Proceedings of Voronezh State University

Series: Economics and Management

Economic Theory

Analysing the efficiency of public procurement procedures using game-theory models

A. M. Zhemkova[1✉]**, L. M. Nikitina**[2]**, T. N. Gogoleva**[3]

[1] Institute of Applied Economic Research, Russian Presidential Academy of National Economy and Public Administration, 82 Vernadsky ave., bld. 1, 119571, Moscow, Russian Federation;
Gaidar Institute for Economic Policy, 3-5 Gazetny lane, bld. 1, 125993, Moscow, Russian Federation

[2, 3] Voronezh State University, 1 University sq., 394018, Voronezh, Russian Federation

Subject. Public procurement plays an important role in providing public services and ensuring that the target programmes of government structures are implemented. Therefore, it is crucial to improve the efficiency of procurement procedures. The efficiency of public procurement is largely determined by the conditions and format of the procurement procedure. So, it is of particular interest to identify the factors influencing the customer's choice of the optimal procedure for the procurement of different types of goods, as well as to assess the impact of these factors on the effectiveness of existing procedures.
Objectives. The aim of the study was to develop a model for selecting procurement procedures for different types of goods and to assess the effectiveness of current public procurement procedures.
Methodology. In the study, we used the findings of auction theory, qualitative and quantitative analysis techniques to identify public procurement, determine its value to participants, and assess its effectiveness. The following goods were selected for empirical assessment: paper, medicines, automotive components, and construction services. The empirical basis of the study was the data obtained from the Unified Information System (UIS) in Procurement website.
Results. We developed and estimated a model for choosing a supplier selection procedure (for empirical assessment, the probability of choosing a certain procedure was determined by the number of uses of the procedures among completed procurement procedures). We also designed and estimated a model of price effectiveness for public procurement procedures that are actually in use (price effectiveness in this study means the final price of the contract, as well as the reduction of the final price against the initial maximum price).
Conclusions. Based on the analysis, we concluded that it is necessary to introduce negotiations as an intermediate procedure between the auction and procurement from a single supplier. Such a procedure is used in other countries. The auction procedure fails to provide the best quality goods, especially in the case of complex goods or services with a high level of uncertainty. For simple goods, an auction is the most favoured procedure under the conditions of high competition and a preference for quality. It allows selecting the most experienced and financially reliable supplier.

Introduction

Trillions of roubles are spent annually on public procurement in Russia: for example, in 2021, according to the Unified Information System in Procurement, the total amount of public sector procurement was about 9.83 trillion roubles, almost 7.5 per cent of GDP. In addition to large budget expenditures, such figures imply the complexity of planning and quality control of public procurement, as well as wide opportunities for manipulation. The increasing relevance of this topic is due to the need to analyse the properties of the public procurement market in order to identify the most effective practices and, in general, to improve the efficiency of public procurement procedures.

One of the key ideas of the study is to use the fundamental provisions and conclusions of auction theory as a theoretical and methodological basis. If we consider the auction theory, the main parameters affecting the efficiency of procurement are the terms and format of the procurement procedure. Thus, by choosing the right procedure for a particular type of goods, it is possible to significantly improve the efficiency of public procurement.

The classical modelling of bidder behaviour under different auction formats dates back to the works by Vickrey (1961), Milgrom & Weber (1982), and Wilson (1977). The conventional approach distinguishes auctions according to the way how the participants assess the value of the auction item and how the bids are made. Thus, an auction may include private value goods, which are valued according to the bidders' own preferences, and common value goods, whose true value is the same for all bidders, but becomes known after the goods have been purchased. In addition, there are also a number of intermediate categories of auction items. For example, based on the consistency of the bidders' valuations, dependent private value goods (Li et al. (2002); De Castro (2010); De Castro & Paarsch (2010)) and independent private value goods (Paarsch (1994, 1997); Donald & Paarsch (1996); Li et al. (2000); Guerre et al. (2000)) can be distinguished. For each type of goods, different bidding strategies are used. While the private independent value model is closest to classical competitive behaviour (more players result in higher prices), the common value model (Hong & Shum, 2004; Hortaçsu & McAdams, 2010) requires bidders to be more cautious due to the possibility of a winner's curse. Therefore, for different groups of goods, the most optimal auction format and, accordingly, the revenue obtained by the seller are different.

