Policy Brief

The Prozorro Impact: what Real Savings an Electronic System Delivers

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Executive Summary

In 2015, the Prozorro electronic system and the Law of Ukraine "On Public Procurement" were developed to reform the deeply corrupt procurement system. In 2021, they ensured accountable purchases in the amount of UAH 1.1 trillion or 18% of Ukraine's GDP.

It is believed that the Prozorro system is effective due to its transparency and legislative design, but it has not yet been confirmed by facts how effective the system is in terms of financial savings.

We identified 40 groups of goods that, as a rule, are most often purchased by public customers, and assessed how much more economically profitable procurement through Prozorro is compared to non-competitive and non-public procurement.

Additionally, we compared 6 products with e-catalog purchases to the same non-competitive purchases.

According to the results we obtained, tender procedures provide savings of more than 5%, and Prozorro market - more than 10%. For each market separately, the level of real savings varies from 1 to 20 percent of the prices of purchases made outside Prozorro.

This is additional and convincing evidence that purchases, a significant part of which in 2022, after the start of a full-scale war, the Government allowed to carry out outside Prozorro, must be returned to the competitive system, and if possible - transferred to the Prozorro market.

Introduction and literature review

The electronic procurement system Prozorro (hereinafter - Prozorro) and the Law of Ukraine "On Public Procurement" (hereinafter - the Law) were developed in 2015 to reform the deeply corrupt procurement system. In 2021, purchases through the system exceeded UAH 1.1 trillion or 18% of Ukraine's GDP. According to the results of 2021, it was used by more than 40,000 customers and more than 260,000 suppliers.

It is believed that the system reduces corruption and, accordingly, the loss of public finances, creates more confidence in businesses that actively participate in public procurement, and thus gives lower prices than would happen in a closed and non-transparent environment. The system is a combination of two dimensions.

The first is the architecture of the system itself, for example, auctions, their design, the sequence of actions and procedures, which are recorded in the law on public procurement and describe the best practices adopted in the OCDS countries[1] to date. The second is the Prozorro electronic system, which implements the requirements of the law.

At the same time, the question of what economic benefit the use of Prozorro in procurement brings to the state remains open.

It is customary to measure the efficiency of Prozorro by such relative indicators as the level of *competition or relative economy*. The latter in 2021 and 2022 is almost 6%. This means that the customer, after issuing a tender, received an average price 6% lower than the level of the expected cost. But this does not mean that the price is 6% lower than the "retail/store" or some conventional "reference" price. Skeptical circles believe that the expected value, which is formed by customers, is overestimated, and therefore the final price received by customers will be the same, or not significantly lower, than it would be when concluding direct contracts outside Prozorro. At the same time, there were not enough facts to confirm or refute this statement.

In 2017, the Center of excellence in procurement at KSE Institute compared prices[2] for competitive and non-competitive procurement. We conclude that competitive procedures provide significantly less price than non-competitive procedures, but the level of savings is actually less due to the higher initial expected cost compared to direct procurement. However, this conclusion was based on the analysis of purchases of only one commodity: natural gas. Other studies of the Prozorro system, which considered the issue of prices, focus on other issues: either on explaining the dependence of the final price on the level of competition and other factors (2019, Nedilchenko[3]) or on issues of the influence of the size of the expected value on the outcome of the auction (2018, Liutov)[4] and (2017, Stepaniuk)[5].

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[1] https://www.oecd.org/governance/public-procurement/
[2] https://cep.kse.ua/article/3-Problems-of-Gas-Procurement/pdf.pdf
[3] https://kse.ua/wp-content/uploads/2019/03/Thesis_Bogdan_Nedilchenko.pdf
[4] https://kse.ua/wp-content/uploads/2019/03/Anton-Liutov17.pdf.pdf
[5] https://cep.kse.ua/article/Vplyv-ochikuvanoyi-vartosti-na-rezultat-auktsionu/pdf.pdf

These studies also covered a limited range of 2-4 standard mono products (for example: paper, gasoline), and all comparisons were usually between tenders within Prozorro itself.

In this analysis, we propose to go beyond the limitations described above and compare the prices that customers receive from procurement with the use of competitive procedures (in particular, Prozorro Market) and without their use (when procurement is completely carried out in a non-competitive manner without the use of Prozorro or with the use of a negotiated procedure).

In 2022, the question of comparing the effectiveness of competitive and non-competitive procurement has become even more relevant.

If last year 2021 three-quarters of the amount spent by customers (840 out of 1.1 billion UAH) was spent on competitive procurement, then in the three quarters of this year - due to the war - it is only 12% (100 million UAH out of 270 billion UAH)[6]. In reality, this share is even smaller, since customers were allowed to purchase goods, works and services with an expected value of more than UAH 50,000 without using the system and to report such purchases only after the cancellation or termination of martial law[7]. Customers are not required to report on purchases with an expected value of up to 50,000 (that is, the purchase itself and information about it remain outside of Prozorro). In October, a new resolution came into force that establishes the specifics of procurement during the war and in the post-war period[8], and provides for mandatory reporting up to the established value thresholds (100,000 UAH for goods; 200,000 UAH for minor repairs and 1,500,000 UAH for works).

Methodology

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The main hypothesis of this research is that purchases made using competitive procedures through Prozorro or Prozorro Market provide a better price for the customer than purchases made in a non-competitive manner.

