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# SCALE EFFECT AT PROZORRO PUBLIC PROCUREMENT SYSTEM: THE EXPECTED EFFECT OF CENTRALIZATION

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*ABSTRACT*

The centralization of public procurement can be the source of a reduction in public spending due to the scale effect. To investigate its effect in public procurement, the relationship between the volume of tender procurement and the price per unit of goods under the contract for 12 commodities of the food industry was analyzed. As a result of the research, it was discovered that an increase in purchases by centralization could reduce the price per unit when purchasing flour, beet, cabbage, potatoes, pork, onions, apples and beef, while for purchases of sugar, pasta and butter of high value the effect was not observed. This suggests that the centralization of public procurement can increase the efficiency of using budget funds, which is consistent with the objectives of the ProZorro project.

*Key words: public procurement, Prozorro, scale effect, centralization*

*JEL classifications: D44, H57, D49*

## 1. Introduction

Procurement of goods and services from the state budget is a significant part of Ukraine's GDP, which in 2017 reached UAH 1028.86 bln[2]. According to the Ministry of Economic Development and Trade of Ukraine (MEDT), ProZorro can achieve a 10% state saving rate due to increased competition and increased transparency of procurement procedures[3]. ProZorro is an electronic system designed to increase the transparency and efficiency of using public funds by facilitating monitoring capabilities for civil society and more competition between suppliers of goods and services. For now, one of the main directions of the MEDT's work is to increase the efficiency of public procurement. One of the promising ways to increase efficiency is the use of a centralization tool — the implementation of centralized orders for goods and

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[2] Expenditures of the State Budget of Ukraine. Resource: http://www.cost.ua/budget/expenditure/
[3] Gribanovsky, Chmil, Shapoval and others. "Is there a savings in ProZorro?"
Resource:https://www.epravda.com.ua/cdn/cd1/2017/03/chy-ye-ekonomiya-v-prozorro/index.html

services, instead of separate orders by each state enterprise. The main source of economies from the centralization is the effect of economies of scale, which implies reducing the price of goods or services per unit due to increased procurement. Our task was to check if this concept works for the Ukrainian public procurement market and whether the centralization could lead to further savings in budget funds.

## 2. Literature review

The effect of economies of scale is the classical concept of economic theory, which is to reduce average costs per unit of output with increasing production in the short run (Lindeman, 2002[4]). The effect of this effect is also manifested in the procurement of raw materials, creating the difference between the wholesale prices at which legal entities purchase large batches of goods and retail prices in trading networks. By extrapolating the influence of this effect on public procurement of goods and services, an increase in volumes allows a significant reduction in the value of goods and a better level of service at a lower price (OECD, 2000[5]). However, in spite of the importance of this effect from the point of view of increasing the efficiency of the use of budget funds, theoretical and empirical literature devotes little attention to this issue. Scientists at the University of Perugia Luigi Albano and Marco Sparro [6] (2010) argue that increasing the cost of a contract in the event of centralization increases the market power of the customer and the attractiveness of the contract in the market, which in turn increases the number of players by reducing the price per unit. In 2012, by analyzing data on contracts for the procurement of medicines in Italian hospitals, Baldy and Vanonne[7] (2012) proved that prices for centralized purchases are significantly lower than for decentralized purchases. At the same time, they showed that in regions with higher levels of corruption, this effect is much lower. These scientific achievements indicate that centralization, related to the scale effect, is one of the main sources of increased savings in public procurement.

## 3.    Statistical analysis

Choosing the basic analytical method, we searched for the one that would be as simple and as accurate as possible to describe the data, minimizing the sum of the squares of errors. In order to test the presence of economies of scale in the public procurement market of Ukraine, we considered the following three econometric models: the linear relationship between the price per unit of goods and the number of units in one lot, the linear relationship with the log-transformation of the main independent variable (the number of

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[4] Lindeman, J. B. (2002). *Microeconomics*. Hauppauge, NY: Barron's Educational Series.
[5] Centralised and Decentralised Public Procurement. (2000). SIGMA Papers. doi:10.1787/5kml60w5dxr1-en
[6] Albano, G. L., & Sparro, M. (2010). Flexible Strategies for Centralized Public Procurement. *Review of Economics and Institutions*, *1*(2). doi:10.5202/rei.v1i2.17
[7] Baldi, S., & Vannoni, D. (2015). The impact of centralization on pharmaceutical procurement prices: the role of institutional quality and corruption. Regional Studies, 51(3), 426-438. doi:10.1080/00343404.2015.1101517

units of goods in the lot) and the dependence in which both variables (dependent - price per unit of the product and the main independent variable) are log-transformed. The main model on which our results are based is a linear model with logarithmic variables. The results of this model provide the most statistically significant coefficients and the highest determination coefficient. In addition, the distribution of values of prices and volumes of purchases is sufficiently offset, and taking logarithms can approximate the distribution to normal (in order to satisfy the assumption of the least squares method and reduce the impact of outliers).