In terms of public procurement, which (at least in its competitive form) is a reverse auction, estimates of the value of goods take the form of private costs of bidding companies to execute the order, and they also consist of a private and a common component. The private component provides information regarding the efficiency of a particular company in performing the contract, it is company-specific. Each supplier knows how many resources it will need to complete the order (human, tangible or intangible, managerial, or other resources) and does not know the costs of its competitors. The common component describes costs that are fully disclosed only after signing the contract and are difficult to estimate during the bidding stage. Thus, a supplier who wins a tender may face the winner's curse, if it fails to consider the fact that its cost estimate may be lower than the true cost required by the customer. In both cases, however, signals about suppliers' expected costs can also be either dependent or independent.

It is worth noting that in reality there are few goods with purely private or common supply costs. Most often costs combine the two components, and one of them prevails.

The empirical literature on public procurement provides another classification of procurement goods, based on the degree of difficulty in verifying the quality of the purchased goods or services by the customer. Following this logic, Goldberg (1977) distinguished between simple and complex goods; Nelson (1970) distinguished between search (quality can be easily and clearly specified in documentation), experimental (quality is checked during operation), and credibility goods (quality is assessed only by expert judgement).

In Russia, the public procurement market attracted the interest of researchers in 2010, when the Russian procurement system was reformed in order to improve its efficiency. Key changes were made to the procurement regulations (Law No. 44-FZ (2013), Law No. 223-FZ (2011)). The Unified Information System in Procurement was launched, which aggregated information on all transactions, etc. We limited the scope of the study to public sector procurement regulated by Law No. 44-FZ. According to the law, the Russian procurement system has several procedures for selecting a supplier, including the main competitive procedures (e-tender, e-auction, and request for quotation) and non-competitive procedures, when the goods are procured from a single supplier. It should be noted that the few Russian studies dedicated to various methods of public procurement concentrate mainly on the assessment of the effectiveness of procurement procedures for simple (homogeneous) goods. For example, Yakovlev et al. (2012, 2013) (granulated sugar), Balsevich, Podkolzina (2014), Ostrovnaya, Podkolzina (2014, 2018) (fuel) showed that in the case of simple goods, the level of procurement prices is on average lower when the auction procedure is chosen.

We previously analysed the use of auctions for procurement of medicines (Zhemkova, 2020). However, the findings cannot be extrapolated to other goods, as each product has specific features. In this study, we also analysed other groups of procurement goods: more standardised and, conversely, complex goods, with lower or higher levels of uncertainty. We empirically assessed the effectiveness of different public procurement procedures.

Research materials and methods

In this study, the analysis included several stages. The first stage involved building an ordered model for the customer to choose the optimal procurement procedure for different types of goods. The second stage involved assessing the price effectiveness of existing procedures from the perspective of the customer (by two parameters: absolute level of final contract prices, and relative level, showing how much the final price is lower than the initial price). The key idea was to identify fundamentally different groups of purchased goods and compare the results of the analysis for each group. For this purpose, we developed a theoretical model describing the procurement process.

In the model, two types of participants make decisions: the customer and suppliers. The customer estimates its expected benefit EU_a from the procurement as follows:

$$EU_a = \propto TR(q_i) - (1 - \propto)P,$$
$$TR(q_i) = A + Bq_i, \quad (1)$$

where $\propto$ is the variable characterising the customer's preference for quality over price, $a \epsilon [0,1]$; $TR(q_i)$ is the net benefit of the customer from the purchase of goods depending on their quality q_i; P is the final price of the contract equal to the bid of the tender winner; B is the value of quality of the goods.

In turn, suppliers decide to participate based on their expected benefit EU_i:

$$EU_i = (b_i - c_i) \times \Pr(b_i < max_{-i}b_j),$$
$$C_i = C_i(v, x_i, q_i) = C_i(v, x_i)q_s, \quad (2)$$

where b_i is the company's bid (price quote); C_i – is the cost that the company will incur if it is awarded the contract, consisting of two components: common v and private x_i. One of the components dominates the other: if v prevails, the specific share of the costs is revealed only after the contract is signed; if x_i prevails, costs are determined by the company's capabilities. Meanwhile, the costs themselves depend on the

quality of the goods supplied q_i, $q_s \in [0,1]$ – is evenly distributed according to the equipartition law $F(q)$.

The auctioneer chooses between procurement procedures with different levels of competitiveness: open tender, electronic auction, request for quotations, or procurement from a single supplier (the set of procedures may differ for different types of goods, a binary choice involves choosing between a completely non-competitive procedure (procurement from a single supplier) and a competitive one (all others). Competitive procedures can also be ranked against each other. In theory, an electronic auction should be more price-competitive than a request for quotations (due to generally larger purchases and greater number of bidders). A tender is the least price-competitive due to the presence of qualitative criteria. If a competitive procedure is chosen (with the exception of a tender), it is assumed that the goods will be procured at the lowest price, but also with the lowest quality. In the case of single supplier procurement, it is assumed that the customer has the opportunity to select a supplier with a preferred quality, and the procurement will take place if the requirement $C_i(v, x_i,)q_s \leqslant P$ is met by the supplier.