We will use two approaches to test this hypothesis. In the first, we will estimate the total effect of tender procedures simultaneously for all 40 goods (for comparison with tender procedures) or 6 goods (for comparison with Prozorro Market), considering them as random effects, since this is a "random" sample from the entire set of purchases (random effects), thus we will build a model with mixed effects (mixed effect model):

$$\log(\text{price } it) = \beta_0 + \beta_1 (\text{YM } it) + \beta_2 (\text{itemCount } it) + \beta_3 (\text{fop } it) + \beta_4 (\text{tender } it) + \varepsilon_{it}$$

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[6] https://bi.prozorro.org/
[7] https://zakon.rada.gov.ua/laws/show/169-2022-%D0%BF#Text
[8] https://zakon.rada.gov.ua/laws/show/1178-2022-%D0%BF#Text

The second approach involves building 40 separate models for each product and 6 models for products from Prozorro Market. These models will include robust regressions, which can be described by the following formula:

$$\log(\text{price}_i) = \beta_0 + \beta_1(\text{YM}_i) + \beta_2(\text{itemCount}_i) + \beta_3(\text{fop}_i) + \beta_4(\text{tender}_i) + \varepsilon_i$$

- where *price* is the logarithm of the price with VAT for a certain product. The use of logarithms makes it easier to compare prices (percentages are used instead of natural values). For example, if the *tender variable* is "yes" (that is, a competitive procedure was used), then the price is higher or lower by X percent;
- *YM* - Year and month of purchase. This categorical variable allows us to remove the influence of time and ever-increasing prices;
- *itemCount* - the number of units of the purchased product to remove the effect of scale (for example, prices in competitive auctions can be lower only due to larger purchase volumes);
- *tender*, is a target categorical variable that can take the value 0/False (without using an electronic system) or 1/True (using Prozorro);
- *fop* - whether the supplier is a Natural Person-Entrepreneur. Such participants more often take part in non-competitive purchases and have an advantage over legal entities - VAT payers, due to the possibility not to pay VAT (this is how the state supports small businesses). Therefore, purchases in non-competitive procedures may appear to be more profitable than they actually are.

In addition, we assume that the terms of contracts for tender procedures are less beneficial for business and can potentially have a negative effect on the price (longer delivery terms, longer payment terms under the contract when leveling, as mentioned above, the factor of purchase volumes). But we cannot include this variable in the model, since such information is not available for non-tender purchases. Also, in the model, we do not take into account the post-purchase relationship between the customer and the supplier (for example, signing additional agreements and increasing the price, which is likely for large tender purchases).

Data description

As data, we use information from September 2021 to October 2022 (one year) regarding transactions from the system of the Ministry of Finance (spending.gov.ua, section "Contracts"[9]), which contain specifications with prices from procurement contracts.

We singled out 40 goods representing seven product groups: office equipment, energy products (gasoline and electricity), food products (sugar, pasta, meat, etc.), agricultural products and vegetables and fruits, pharmaceutical products, construction materials (cement, paint) and detergents. These goods were selected based on the opportunity to

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[9]https://data.gov.ua/pages/835-recm-budget-contracts

correctly compare their prices. For example, the description of the product "a4 paper 80 mg 500 sheets" in the pack quite accurately describes the product at the level of a separate compared unit[10]. We removed outliers from the data using the "IQR" method (a way of measuring the spread of the middle 50% of a data set, which is calculated as the difference between the first quartile (25th percentile) and the third quartile (75th percentile) of the data set).

In addition, the product description does not include various brands, which, in our opinion, is quite justified. For example, if a customer is buying a phone, then its direct technical characteristics may matter, which usually have less influence on the price than the brand, which, however, does not have the same influence on the functioning of the device. Especially if we are talking about the purchase of goods with budget funds.

Each contract contains information whether this procurement was carried out through a tender procedure or not. By non-competitive procurement, we mean procurement without Prozorro, based on the results of which a report is drawn up on concluded contracts without the use of Prozorro, and procurement according to the negotiation procedure. By competitive procedures, we mean tenders and simplified procurement through Prozorro.

In addition, we compare the received information with the prices of six selected products from Prozorro Market. These are purchases using the electronic catalog in Prozorro, which can be both in the form of direct purchases (up to 100,000 UAH) and in the form of requests for price proposals (from 100,000 UAH).

Figure 1. Prices for an example of four goods, depending on whether they were purchased competitively (blue), through the Prozorro market (green) or non-competitively (gray).