Consequently, we simulate nonlinear relationships using logarithmic forms in a linear regression model. Therefore, our model is linear in terms of parameters and looks like this:

$$ln\, y_k = \beta_0 + \beta_{1k}\, ln\, x_{1k} + \beta_{2k} x_{2k} + \beta_{3k} \delta_{1k} + \beta_{4k} \delta_{2k} + \varepsilon_k \,,$$

where $y_k$ - price per unit of goods;
$x_{1k}$ - quantity of items in the lot;
$x_{2k}$ - number of participants (competitors) in one purchase;
$\delta_{1k}$ - a binary variable that defines the purchase with only one competitor;
$\delta_{2k}$ - a binary variable that defines the type of procurement (upstream or open bidding).
$k$ is the product identifier. Since we analyze 12 products, $k = \overline{1;12}$.

The results of the main model and the other two are presented in the appendices.
The ProZorro database has been loaded with information about the following indices:
- price per lot,
- the number of participants,
- the number of items in the lot.

## 4. Conclusion

The results of the regression analysis showed that the effect of economies of scale is present in most of the markets of the studied goods. Thus, the largest decrease in the price per unit of goods is observed in the markets of onion and beet (in response to the increase in the quantity of goods in the lot by 1%, the price is reduced by 0.54% and 0.48% respectively)
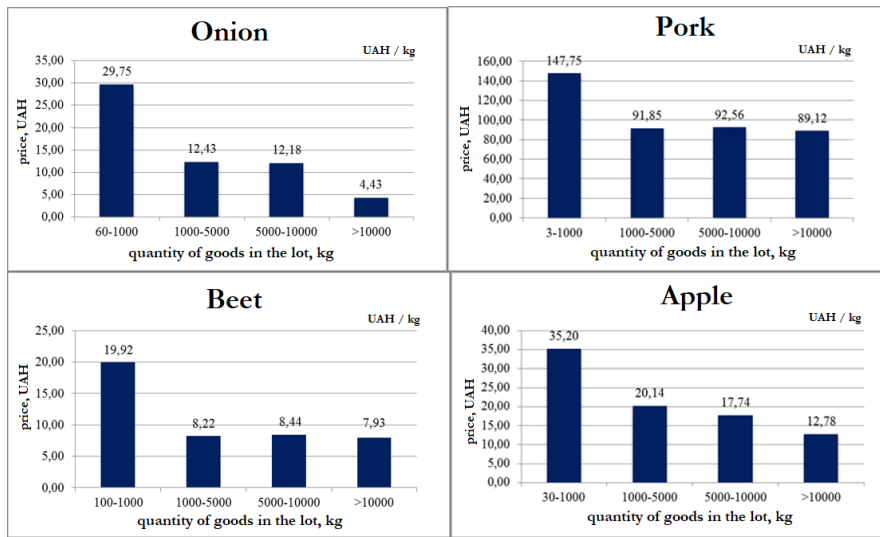
**Figure 1. Price dynamics per unit of output**
*Source: Own calculations based on ProZorro data[8]*

The presence of economies of scales with an increase in purchasing volume is also observed in the markets of such goods as beef, pork, apples, cabbage, flour, potatoes.



**Figure 2. Dynamics of prices per unit of output**
*Source: Own calculations based on ProZorro data[9]*

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[8] https://public.api.openprocurement.org/api/0/tenders
[9] https://public.api.openprocurement.org/api/0/tenders

In the markets of butter, pasta and sugar, there is no economies of scale effect (Figure 3). At the same time, the dynamics of prices in the sugar market contradicts the classical economic theory, since with the increase in the size of a purchase the price of sugar per kilogram increases, but the influence of the amount of goods in the lot on the price per unit of goods was statistically insignificant. The current tendency in the markets for sugar and pasta may be so due to the fact that these products are products with a long shelf life. Therefore, we can assume that suppliers, expecting a decline in demand for products after large-scale purchases, increase the price per unit of output for the large volume of lots.