Thus, the procured goods can be categorised both by quality criteria (simple or complex goods) and by the predominant component (private x_i or common v) in the cost structure of their supply. Our main hypothesis was that for different groups of goods, procurement procedures may vary in their effectiveness. In this study, we selected four commodity groups to analyse the effectiveness of procurement procedures in Russia, reflecting the characteristics of each of these groups:

– paper is a simple good with private costs (homogeneous product, its quality is easily verified at the time of purchase, all characteristics are clearly documented, only the capacity of the supplier matters);

– medicines are complex goods with private costs (quality varies significantly even within specific OKPD2 (Russian Classification of Products by Economic Activities) codes and is difficult to verify, but production costs are determined only by the capacity of the producers);

– the supply of automotive components is a simple commodity with common costs (despite the simplicity and specification of the components themselves, this group is generally procured as "repair and maintenance of vehicles", which does not allow suppliers to know in advance what parts will be required, so, the common component prevails);

– construction services are a complex commodity with common costs (detailed terms of reference, post-negotiations, a large scope of work is disclosed already at the stage of contract execution, the common component prevails).

The main source of data was the website of the UIS in Procurement, as well as the RUSLANA database as a source of information on suppliers of goods. The final sample contained data on 50 thousand purchases of the target goods and services for 2017–2018, provided they were finalised. Each group of goods was analysed separately. Each sample contained information on the procurement procedure, procurement volume, final and initial procurement price, the value of quality and the customer's attitude to quality, the level of competition for the supply of goods, and other characteristics of the procurement.

During the first stage of the analysis, we identified the determinants of the customer's choice of the type of procurement procedure. Since the main parameters of the model, which are quality indicators and customer's attitude to quality, are unobservable variables, it was necessary to find adequate proxies to describe them. Thus, the key factors influencing the customer's choice of the most suitable procedure were considered to be the value of product quality (the ratio of product/service price to the group average); the cost of product quality (the ratio of the group average market price to the average for the entire OKPD code, reflecting how expensive it is in general to produce similar products compared to others); and the customer's preference for quality over price (the customer's budget level (municipal, regional, or federal) and customer (hospital) ranking[1] for medicines);

---

[1] Final scores of organisations for 2015–2017 Accessed on 24.10.2019. Official website for information about state (municipal) institutions. URL: https://www.bus.gov.ru/pub/top-organizations-first

level of competition (number of suppliers of the group's product who have previously participated in procurement procedures within the sample). Additional variables were supplier experience (number of times the supplier participated in procurement procedures within the sample); customer experience (number of times the customer procured within the sample); special contract terms and conditions; contract duration, and supplier ranking (measured by the logarithm of its revenue).

The main hypotheses for the first part of the analysis were:

Hypothesis 1. Price-competitive procedures are less favoured when the value of product quality is high and when the customer prefers quality over price.

Hypothesis 2. Increased competition for complex goods reduces the benefits of competitive procedures, and for simple goods, it increases the benefits.

Hypothesis 3. Auctions are preferable to negotiations when a company's costs of supplying a quality product are high (marginal cost of quality).

We made the following assumptions about the nature of the relationship between the choice of procedure and the other variables: experienced customers and suppliers may potentially have an established relationship in the procurement market and, for example, are more likely to participate in a single supplier procedure; auctions are used to select a more reliable supplier of a simple commodity, whereas a supplier of a complex commodity is selected through a non-competitive procedure; the duration of the contract may have a divergent effect on the choice, but the promptness of delivery is likely to allow a non-competitive procedure to be used.

To test the hypotheses, we used an ordered model for the choice between competitive and non-competitive procedures with the dependent variable being the probability of a customer choosing one or the other procedure (measured by the number of these procedures among the completed procurements in the sample):

$$\Pr(TYPE) = \beta_0 + \beta_1 \ln Q + \beta_2 \ln N + \beta_3 q + \beta_4 R_Z + \beta_5 EXP_Z + \beta_6 EXP_P + \beta_7 R_P + \beta_8 TYME + \beta_9 C, \quad (3)$$

where $TYPE$ is the type of procedure (0 – request of quotation; 1 – e-auction; 2 – single supplier); $\Pr(.)$ is the probability of choosing a certain procedure; q is the value of quality of the goods within the group; R_Z is the customer's preference for quality over price (customer level parameter); N is the level of competition; C is the cost of quality of the goods; Q is the volume of supply (in relation to the procurement of goods); EXP_Z is the customer's experience; EXP_P is the supplier's experience; P_P is the supplier's ranking; and $TYME$ is the duration of the contract.