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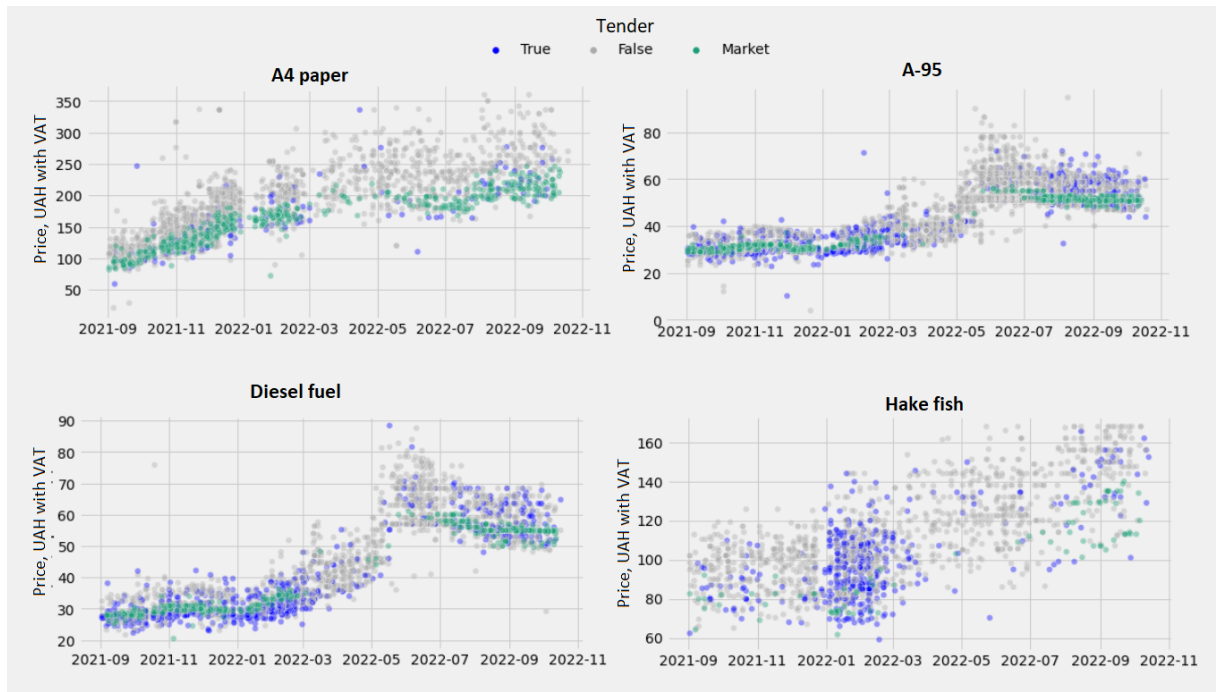
[10]https://en.wikipedia.org/wiki/Stock_keeping_unit

See the descriptive statistics of the data in the Appendices in Table 1 and Table 2.

The results

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Common model for all goods

The model, where we consider 40 different markets (commodities) as random effects, shows that conducting tender procedures is associated with prices 5.2% (plus confidential intervals) lower than in the absence of tender procedures (see Table 3.).
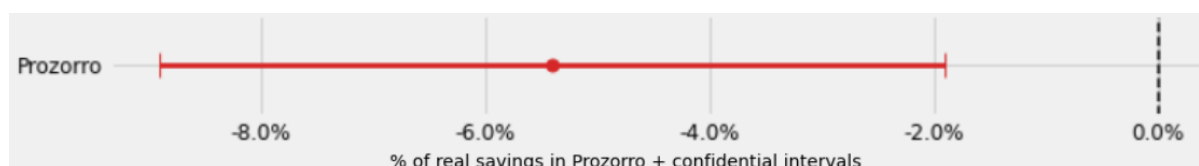
This roughly corresponds to the level of relative savings (between the expected and the final price of the tender), which can be calculated from the Prozorro analytics module. Thus, we can state that the withdrawal of procurement from Prozorro during the war may cost corresponding costs (higher prices), which are approximately equal to the size of the relative savings for competitive (tender) procurement in the past year.

Another model, where we use for comparison 6 goods that are procured either without tender procedures or through Prozorro Market, shows that procurement through the latter is associated with lower prices by 11.8%. This is a rather unexpected result, which shows that for a number of positions (more details below) Market provides better price conditions for the customer.

Separate models for 40 goods (comparison of tender procedures and direct procurement)

The simulation results for each group of goods are presented in the figure below (see in the Appendix the tabular form with additional data and types of simulation Tab. 4.).

Coefficients that have statistical significance (that is, do not cross zero) are marked with a red circle, and a red line indicates confidence intervals). These coefficients show how much lower or higher the price as a percentage of VAT is associated with conducting competitive procedures compared to non-competitive ones.