In turn, the behavior of prices in the market for chicken eggs is quite ambiguous (Figure 3), but the price change is insignificant, as the impact of the quantity of goods in the lot on the price per unit of goods also turned out to be statistically insignificant.
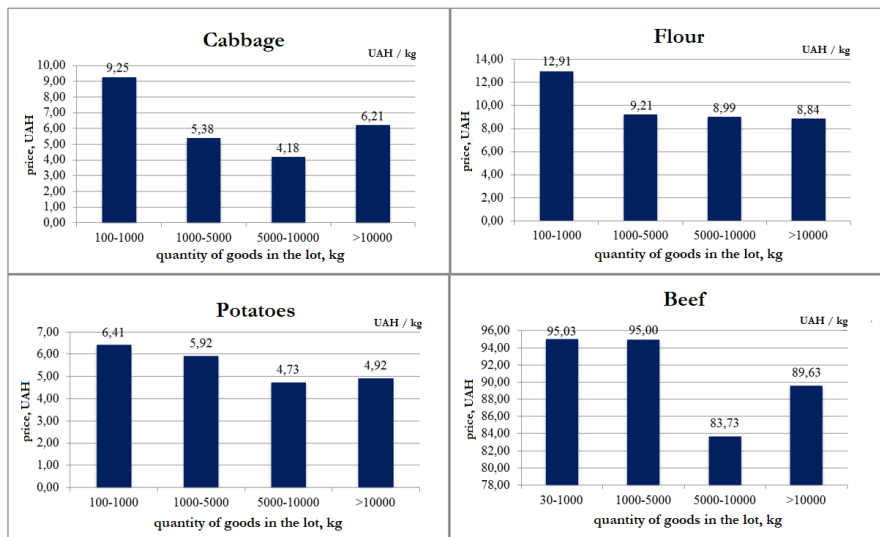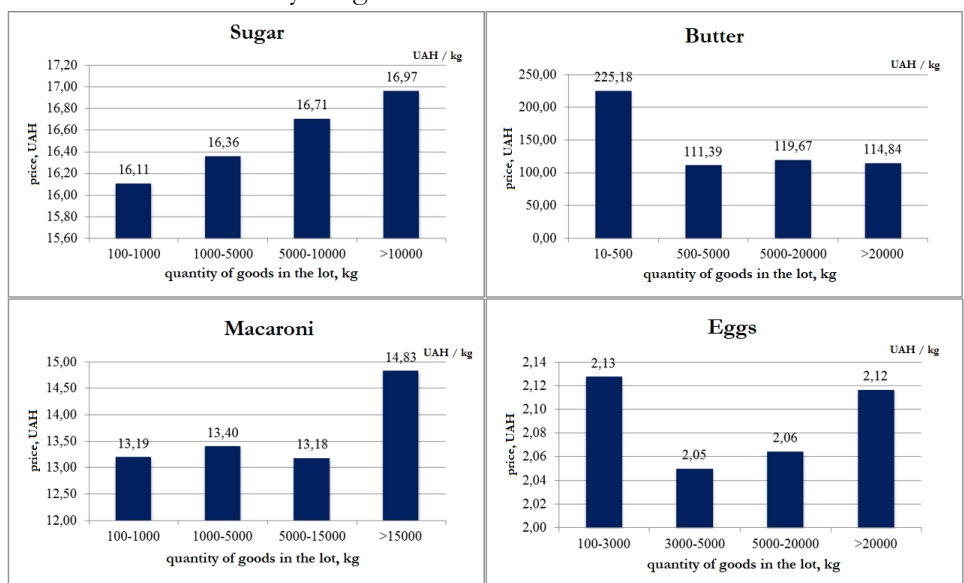


**Figure 3. Dynamics of prices per unit of output**
*Source: Own calculations based on ProZorro data[10]*

The presence of the scale effect for most of the studied goods shows that due to the centralization of procurement it will be possible to increase the economies resulting from the competitive procurement procedure. The scale effect is most significant for the purchase of beets and onions, the centralization of which is likely to lead to lower costs for public institutions. A similar situation is observed in the markets for beef, pork, apples, cabbage, flour and potatoes. At the same time, centralization is not appropriate for the procurement of sugar, butter, pasta and eggs, because there is no "economies of scale" effect for these products. Given the fact that such a situation in the markets of these goods is caused by the desire of suppliers

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[10] https://public.api.openprocurement.org/api/0/tenders

to maximize their own profits, and it is quite logical from the economic point of view, the emergence of the "scale effect" for these goods is possible as the result of state interventions.