During the second stage of the analysis, we assessed the price effectiveness of already implemented procurement procedures from the customer's point of view. For this purpose, a linear OLS model was used to assess how the listed factors and the choice of procedure are related to the level of procurement prices. The dependent variable was the final contract price (P), as well as the difference between the initial and final price (dP) following the contracting process.

Hypotheses about the nature of the impact of key variables on the level and variance of procurement prices are provided below:

Hypothesis 4. Complex goods are characterised by higher price levels and less price reduction compared to the initial price when the auction procedure is chosen.

Hypothesis 5. For complex goods, the level of procurement prices should be higher under conditions of high value of quality and customer's preference for quality over price, and when a more experienced and financially reliable supplier is selected.

Hypothesis 6. Under high level of competition, complex goods are characterised by higher price levels and less price reductions.

The hypotheses were tested using a linear OLS model:

$$(dP_{1,2}) = \beta_0 + \beta_1 TYPE + \beta_2 \ln Q + \beta_3 \ln N + \beta_4 TYME + \beta_5 q + \beta_6 R_Z + \beta_7 EXP_Z + \beta_8 EXP_P + \beta_9 R_P + \beta_{10} MSP, \quad (4)$$

where MSP is a special preference in the selection of the winner, e. g., favouring small and medium-sized enterprises; other designations can be found above.

Results and discussion

The results of the model estimation of the choice of procurement procedure for each of the goods are presented in Table 1. Since the use of the logit model does not allow to interpret the estimated values of the coefficients, but only the direction of dependence, we calculated the marginal effects at the midpoint for each parameter to obtain estimates. They are presented in the table.

The estimation allowed us to draw the following conclusions. First, on average, the value of quality matters only for complex products. The greater the variation in quality within narrow product groups, the less preferable the auction procedure is for customers. A high value of quality, based on the proxy that was chosen to estimate the parameter, also means a high price spread between similar goods, which increases the probability that a supplier of a cheap but low-quality product wins the auction. For complex goods, auctions are less preferable when quality is more important to the customer than price. They are more preferable for simple goods. For simple goods, the auction format helps to select, on average, a more experienced and reliable supplier. For complex goods, the opposite is true (for medicines, the supplier ranking is not important,

as high financial stability does not at all reflect the quality of the product to be delivered and is not as important for delivery; however, for other markets, especially for long-term contracts, supplier ranking is important).

For simple goods, as competition increases, customers more often prefer competitive procedures, while for complex goods, on the contrary, customers prefer non-competitive procedures. This is consistent with the logic for the procurement of complex goods: the more suppliers that are on the market, the lower the probability that a supplier capable of delivering a higher quality product will win the auction (where suppliers compete solely on price). Finally, auctions are less favoured under the condition of high cost of quality for all types of goods except complex goods with a common cost component. That is, in most cases, customers prefer to use non-competitive procedures to procure relatively more expensive groups of goods, and auctions for cheap goods. Another interesting finding is that the choice of the single supplier procedure is on average associated with longer contracts. The only exception is the procurement of medicines, which may require a simplified procedure due to the high urgency.

Thus, we rejected hypothesis number three, which states that auctions should be preferred

T a b l e 1

Overall model estimation results for the choice of procedure across all samples

	Paper	Medicines	Automotive components	Construction
1. Value of quality	–	0.03***	–	0.007*
2. Customer level (base – municipal): regional federal Hospital ranking	–0.02** –	0.03***	–0.1*** 0.02***	0.013** 0.019***
3. Competition	–0.013***	0.05***	–0.01***	0.07***
4. Cost of quality	0.03***	0.08***	0.018**	–0.005**
5. Volume of supply	–	–0.05***	0.03***	0.05***
6. Duration of the contract	0.008**	–0.06***	0.037***	0.004**
7. Customer's experience	0.019***	0.08***	0.02***	–0.005**
8. Supplier's experience	–0.004*	0.08***	–0.06***	0.015***
9. Supplier's ranking	0.09***	–	0.007***	0.003*
Pseudo R^2	0.27	0.29	0.26	0.28
Number of observations	3428	2023	3859	2729

S o u r c e: authors' calculations. *** p < 0,01, ** p < 0,05, * p < 0,1***. The table shows the calculated marginal effects.

to negotiations when companies' costs of supplying a quality product are high. The rest of the findings are consistent with the stated hypotheses.

The results of OLS estimation of the second model (to analyse the price effectiveness of the used procedures) in both specifications are presented below in Tables 2 and 3.