Figure 2. The price difference in the Prozorro system and outside it for 40 products separately.
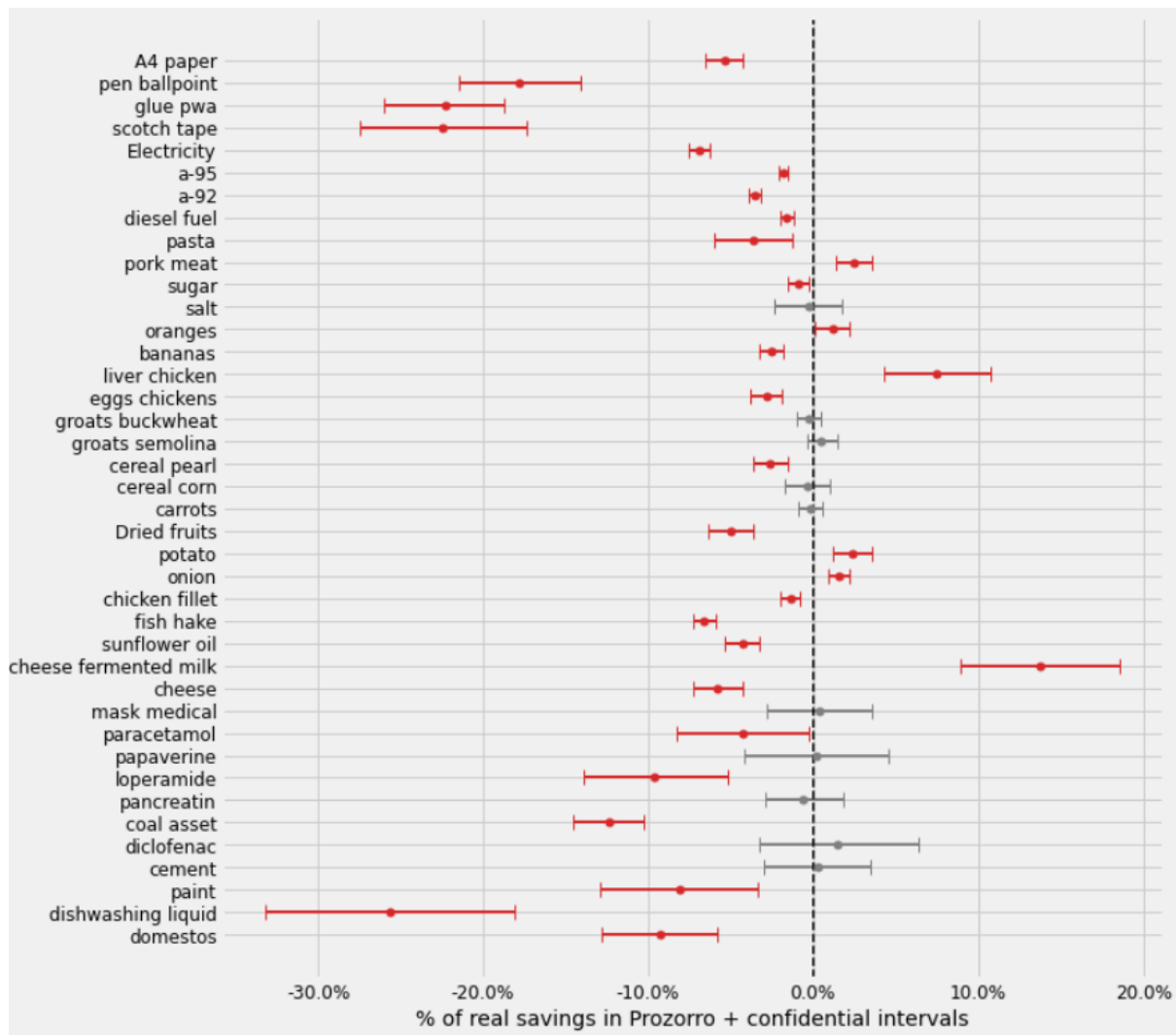
Office goods: according to the CPV code class "3019 Miscellaneous office equipment and supplies", dozens of goods are purchased, but the majority of purchases, which amounted to UAH 2.36 billion in 2021, are for office paper. All four goods in this class that we chose to research showed that using Prozorro allows to get a better price than buying outside of Prozorro. So, the cost of paper is lower by almost 6%, other goods - up to 20%.

Energy products: in 2021, the purchase of electricity amounted to UAH 50 billion. Competitive procurement is associated with 7% lower prices. In 2021, purchases of diesel fuel, A-95 and A-92 gasoline amounted to almost UAH 25 billion. Price coefficients, subject to tender procurement, show 2 to 4% lower prices.

*Food products/*Agriculture*:* model results show that cottage cheese prices are higher, while others are either not statistically significant (gray) or lower. In particular, such expensive goods as sunflower oil or hake fish are purchased 5-7% cheaper, respectively, through tender procedures in the Prozorro system. For a whole group of other products, the savings is within 3-5%.

Pharmaceutical products and products: the majority of pharmaceuticals and medical products (in 2021, public customers spent UAH 25 billion in this direction), which we chose

for the research, show significantly lower prices under the condition of using competitive procedures or do not have statistical significance.
Building materials and household chemicals: Competitive procurement is associated with significantly lower prices.

Separate models for 6 goods (comparison of Prozorro Market and direct purchases)

Next, we will compare purchases through Prozorro Market and non-competitive purchases. The result is presented in Figure 3 (more details see Table 5.).

Figure 3. Price difference between Prozorro Market and non-competitive purchases for six goods

The model shows that prices in Prozorro Market are associated with significantly lower prices compared to non-competitive purchases, except for fuel. The price coefficients for the latter either do not have statistical significance or are higher within 1%.

Conclusion

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Our research, which was based on data from September 2021 to October 2022, shows that when making purchases without Prozorro, prices are usually 5 percent or more higher than when using competitive procedures in Prozorro (which roughly corresponds to the level of savings that is calculated from the expected cost in BI). For each of the 40 goods separately, the level of savings varies from 1 to 20+ percent.

In 2022, customers have significantly reduced procurement budgets and can partially spend them outside the Prozorro system, as a result of which only every third hryvnia was   spent competitively.

The results of this research are further evidence that procurement, a significant proportion of which in 2022, after the start of full-scale war, the Government allowed to be carried out outside Prozorro, must be returned to a competitive and transparent system.

Appendices

Table 1. Descriptive statistics for 40 goods (on the left without a tender, on the right - tender procedures).