Thus, among the potential actions of state bodies there may be the direct regulation of purchases of sugar and pasta, by establishing strict control over the prices for large purchases, and direct or indirect stimulus for suppliers to reduce prices with an increase in the volume of purchases.

Thus, the presence of the scale effect in food markets indicates that it can exist in other markets, which could be a favorable area for future researches aimed at increasing the efficiency of ProZorro's operation and increasing the amount of saved public funds through this competitive platform.

**Appendix A**

The price per unit of goods in the lot was calculated by dividing the price of the lot by the number of items in the lot. As a result of work with data, we received 6778 observations for 12 food products (for each at least 211 observations), including pre-threshold purchases and procurement by competitive procedure from 04.2016 to 09.2017.

The results of constructing three types of regression models for each of the studied goods are given in Table 1.

**Table 1. Comparing of the coefficients of 3 models of linear regression**

| Food products | Number of observations | Change the price per unit for each additional 1000 units | Change the price per unit for 1% increase in the number of units | Elasticity of price change from change in the number of units in a lot |
|---|---|---|---|---|
| Flour | 261 | -0.09* | -2*** | -0.14*** |
| Beet | 211 | -0.58* | -6.02*** | -0.48*** |
| Cabbage | 283 | -0.04* | -1.74 | -0.24*** |
| Potato | 276 | -0.01 | -0.55*** | -0.10*** |
| Macaroni | 691 | 0.03 | 0.02 | 0.0008 |
| Butter | 2093 | -0.68* | -3.38* | -0.03 |
| Pork | 410 | -5.79* | -107.3 | -0.24*** |
| Onion | 252 | -3.29*** | -8.99*** | -0.54*** |
| Apples | 265 | -0.76 | -19.46*** | -0.32*** |
| Beef | 256 | -0.89 | -4.26** | -0.04** |
| Eggs | 1041 | 0.0002 | -0.03* | -0.02* |
| Sugar | 739 | 0.03* | 0.12 | 0.01 |

*   - the coefficient is statistically significant for a 90% confidence interval;

**  - the coefficient is statistically significant for a 95% confidence interval;

*** - the coefficient is statistically significant for a 99% confidence interval;

Source: Own calculations based on ProZorro data[11]

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[11] https://public.api.openprocurement.org/api/0/tenders

## Appendix B. Regression results (Stata)

```
Model: ln(Price)=ln(Numb)+Comp+SComp+DZ
    -------------------------------------------------------------------------------------
                    Борошно       Буряк        Капуста       Картопля      Макарони       Масло
                    lPrice        lPrice       lPrice        lPrice        lPrice         lPrice
    -------------------------------------------------------------------------------------
    lNumb           -0.136***     -0.475***    -0.240***     -0.101***     0.000763       -0.0247
                    (-5.98)       (-11.58)     (-7.40)       (-5.85)       (0.11)         (-1.82)

    Comp            0.0246        -0.00823     0.0229        0.00254       0.00944        0.00543
                    (1.29)        (-0.22)      (0.63)        (0.13)        (1.54)         (0.89)

    SComp           0.208*        -0.0338      0.0999        -0.00815      -0.0314        0.00250
                    (2.55)        (-0.23)      (0.95)        (-0.13)       (-1.35)        (0.12)

    DZ              -0.519***     -1.460***    -0.826***     -0.316***     -0.00975       0.233***
                    (-5.16)       (-4.66)      (-6.46)       (-5.52)       (-0.19)        (-5.91)

    _cons           3.614***      7.088***     4.221***      2.801***      2.555***       4.959***
                    (14.77)       (14.54)      (12.32)       (14.52)       (32.97)        (46.61)
    -------------------------------------------------------------------------------------
    N               261           211          283           276           691            2093
    R^2             0.18          0.38         0.19          0.115         0.0015         0.06
    -------------------------------------------------------------------------------------
                    Свинина       Цибуля       Яблука        Яловичина     Яйця           Цукор
                    lPrice        lPrice       lPrice        lPrice        lPrice         lPrice
    -------------------------------------------------------------------------------------
    lNumb           -0.243***     -0.540***    -0.319***     -0.0435**     -0.0154*       0.00755
                    (-5.73)       (-16.07)     (-6.90)       (-2.95)       (-2.22)        (1.64)

    Comp            0.0164        -0.0161      -0.0265       -0.0251       0.0248**       0.0138**
                    (0.46)        (-0.41)      (-0.54)       (-1.86)       (2.66)         (3.05)

    SComp           -0.159*       -0.0293      0.100         -0.120**      0.00617        -0.00848
                    (-2.15)       (-0.22)      (0.86)        (-2.68)       (0.28)         (-0.68)

    DZ              -0.481***     -1.309***    -1.302***     -0.105*       -0.181***      -0.0110
                    (-4.74)       (-3.79)      (-5.93)       (-2.02)       (-4.51)        (-0.63)

    _cons           6.554***      7.632***     6.320***      4.982***      0.969***       2.713***
                    (18.82)       (17.60)      (12.02)       (35.83)       (10.24)        (54.65)
    -------------------------------------------------------------------------------------
    N               410           251          265           256           1041           739
    R^2             0.22          0.46         0.295         0.06          0.03           0.05
    -------------------------------------------------------------------------------------
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001
```

```
Model: Price=ln(Numb)+Comp+SComp+DZ
```