T a b l e 2

Overall model estimation results for comparing the determinants of the final contract price

	Paper	Medicines	Automotive components	Construction
1. Type of procedure *(base – request for quotation):*				
e-auction	−0.23***	–	1.38***	0.75***
single supplier	−0.23***	0.26***	1.03***	1.05***
2. Value of quality	–	0.65***	0.013***	0.08***
3. Customer level *(base – municipal):*				
regional	0.138***	–	0.68***	–
federal	0.149***		0.65***	−0.62***
Hospital ranking				
4. Competition	−0.09***	0.218***	−0.08***	0.017*
5. Volume of supply	0.91***	−0.12***	0.2***	0.27***
6. Duration of the contract	−0.018*	−0.03*	0.47***	0.47***
7. Customer's experience	−0.08***	–	−0.78***	−0.61***
8. Supplier's experience	–	−0.013***	−0.44**	–
9. Supplier's ranking	0.39***	−0.001*	–	0.17***
10. Special conditions (SME)	0.06**	–	−0.77**	0.27***
Pseudo R^2	0.83	0.66	0.55	0.69
Number of observations	3428	2502	3836	2662

S o u r c e : authors' calculations. *** p < 0,01, ** p < 0,05, * p < 0,1***.

T a b l e 3

Overall model estimation results for comparing the determinants of the deviation of the final contract price from the initial price

	Paper	Medicines	Automotive components	Construction
1. Type of procedure *(basic – request for quotation):*				
e-auction	0.48**	–	0.87***	−0.36**
single supplier	−1.23***	−0.2***	1.3***	−0.99***
2. Value of quality	–	0.66***	–	0.06***
3. Customer level *(base – municipal):*				
regional	0.41***	–	–	0.3***
federal	−0.39*		0.28**	−1.09***
Hospital ranking				
4. Competition	0.03**	0.11*	0.04*	0.56***
5. Volume of supply	0.019**	0.89***	0.34***	0.4***
6. Duration of the contract	0.19***	–	0.44***	0.25***
7. Customer's experience	0.38***	0.05**	0.36***	−0.16***
8. Supplier's experience	0.1***	–	−0.25***	0.67***
9. Supplier's ranking	–	−0.006*	–	−0.14**
10. Special conditions (SME)	0.15*	–	−1.03***	−0.18**
Pseudo R^2	0.62	0.74	0.59	0.81
Number of observations	2420	2502	2265	2543

S o u r c e : authors' calculations. *** p < 0,01, ** p < 0,05, * p < 0,1***.

The model estimation showed that, on average, choosing the auction procedure was associated with a lower level of procurement prices. This relationship was observed for all goods except for simple goods with private costs (paper). Moreover, the auction results in a larger difference between the final price and the initial price for all complex goods. Thus, more competitive procedures are more beneficial in terms of customer costs for all types of goods, except for the simplest and most transparent ones. This conclusion completely contradicts Hypothesis 4, but some similar findings were obtained in some similar studies for other countries (Lalive & Schmutzler, 2011).

A high value of quality is again more significant for complex goods. On average, it is associated with higher contract prices. The customer's preference for quality over price is associated with higher price levels for all goods. On average, the price level is higher for most goods when a more reliable supplier is selected. Finally, for complex goods, high competition results in higher auction prices, and for simple goods, single supplier procurement is associated with higher prices. High competition results in a greater reduction in the final price compared to the initial price for all goods. Interestingly, longer contracts for goods with private costs are on average cheaper, while those for goods with common costs are more expensive. In the former case, an auction is more common, while in the latter case a single supplier procedure prevails. The high level of uncertainty that is associated with goods with common costs increases even more when the delivery time increases, forcing suppliers to compensate for the risks. In contrast, the lack of urgency for the delivery of goods with transparent private costs allows for a discount.

Thus, as a result of the analysis, we rejected hypothesis 4, according to which choosing an auction procedure results in a higher procurement price and a smaller price reduction compared to the initial maximum contract price. We did not reject hypothesis 5: for complex goods, the price level is indeed higher under conditions of a high level of quality and a preference for quality over price, as well as when choosing a more experienced

and financially reliable supplier. We partially rejected hypothesis 6, the part stating that high competition also leads to a greater reduction in the final price compared to the initial price for all types of goods, including complex ones.

The main conclusion of the analysis is that, on average, for more complex goods, as well as goods with a common cost component (high uncertainty), competitive procedures are less favourable, despite the price benefit for the customer. This is especially true when the quality of the procured goods is very important to the customer. Customers are willing to overpay by choosing non-competitive procedures with a higher price to be sure that they will receive a quality product or service. For complex procurements and procurements with high levels of uncertainty, there is a risk of adverse selection in competitive procedures: an unscrupulous supplier can offer a lower price and win, but may not be able to fulfil the contract to the required standard. This risk only increases in a highly competitive environment.