product	count	mean	std	min	25%	50%	75%	max
"папір" "а4" "80" "500"	1688.0	158.4	47.1	17.6	122.5	154.7	193.6	302.0
"ручка" "кулькова"	2491.0	7.2	4.6	1.0	3.7	6.0	10.0	21.0
"клей" "пва" "200"	398.0	18.3	5.4	8.1	14.9	17.5	21.0	33.2
"скотч" "48" "100"	249.0	32.9	11.2	6.9	25.0	30.0	38.3	62.0
"а-95"	3118.0	41.9	11.0	3.3	31.4	43.9	51.0	79.0
"а-92"	1894.0	30.4	4.4	20.8	27.8	30.0	33.0	44.0
"дизельне" "паливо"	1752.0	42.6	13.2	20.4	29.9	40.6	55.0	78.5
"електрична" "енергія"	2535.0	4.6	1.1	1.4	3.9	4.6	5.4	7.6
"макарони"	1293.0	26.7	6.1	11.2	22.5	26.0	30.0	46.0
"ясо" "свинини"	379.0	133.9	21.6	79.5	120.0	132.0	150.0	195.0
"цукор"	3008.0	29.7	4.3	14.7	27.0	29.0	32.0	46.0
"сіль"	2275.0	12.7	8.5	0.0	7.5	9.3	13.5	51.0
"апельсини"	582.0	45.8	8.5	25.0	40.0	45.0	52.0	69.0
"банани"	1005.0	37.7	6.1	22.7	34.0	37.6	40.3	54.0
"печінка" "куряча"	175.0	62.7	16.9	26.4	48.0	65.0	74.9	110.0
"яйця" "курячі"	977.0	3.5	0.5	2.1	3.2	3.5	3.8	5.0
"крупа" "гречана"	1540.0	51.9	10.9	27.0	44.1	49.0	57.5	87.0
"крупа" "манна"	1440.0	20.3	3.6	11.5	17.8	19.8	22.7	30.6
"крупа" "перлова"	1180.0	16.0	3.1	9.0	13.8	15.6	18.0	24.8
"крупа" "кукурудзяна"	666.0	19.5	4.1	8.6	16.9	19.0	22.1	30.0
"морква"	3584.0	18.8	9.1	0.0	11.2	16.0	25.0	45.0
"Сухофрукти"	1503.0	52.5	13.6	20.0	43.0	50.0	60.0	96.0
"картопля"	2986.0	10.9	3.5	0.7	8.5	10.4	13.0	22.0
"цибуля"	3497.0	18.3	8.5	0.0	12.0	15.0	25.0	46.0
"куряче" "філе"	1266.0	125.1	15.1	86.2	115.0	125.0	135.0	161.0
"риба" "хек"	1363.0	95.5	17.6	55.8	82.5	90.0	105.3	140.0
"олія" "соняшникова"	911.0	63.4	10.5	34.0	56.0	63.7	70.0	95.0
"сир" "кисломолочний" "5"	171.0	93.6	41.4	10.0	67.8	95.0	122.5	190.0
"сир" "твердий" "50"	419.0	203.8	39.3	115.0	180.0	203.4	227.3	305.0
"асло" "вершкове" "7" "200"	133.0	130.1	97.5	21.8	42.5	57.9	224.8	299.9
"маска" "медична"	810.0	1.3	0.6	0.5	0.9	1.1	1.5	3.5
"парацетамол" "500" "10"	285.0	19.2	5.8	1.0	13.8	19.1	24.0	35.0
"папаверин" "20" "2" "10"	97.0	56.5	12.6	33.0	47.1	55.7	66.5	90.9
"лоперамід" "20"	212.0	14.3	2.9	7.8	12.7	14.6	16.0	21.5
"панкреатин" "8000" "50"	208.0	59.2	7.0	45.7	54.1	57.7	64.2	82.0
"вугілля" "актив"	615.0	3.9	0.9	1.5	3.4	3.7	4.4	6.3
"диклофенак" "25" "3" "5"	135.0	29.9	13.8	3.3	22.1	27.8	35.3	61.5
"цемент" "500" "25"	517.0	112.5	26.9	65.8	90.0	110.0	130.0	195.0
"емаль" "115" "2,8" "біла"	335.0	230.9	72.7	57.1	178.0	218.0	279.0	432.0
"миття" "посуду" "1"	215.0	49.6	17.2	9.9	37.0	48.2	60.0	104.8
"доместос" "1"	467.0	73.4	14.8	33.0	63.0	72.5	83.5	115.2

