–6.251	–2.926	I(1)
1% level	–4.583	–5.835	–2.886	–4.583	–5.835	–2.886	
5% level	–3.321	–4.247	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.901	–1.599	–2.801	–3.590	–1.599	
Number of participants, units	–1.477	–4.389	–0.606	–1.325	–0.511	–0.604	I(1)
1% level	–4.583	–6.292	–2.886	–4.583	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.701	–1.599	–2.801	–3.590	–1.599	
Number of suppliers, units	2.756	0.884	4.149	–4.026	–5.931	–3.506	I(1)
1% level	–4.803	–6.292	–2.937	–4.583	–5.835	–2.886	
5% level	–3.403	–4.450	–2.006	–3.321	–4.247	–1.996	
10% level	–2.842	–3.701	–1.598	–2.801	–3.590	–1.599	
Number of failed procedures, pieces	–2.735	–5.659	–1.967	–4.053	–3.427	–1.967	I(1)
1% level	–4.803	–6.292	–2.886	–4.803	–5.835	–2.886	
5% level	–3.403	–4.450	–1.996	–3.403	–4.247	–1.996	
10% level	–2.842	–3.701	–1.599	–2.842	–3.590	–1.599	
Inflation index, %	–2.474	–3.354	–2.471	–2.474	–3.352	–2.471	I(0)
1% level	–4.583	–5.835	–2.886	–4.583	–5.835	–2.886	
5% level	–3.321	–4.247	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.901	–1.599	–2.801	–3.590	–1.599	
Revenues of the state budget, millions UAH	–3.778	–3.526	–4.057	–6.334	–6.388	–6.487	I(1)
1% level	–4.583	–5.835	–2.886	–4.583	–5.835	–2.886	
5% level	–3.321	–4.247	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.590	–1.599	–2.801	–3.590	–1.599	

Table 4. Results of the stationary study of the first differences in the indicators of savings in the public procurement system and the factors that may affect them

Indicator	*ADF* *H0*: I(1)			*PP* *H0*: I(1)			Conclusion
	N	*C*	*T, C*	*N*	*C*	*T, C*	
Savings, UAH thousand	–4.437	–4.790	–3.524	–4.437	–10.015	–3.541	I(0)
1% level	–4.582	–5.522	–2.886	–4.582	–5.835	–2.886	
5% level	–3.321	–4.108	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.515	–1.599	–2.801	–3.590	–1.599	
Population of Ukraine, people	–2.589	–2.705	–0.581	–2.573	–6.242	–0.344	I(0)
1% level	–4.583	–6.292	–2.886	–4.582	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.702	–1.599	–2.801	–3.590	–1.599	
GDP at actual prices, UAH mln	–4.453	–3.801	–3.460	–3.846	–3.272	–2.890	I(0)
1% level	–4.582	–6.292	–2.886	–4.582	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.702	–1.599	–2.801	–3.590	–1.599	
Number of contracts, pieces	–2.195	–4.405	–1.797	–2.303	–1.437	–1.809	I(0)
1% level	–4.583	–6.292	–2.886	–4.582	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.702	–1.599	–2.801	–3.590	–1.599	
The amount of contracts, UAH bln	–3.011	–3.671	–2.926	–3.058	–6.251	–2.926	I(0)
1% level	–4.583	–5.835	–2.886	–4.582	–5.835	–2.886	
5% level	–3.321	–4.247	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.590	–1.599	–2.801	–3.590	–1.599	
Number of participants, units	–1.477	–4.389	–0.606	–1.325	–0.511	–0.604	I(0)
1% level	–4.583	–6.292	–2.886	–4.582	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.702	–1.599	–2.801	–3.590	–1.599	
Number of suppliers, units	2.756	0.884	4.149	–4.026	–5.931	–3.506	I(0)
1% level	–4.582	–6.292	–2.937	–4.582	–5.835	–2.886	
5% level	–3.321	–4.450	–2.006	–3.321	–4.247	–1.996	
10% level	–2.801	–3.702	–1.598	–2.801	–3.590	–1.599	
Number of failed procedures, pieces	–2.735	–5.659	–1.967	–4.053	–3.427	–1.967	I(0)
1% level	–4.582	–6.292	–2.886	–4.582	–5.835	–2.886	
5% level	–3.321	–4.450	–1.996	–3.321	–4.247	–1.996	
10% level	–2.801	–3.702	–1.599	–2.801	–3.590	–1.599	
Revenues of the state budget, millions UAH	–3.778	–3.526	–4.057	–6.334	–6.685	–7.855	I(0)
1% level	–4.583	–5.835	–2.886	–4.582	–6.292	–2.937	
5% level	–3.321	–4.247	–1.996	–3.321	–4.450	–2.006	
10% level	–2.801	–3.590	–1.599	–2.801	–3.702	–1.598	

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Table 5. Granger causality study for the indicator of saving public procurement (in the first differences)

Indicator	Lag		
	1	2	3
Δ (SAVING)		→	→
CPI	–	–	–
Δ (POPULATION)	–	–	→
Δ (GDP)	–	–	→
Δ (CONTRACTS)	–	→	→
Δ (AMOUNT_OF_CONTRACTS)	–	–	–
Δ (NUMBER_OF_PARTICIPANTS)	–	→	→
Δ (NUMBER_OF_SUPPLIERS)	→	→	→
Δ (NOT_TAKE_PLACE)	–	–	→
Δ (INCOME)	–	←	→

characterizes only part of the result, since the indicators used characterize the quantitative analysis. Using qualitative indicators can lead to ambiguous conclusions. Indicators characterizing the overall economic efficiency of the use of the electronic system of public procurement may be subjective, since it provides a non-cost estimate of the use of the system, and an indicator of the qualitative characteristics of the offer.

The conducted research indicates the need to determine the economic efficiency of the use of funds in the public procurement system through a complete approach, and taking into account both quantitative and qualitative component.

CONCLUSION

According to the results of the study, the following conclusions can be drawn.

First, the problems of public procurement, their legislative framework and implementation mechanisms are the subject of research in countries where the public finance and public procurement sector is undergoing transformation.

Secondly, in the world practice as well as in the domestic market, electronic purchases are becoming increasingly popular, which can significantly increase the transparency of public procurement procedures and is one way to reduce the level of corruption in this area, which is important for all countries without any exception.

Thirdly, the use of the traditional coefficient method of financial analysis does not provide a complete picture of the effective implementation of public procurement procedures.

Fourth, using the method for calculating the effectiveness of electronic public procurement for Granger causality characterizes only part of the result, since the indicators used are elements of quantitative analysis.

Last, in order to have a more complete picture of the effective implementation of electronic public procurement, it is necessary to carry out a comprehensive assessment of both quantitative and qualitative parameters.

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