Procurement from a single supplier is an extreme manifestation of the customer's monopoly power and is regulated to be carried out rather rarely. At the same time, the current competitive procedures (which are also used for a rather small share of complex procurements) are cumbersome and time-consuming. These factors together allowed us to conclude that there may be a need for an intermediate procurement procedure, an analogue of negotiations. Such a procedure is common in Western practice. Auctions cannot always ensure the best quality complex goods, goods with common costs, because the supplier is selected on the basis of the offered bid (taking into account the restrictive conditions for participation). As a result, customers often have to resort to so-called post-negotiations and coordination after the contract has been awarded. This lack of transparency and regulation contributes neither to improving the quality of services procured, nor to reducing costs or attracting new suppliers. Introducing an intermediate regulated procedure would reduce the risks of adverse selection in the

procurement of complex goods, but would limit the unfair monopoly power of the customer.

For simple goods, there is no such problem, auction is the most favoured procedure under the conditions of high competition, value of quality, and preference for quality over price. It ensures the most experienced and financially reliable supplier. To improve the procurement process, reduce the chances of manipulation, and attract new suppliers for simple goods, it would be better to further simplify the procedures, reduce bureaucracy, and automate the process, including through the development of a data bank of unified model contracts, as well as unified product specifications.

Conclusions

The main assumption of this study was that different public procurement procedures may vary in effectiveness for different types of goods. The two criteria that were used to fundamentally distinguish all goods, according to the theory, were the quality of the goods (simple goods, when the quality can be checked at the time of delivery, or complex goods, which cannot be checked immediately) and the predominant component in the cost structure of their delivery (private component, when the costs are specific to a particular company, or general component, when most of the costs are revealed only upon signing the contract and are the same for all suppliers). Therefore, the following products were selected for empirical assessment: paper (simple commodity with private costs), medicines (complex commodity with private costs), automotive components (simple commodity with common costs), and construction and road works (complex commodity with common costs).

The first part of the analysis showed that, other things being equal, auctions are more often chosen by customers under conditions of low value of quality (for complex goods). Customers choose an auction when they prefer quality over price (for simple goods), and single supplier procurement for complex goods. For simple goods, auctions allow selecting, on average, a more experienced and reliable supplier, while for complex goods the single supplier procurement is more favourable. For simple goods, as competition increases, customers choose the auction more often, and for complex goods, they tend to choose the single supplier procedure. Finally, auctions are less favoured under the condition of high cost of quality for all types of goods except complex goods with a common cost component. That is, in most cases, customers prefer to use non-competitive procedures to procure relatively more expensive groups of goods, and auctions for cheap goods.

The estimation of price effectiveness of the current procedures showed that, on average, the level of procurement prices is lower for auctions than for single supplier procurement. This is true for all goods, except for simple goods with a private cost component (paper). At the same time, the reduction of the final prices for complex goods compared to the initial prices was greater in case of the auction. Under conditions of high competition, the price level is on average lower for simple goods and higher for complex goods. For all goods, high competition is associated with greater price reductions. For complex goods, prices are higher under conditions of high value of quality. Under the conditions of strong preference for quality over price, they are higher for all goods. For most products, prices are higher when a more reliable supplier is selected.

Based on the analysis, we can conclude that, in practice, the auction procedure widely used in Russian public procurement is not always capable of delivering the best quality goods, especially in the case of contracts for complex goods or services involving a high level of uncertainty, which often require post-contract coordination. Although auctions result in lower prices on average, customers of complex goods would often prefer to pay more to be sure of receiving a quality product. On the other hand, for simple goods, auctions are indeed the most preferable procedure in the face of both high competition and preference for quality. They allow the selection of the most experienced and financially reliable supplier. However, they are not always the

most efficient mechanism for the procurement of complex goods.

Further development of the study. In this study, only one commodity is analysed as an example of each group of procured goods. To verify the consistency of the results, more types of goods, each of them with their own characteristics, could be included in the analysis. It is also interesting to verify the results by analysing a cross-sectional sample of all commodity groups together. The work can also be extended to analyse the risks, reasons for failure, and the inefficiency of different procurement procedures for each of the selected groups of goods. Another direction for the development of the study could be to include endogeneity in the model. It appears, among other things, when we include the competition parameter in the model. In turn, this parameter, measured by the number of available sellers, depends on the procedure type and procurement prices.

Conflict of Interest

The authors declare the absence of obvious and potential conflicts of interest related to the publication of this article.