product	count	mean	std	min	25%	50%	75%	max
"папір" "а4" "80" "500"	129.0	146.2	41.2	59.2	114.8	149.4	175.9	280.0
"ручка" "кулькова"	307.0	5.8	4.6	1.0	2.2	4.3	8.8	20.3
"клей" "пва" "200"	32.0	12.6	3.3	8.0	10.0	11.6	15.0	21.5
"скотч" "48" "100"	18.0	30.4	13.9	13.0	20.2	26.4	41.4	55.0
"а-95"	709.0	35.9	10.5	8.5	28.6	31.0	48.6	71.2
"а-92"	699.0	28.8	3.4	21.0	27.0	28.9	30.6	44.0
"дизельне" "паливо"	746.0	34.1	11.5	20.4	27.0	29.1	35.6	73.7
"електрична" "енергія"	2726.0	4.4	1.1	1.4	3.7	4.4	5.2	7.4
"макарони"	46.0	25.0	7.1	15.6	18.9	23.7	29.0	42.2
"ясо" "свинини"	329.0	127.8	20.6	78.6	113.1	127.0	140.0	190.0
"цукор"	278.0	29.4	4.4	19.2	26.5	28.7	32.0	42.0
"сіль"	103.0	12.8	7.7	1.0	8.3	10.0	15.0	40.0
"апельсини"	442.0	45.3	8.2	24.0	40.0	45.0	50.0	69.0
"банани"	570.0	37.4	5.3	24.0	34.0	36.6	40.0	54.1
"печінка" "куряча"	54.0	61.9	14.5	30.0	51.2	61.6	70.9	102.0
"яйця" "курячі"	261.0	3.5	0.5	2.2	3.2	3.5	3.9	4.9
"крупа" "гречана"	395.0	50.9	9.2	28.0	45.0	49.8	55.8	87.4
"крупа" "манна"	190.0	20.0	3.8	11.8	17.5	19.5	22.9	30.0
"крупа" "перлова"	383.0	15.5	3.1	8.7	13.2	15.0	17.6	24.0
"крупа" "кукурудзяна"	234.0	19.4	4.0	11.0	16.6	18.6	22.0	30.4
"морква"	1088.0	16.5	7.2	3.9	11.9	15.0	19.3	45.0
"Сухофрукти"	328.0	51.7	15.2	25.0	40.4	49.0	60.0	95.0
"картопля"	636.0	11.2	3.8	3.8	8.1	11.4	13.9	21.9
"цибуля"	1078.0	16.7	7.0	4.2	12.0	15.0	18.0	45.4
"куряче" "філе"	812.0	125.8	13.3	86.0	117.0	126.0	134.5	164.6
"риба" "хек"	444.0	86.3	15.0	55.0	75.0	84.9	92.7	138.0
"олія" "соняшникова"	195.0	63.1	10.7	42.9	54.5	64.0	69.8	95.0
"сир" "кисломолочний" "5"	68.0	99.0	33.6	12.5	85.5	104.6	120.0	154.0
"сир" "твердий" "50"	254.0	207.3	39.0	115.0	186.1	200.0	233.4	301.1
"масло" "вершкове" "7" "200"	46.0	159.8	88.4	22.2	51.6	190.0	223.2	310.0
"маска" "медична"	139.0	1.1	0.5	0.4	0.8	1.0	1.2	3.5
"парацетамол" "500" "10"	61.0	16.2	5.0	9.7	13.0	13.8	20.3	25.2
"папаверин" "20" "2" "10"	43.0	56.6	16.6	34.5	40.1	57.3	71.8	92.0
"лоперамід" "20"	31.0	12.4	3.1	7.8	9.4	12.3	15.7	17.1
"панкреатин" "8000" "50"	43.0	59.5	9.9	47.1	51.5	55.1	69.2	81.6
"вугілля" "актив"	72.0	3.6	0.6	1.7	3.1	3.6	4.1	5.9
"диклофенак" "25" "3" "5"	81.0	28.9	15.5	0.1	16.8	28.8	35.0	62.2
"цемент" "500" "25"	14.0	94.8	22.2	69.6	85.0	87.0	107.2	144.2
"емаль" "115" "2,8" "біла"	19.0	221.1	87.3	88.4	152.0	216.5	288.4	347.4
"миття" "посуду" "1"	24.0	36.2	19.8	11.6	20.5	29.6	45.4	82.4
"доместос" "1"	14.0	69.6	17.5	48.3	54.0	67.5	76.1	102.2

Table 2. Descriptive statistics for 6 goods from the market.

product	count	mean	std	min	25%	50%	75%	max
a4 80 500	501.0	162.2	40.3	72.2	125.8	165.0	196.0	246.5
a-95	434.0	41.1	10.3	28.5	30.9	35.3	51.0	57.0
a-92	204.0	32.7	6.8	0.0	29.5	30.7	32.1	54.1
енергія	109.0	4.4	1.0	1.2	3.7	4.3	5.0	10.2
Дизельне паливо	361.0	41.0	12.7	20.4	29.8	33.2	55.0	61.0
Цукор	44.0	704.5	767.4	1.7	32.0	36.5	1429.9	1850.0