References

1. Balsevich, A., & Podkolzina, E. A. (2014). Causes and consequences of low competition in public procurement in Russia. *HSE Economic Journal*, *18*(4), 563–585. (In Russian).

2. De Castro, L. I. (2010). Affiliation, Equilibrium Existence and the Revenue Ranking of Auctions. *Discussion Papers, Northwestern University, Center for Mathematical Studies in Economics and Management Science*, *1530*.

3. De Castro, L. I., & Paarsch, H. J. (2010). Testing affiliation in private-values models of first-price auctions using grid distributions. *Annals of Applied Statistics*, *4*(4), 2073–2098. https://doi.org/10.1214/10-AOAS344

4. Donald, S. G., & Paarsch, H. J. (1996). Identification, estimation, and testing in parametric empirical models of auctions within the independent private values paradigm. *Econometric Theory*, *12*(3), 517–567. https://doi.org/10.1017/s0266466600006848

5. Goldberg, V. P. (1977). Competitive Bidding and the Production of Precontract Information. *The Bell Journal of Economics*, *8*(1), 250. https://doi.org/10.2307/3003497

6. Guerre, E., Perrigne, I., & Vuong, Q. (2000). Optimal nonparametric estimation of first-price auctions. *Econometrica*, *68*(3), 525–574. https://doi.org/10.1111/1468-0262.00123

7. Hong, H., & Shum, M. (2004). Rates of information aggregation in common value auctions. *Journal of Economic Theory*, *116*(1), 1–40. https://doi.org/10.1016/S0022-0531(03)00224-2

8. Hortaçsu, A., & McAdams, D. (2010). Mechanism choice and strategic bidding in divisible good auctions: An empirical analysis of the turkish treasury auction market. *Journal of Political Economy*, *118*(5), 833–865. https://doi.org/10.1086/657948

9. Lalive, R., & Schmutzler, A. (2011). Auctions vs Negotiations in Public Procurement: Which Works Better? *Working Paper Series, University of Zurich, Department of Economics*, *23*. https://doi.org/10.2139/ssrn.2687039

10. Li, T., Perrigne, I., & Vuong, Q. (2000). Conditionally independent private information in OCS wildcat auctions. *Journal of Econometrics*, *98*(1), 129–161. https://doi.org/10.1016/S0304-4076(99)00081-0

11. Li, T., Perrigne, I., & Vuong, Q. (2002). Structural Estimation of the Affiliated Private Value Auction Model. *The RAND Journal of Economics*, *33*(2), 171. https://doi.org/10.2307/3087429

12. Milgrom, P. R., & Weber, R. J. (1982). A Theory of Auctions and Competitive Bidding. *Econometrica*, *50*(5), 1089. https://doi.org/10.2307/1911865

13. Nelson, P. (1970). Information and Consumer Behavior. *Journal of Political Economy*, *78*(2), 311–329. https://doi.org/10.1086/259630

14. Ostrovnaya, M. V., & Podkolzina, E. A. (2014). Reducing the effectiveness of auctions and combating restrictions on competition in public procurement. *Economic Issues*, *11*, 41–57. (In Russian).

15. Ostrovnaya, M. V., & Podkolzina, E. A. (2018). Restrictions on competition using the example of Russian government procurement. *Economic Issues*, *2*, 56–73. (In Russian).

16. Paarsch, H. J. (1997). Deriving an estimate of the optimal reserve price: An application to British Columbian timber sales. *Journal of Econometrics*, *78*(2), 333–357. https://doi.org/10.1016/s0304-4076(97)00017-1

17. Paarsch, H. J. (1994). A Comparison of Estimators for Empirical Models of Auctions. *Annales d'Économie et de Statistique*, *34*, 143–157. https://doi.org/10.2307/20075950

18. Vickrey, W. (1961). Counterspeculation, Auctions, and Competitive Sealed Tenders. *The Journal of Finance*, *16*(1), 8–37. https://doi.org/10.1111/j.1540-6261.1961.tb02789.x

19. Wilson, R. (1977). A bidding model of perfect competition. *Review of Economic Studies*, *44*(3), 511–518. https://doi.org/10.2307/2296904

20. Yakovlev, A. A., Bashina, A. S., & Demidova, O. A. (2013). Analysis of the effectiveness of purchasing methods for simple homogeneous goods (using the example of granulated sugar). *HSE Economic Journal*, *17*(4), 649–677. (In Russian).