Table 3. Results with random effects for 40 goods (left) and 6 goods from Prozorro Market (right)

```
                    Mixed Linear Model Regression Results
==================================================================
Model:                MixedLM   Dependent Variable:   np.log(priceVat)
No. Observations:     66126     Method:               REML
No. Groups:           40        Scale:                0.0928
Min. group size:      151       Log-Likelihood:       -15542.9755
Max. group size:      5507      Converged:            Yes
Mean group size:      1653.2
------------------------------------------------------------------
                          Coef.  Std.Err.   z    P>|z| [0.025 0.975]
------------------------------------------------------------------
Intercept                 3.302   0.182 18.189 0.000  2.946  3.658
C(tender)[T.True]        -0.052   0.018 -2.891 0.004 -0.087 -0.017
YM[T.2021-10]             0.007   0.006  1.156 0.248 -0.005  0.020
YM[T.2021-11]             0.067   0.006 10.712 0.000  0.054  0.079
YM[T.2021-12]             0.122   0.006 20.729 0.000  0.110  0.133
YM[T.2022-01]             0.188   0.006 33.454 0.000  0.177  0.199
YM[T.2022-02]             0.186   0.006 32.023 0.000  0.174  0.197
YM[T.2022-03]             0.259   0.007 36.913 0.000  0.245  0.272
YM[T.2022-04]             0.320   0.008 40.780 0.000  0.304  0.335
YM[T.2022-05]             0.408   0.008 52.900 0.000  0.393  0.423
YM[T.2022-06]             0.530   0.007 75.780 0.000  0.516  0.544
YM[T.2022-07]             0.529   0.008 66.917 0.000  0.514  0.545
YM[T.2022-08]             0.533   0.007 76.607 0.000  0.519  0.546
YM[T.2022-09]             0.552   0.007 82.036 0.000  0.538  0.565
YM[T.2022-10]             0.534   0.010 55.074 0.000  0.515  0.553
YM[T.2022-11]             0.509   0.074  6.869 0.000  0.364  0.654
fop                       0.056   0.003 20.366 0.000  0.050  0.061
itemCount                -0.000   0.000 -3.503 0.000 -0.000 -0.000
Group Var                 1.317   0.975
Group x tender[T.True] Cov 0.042  0.071
tender[T.True] Var        0.012   0.010
==================================================================
```

```
                    Mixed Linear Model Regression Results
==================================================================
Model:                MixedLM   Dependent Variable:   np.log(priceVat)
No. Observations:     14849     Method:               REML
No. Groups:           6         Scale:                0.0376
Min. group size:      1541      Log-Likelihood:       3181.3719
Max. group size:      3982      Converged:            Yes
Mean group size:      2474.8
------------------------------------------------------------------
                          Coef.  Std.Err.   z    P>|z| [0.025 0.975]
------------------------------------------------------------------
Intercept                 3.419   0.513  6.667 0.000  2.414  4.425
C(tender)[T.Market]      -0.118   0.037 -3.154 0.002 -0.191 -0.045
YM[T.2021-10]             0.064   0.009  7.289 0.000  0.047  0.081
YM[T.2021-11]             0.158   0.008 18.945 0.000  0.141  0.174
YM[T.2021-12]             0.218   0.008 27.759 0.000  0.203  0.234
YM[T.2022-01]             0.274   0.009 31.475 0.000  0.257  0.291
YM[T.2022-02]             0.267   0.009 30.199 0.000  0.250  0.285
YM[T.2022-03]             0.319   0.009 34.119 0.000  0.300  0.337
YM[T.2022-04]             0.337   0.009 36.180 0.000  0.318  0.355
YM[T.2022-05]             0.540   0.010 55.787 0.000  0.521  0.559
YM[T.2022-06]             0.610   0.009 69.299 0.000  0.593  0.628
YM[T.2022-07]             0.590   0.010 61.236 0.000  0.571  0.609
YM[T.2022-08]             0.585   0.009 65.456 0.000  0.567  0.602
YM[T.2022-09]             0.607   0.009 67.459 0.000  0.589  0.625
YM[T.2022-10]             0.615   0.012 51.285 0.000  0.591  0.638
YM[T.2022-11]             0.608   0.087  6.991 0.000  0.438  0.779
fop                       0.056   0.006  9.819 0.000  0.045  0.067
Group Var                 1.578   5.388
Group x tender[T.Market] Cov 0.027 0.281
tender[T.Market] Var      0.008   0.028
==================================================================
```

Table 4. Model results for 40 goods

reg	r2	product	coef	conf_int_min	conf_int_max	err	significant?
ols	0.276	доместос 1	-0.083	-0.178	0.013	0.095	not significant
ols	0.147	миття посуду 1	-0.236	-0.419	-0.054	0.182	significant
ols	0.461	емаль 115 2,8 біла	-0.241	-0.375	-0.107	0.134	significant
ols	0.554	цемент 500 25	-0.022	-0.097	0.054	0.075	not significant
ols	0.175	диклофенак 25 3 5	0.032	-0.162	0.226	0.194	not significant
ols	0.184	вугілля актив	-0.046	-0.111	0.020	0.065	not significant
ols	0.207	панкреатин 8000 50	-0.013	-0.062	0.036	0.049	not significant
ols	0.098	лоперамід 20	-0.157	-0.254	-0.059	0.097	significant
ols	0.089	папаверин 20 2 10	-0.016	-0.111	0.079	0.095	not significant
ols	0.201	парацетамол 500 10	-0.109	-0.214	-0.005	0.104	significant
ols	0.058	маска медична	-0.169	-0.247	-0.091	0.078	significant
ols	0.173	сир твердий 50	-0.023	-0.056	0.010	0.033	not significant
ols	0.094	сир кисломолочний 5	0.148	-0.045	0.342	0.193	not significant
ols	0.119	олія соняшникова	-0.020	-0.046	0.005	0.026	not significant
ols	0.619	риба хек	-0.073	-0.088	-0.058	0.015	significant
ols	0.185	куряче філе	-0.019	-0.031	-0.007	0.012	significant
ols	0.708	цибуля	-0.003	-0.022	0.015	0.019	not significant
ols	0.205	картопля	0.006	-0.022	0.034	0.028	not significant
ols	0.126	Сухофрукти	-0.001	-0.034	0.032	0.033	not significant
ols	0.692	морква	-0.017	-0.036	0.003	0.020	not significant
ols	0.122	крупа кукурудзяна	-0.019	-0.051	0.014	0.033	not significant
ols	0.204	крупа перлова	-0.040	-0.063	-0.018	0.023	significant
ols	0.311	крупа манна	-0.018	-0.042	0.006	0.024	not significant
ols	0.667	крупа гречана	-0.017	-0.033	-0.001	0.016	significant
ols	0.233	яйця курячі	-0.031	-0.053	-0.009	0.022	significant
ols	0.161	печінка куряча	0.002	-0.082	0.087	0.085	not significant
ols	0.386	банани	-0.024	-0.039	-0.008	0.016	significant
ols	0.290	апельсини	-0.011	-0.034	0.011	0.023	not significant
ols	0.597	сіль	0.045	-0.028	0.119	0.074	not significant
ols	0.269	цукор	-0.020	-0.037	-0.004	0.016	significant
ols	0.285	ясо свинини	-0.028	-0.054	-0.001	0.027	significant
ols	0.299	макарони	-0.053	-0.114	0.008	0.061	not significant
ols	0.882	дизельне паливо	-0.037	-0.047	-0.027	0.010	significant
ols	0.601	а-92	-0.029	-0.038	-0.019	0.009	significant
ols	0.819	а-95	-0.013	-0.023	-0.003	0.010	significant
ols	0.113	електрична енергія	-0.082	-0.098	-0.066	0.016	significant
ols	0.358	скотч 48 100	-0.271	-0.422	-0.121	0.150	significant
ols	0.378	клей пва 200	-0.360	-0.454	-0.266	0.094	significant
ols	0.052	ручка кулькова	-0.279	-0.360	-0.199	0.081	significant
ols	0.716	папір а4 80 500	-0.115	-0.145	-0.084	0.031	significant

reg	product	coef	conf_int_min	conf_int_max	err	significant?
Robust	доместос 1	-0.093	-0.128	-0.058	0.035	significant
Robust	миття посуду 1	-0.256	-0.332	-0.181	0.076	significant
Robust	емаль 115 2,8 біла	-0.081	-0.129	-0.034	0.047	significant
Robust	цемент 500 25	0.003	-0.030	0.035	0.033	not significant
Robust	диклофенак 25 3 5	0.015	-0.033	0.064	0.049	not significant
Robust	вугілля актив	-0.124	-0.145	-0.103	0.021	significant
Robust	панкреатин 8000 50	-0.006	-0.029	0.018	0.024	not significant
Robust	лоперамід 20	-0.096	-0.139	-0.052	0.043	significant
Robust	папаверин 20 2 10	0.002	-0.042	0.046	0.044	not significant
Robust	парацетамол 500 10	-0.043	-0.083	-0.003	0.040	significant
Robust	маска медична	0.004	-0.028	0.036	0.032	not significant
Robust	сир твердий 50	-0.058	-0.073	-0.043	0.015	significant
Robust	сир кисломолочний 5	0.137	0.089	0.186	0.048	significant
Robust	олія соняшникова	-0.043	-0.054	-0.033	0.011	significant
Robust	риба хек	-0.066	-0.073	-0.059	0.007	significant
Robust	куряче філе	-0.014	-0.020	-0.008	0.006	significant
Robust	цибуля	0.016	0.009	0.022	0.007	significant
Robust	картопля	0.024	0.012	0.036	0.012	significant
Robust	Сухофрукти	-0.050	-0.064	-0.036	0.014	significant
Robust	морква	-0.002	-0.009	0.006	0.007	not significant
Robust	крупа кукурудзяна	-0.004	-0.017	0.010	0.014	not significant
Robust	крупа перлова	-0.026	-0.036	-0.015	0.010	significant
Robust	крупа манна	0.005	-0.004	0.015	0.009	not significant
Robust	крупа гречана	-0.003	-0.010	0.005	0.008	not significant
Robust	яйця курячі	-0.028	-0.038	-0.019	0.009	significant
Robust	печінка куряча	0.075	0.043	0.107	0.032	significant
Robust	банани	-0.025	-0.033	-0.018	0.007	significant
Robust	апельсини	0.012	0.001	0.022	0.010	significant
Robust	сіль	-0.003	-0.024	0.017	0.021	not significant
Robust	цукор	-0.009	-0.015	-0.003	0.006	significant
Robust	ясо свинини	0.025	0.014	0.036	0.011	significant
Robust	макарони	-0.036	-0.060	-0.013	0.024	significant
Robust	дизельне паливо	-0.016	-0.020	-0.012	0.004	significant
Robust	а-92	-0.035	-0.039	-0.032	0.004	significant
Robust	а-95	-0.018	-0.021	-0.015	0.003	significant
Robust	електрична енергія	-0.069	-0.075	-0.063	0.006	significant
Robust	скотч 48 100	-0.225	-0.275	-0.174	0.050	significant
Robust	клей пва 200	-0.223	-0.260	-0.187	0.036	significant
Robust	ручка кулькова	-0.178	-0.215	-0.141	0.037	significant
Robust	папір а4 80 500	-0.054	-0.065	-0.043	0.011	significant

where coef is a coefficient in percent for the price under the condition of holding a tender procedure

Table 5. Model results for 6 goods from Prozorro Market

reg	r2	product	coef	conf_int_min	conf_int_max	err	significant?	reg	r2	product	coef	conf_int_min	conf_int_max	err	significant?
ols	0.76	"папір" "a4" "80" "500"	-0.138	-0.154	-0.122	0.035	significant	robust	n.a.	"папір" "a4" "80" "500"	-0.163	-0.168	-0.157	0.022	significant
ols	0.12	"електрична" "енергія"	-0.114	-0.171	-0.057	0.089	significant	robust	n.a.	"електрична" "енергія"	-0.087	-0.105	-0.068	0.019	significant
ols	0.83	"a-95"	-0.027	-0.039	-0.015	0.022	significant	robust	n.a.	"a-95"	0.005	0.002	0.008	-0.024	significant
ols	0.39	"a-92"	-0.009	-0.024	0.005	-0.005	not significant	robust	n.a.	"a-92"	0.000	-0.005	0.006	-0.061	not significant
ols	0.889	"дизельне" "паливо"	-0.041	-0.054	-0.028	0.012	significant	robust	n.a.	"дизельне" "паливо"	0.016	0.011	0.020	-0.035	significant
ols	0.597	"риба" "хек"	-0.222	-0.251	-0.193	0.175	significant	robust	n.a.	"риба" "хек"	-0.227	-0.240	-0.214	0.154	significant

where coef is the percentage coefficient for the price under the condition of purchase through Prozorro Market