21. Yakovlev, A. A., Demidova, O. A., & Balaeva, O. (2012). Reasons for the decline in prices at auctions and problems of execution of government contracts (empirical analysis based on microdata). *Economic Issues*, *1*, 65–83. (In Russian). https://doi.org/10.32609/0042-8736-2012-1-65-83

22. Zhemkova, A. M. (2020). A model for choosing a public procurement procedure using the example of medicines. *Bulletin of Voronezh State University. Series: Economics and Management*, *(3)*, 48–59. (In Russian). https://doi.org/10.17308/econ.2020.3/3104

Aleksandra M. Zhemkova, Senior Researcher, Institute of Applied Economic Research, Russian Academy of National Economy and Public Administration; Gaidar Institute for Economic Policy, Moscow, Russian Federation

E-mail: zhemkova-am@ranepa.ru

ORCID ID: 0000-0002-0033-6028

Larisa M. Nikitina, Dr. Sci. (Econ.), Full Prof., Voronezh State University, Voronezh, Russian Federation

E-mail: lanikitina@yandex.ru

ORCID ID: 0000-0002-7375-2225

Tatiana N. Gogoleva, Dr. Sci. (Econ.), Full Prof., Voronezh State University, Voronezh, Russian Federation

E-mail: tgogoleva2003@mail.ru

ORCID ID: 0000-0002-8053-0460

Вестник Воронежского государственного университета
Серия: Экономика и управление

Экономическая теория

Анализ эффективности процедур государственных закупок на основе теоретико-игровых моделей

А. М. Жемкова[1✉]**, Л. М. Никитина**[2]**, Т. Н. Гоголева**[3]

[1] Институт прикладных экономических исследований, Российская академия народного хозяйства и государственной службы при Президенте Российской Федерации, пр-т Вернадского, 82, стр. 1, 119571, Москва, Российская Федерация; Институт экономической политики им. Е. Т. Гайдара, Газетный пер., д. 3-5, стр. 1, 125993, Москва, Российская Федерация

[2, 3] Воронежский государственный университет, Университетская пл. 1, 394018, Воронеж, Российская Федерация

Предмет. Государственные закупки играют важную роль в сфере предоставления государственных услуг и обеспечения реализации целевых программ правительственных структур. В связи с этим решающее значение принимает повышение эффективности процедур закупок. Во многом эффективность государственных закупок определяется условиями и форматом закупочной процедуры, в связи с чем особый интерес представляет выявление факторов, влияющих на выбор заказчиком оптимальной процедуры для закупки товаров различного типа, а также оценка влияния этих факторов на эффективность применения существующих процедур.

Цель. Разработка модели выбора закупочных процедур для различных типов товаров и оценка эффективности применяющихся на практике процедур государственных закупок.

Методология. В исследовании использовались выводы теории аукционов; методы качественного и количественного анализа для идентификации государственных закупок, выявления их ценности для участников и проведения оценки эффективности государственных закупок. Для эмпирической оценки были выбраны следующие товары: бумага, лекарственные препараты, поставка автокомплектующих, услуги строительства. Эмпирическую базу исследования составили данные, полученные с сайта Единой информационной системы (ЕИС) в сфере закупок.

Результаты. Разработана и оценена модель для выбора процедуры определения поставщика (для эмпирической оценки вероятность выбора определялась по количеству тех и других процедур в состоявшихся закупочных процедурах), а также модель ценовой эффективности применяющихся на практике процедур государственных закупок (под ценовой эффективностью в работе понималась итоговая цена контракта, а также снижение итоговой цены в сравнении с начальной максимальной).

Выводы. На основе проведенного анализа можно судить о необходимости введения промежуточной процедуры между аукционом и закупкой у единственного поставщика, имеющейся в зарубежной практике, – переговоров. Процедура аукциона не способна обеспечить поставку наиболее качественных товаров, особенно в случае сложных товаров или услуг с высоким уровнем неопределенности. Для простых товаров аукцион является наиболее предпочтительной про-

цедурой в условиях и высокой конкуренции, и предпочтения качества: он позволяет отобрать наиболее опытного и финансово надежного поставщика.

Жемкова Александра Михайловна, старший научный сотрудник, Институт прикладных экономических исследований, Российская академия народного хозяйства и государственной службы при Президенте Российской Федерации, Москва, Российская Федерация; Институт экономической политики им. Е. Т. Гайдара, Москва, Российская Федерация

E-mail: zhemkova-am@ranepa.ru
ORCID ID: 0000-0002-0033-6028

Никитина Лариса Михайловна, д-р экон. наук, профессор, Воронежский государственный университет, Воронеж, Российская Федерация

E-mail: lanikitina@yandex.ru
ORCID ID: 0000-0002-7375-2225

Татьяна Николаевна Гоголева, д-р экон. наук, профессор, Воронежский государственный университет, Воронеж, Российская Федерация

E-mail: tgogoleva2003@mail.ru
ORCID ID: 0000-0002-8053-0460