| | Борошно Price | Буряк Price | Капуста Price | Картопля Price | Макарони Price | Масло Price |
|---|---|---|---|---|---|---|
| lNumb | -2.002*** | -6.020*** | -1.744*** | -0.552*** | 0.0186 | -3.381* |
| | (-4.79) | (-9.45) | (-7.10) | (-5.53) | (0.21) | (-2.36) |
| Comp | 0.302 | -0.722 | 0.129 | -0.0398 | 0.106 | 0.306 |
| | (1.02) | (-1.36) | (0.49) | (-0.34) | (1.33) | (0.27) |
| SComp | 3.792** | -1.010 | 0.837 | -0.141 | -0.388 | -0.198 |
| | (2.63) | (-0.46) | (1.11) | (-0.38) | (-1.32) | (-0.07) |
| DZ | -6.969*** | -21.26*** | -4.947*** | -1.502*** | -0.291 | -28.55*** |
| | (-4.14) | (-4.02) | (-5.41) | (-4.72) | (-0.42) | (-4.81) |
| _cons | 30.34*** | 79.81*** | 24.07*** | 11.71*** | 13.29*** | 151.5*** |
| | (6.87) | (9.75) | (9.19) | (10.43) | (12.86) | (11.70) |
| N | 261 | 211 | 283 | 276 | 691 | 2093 |
| R^2 | 0.16 | 0.34 | 0.19 | 0.1 | 0.01 | 0.04 |

| | Свинина lPrice | Цибуля lPrice | Яблука lPrice | Яловичина lPrice | Яйця lPrice | Цукор lPrice |
|---|---|---|---|---|---|---|
| lNumb | -107.3 | -8.992*** | -19.46*** | -4.255** | -0.0299* | 0.116 |
| | (-1.55) | (-12.09) | (-4.18) | (-3.08) | (-2.22) | (1.55) |
| Comp | 15.56 | -0.890 | -1.727 | -2.660* | 0.0498** | 0.222** |
| | (0.97) | (-1.09) | (-0.70) | (-2.00) | (2.66) | (2.89) |
| SComp | -6.276 | -1.781 | 7.674 | -10.64* | 0.0161 | -0.119 |
| | (-0.18) | (-0.61) | (0.97) | (-2.35) | (0.37) | (-0.58) |
| DZ | -205.5 | -24.23** | -72.85*** | -10.43 | -0.365*** | -0.175 |
| | (-1.51) | (-3.17) | (-4.64) | (-1.87) | (-4.63) | (-0.61) |
| _cons | 964.0 | 109.7*** | 235.6*** | 140.3*** | 2.602*** | 15.17*** |
| | (1.79) | (11.05) | (4.90) | (10.21) | (14.20) | (18.43) |
| N | 410 | 251 | 265 | 256 | 1041 | 739 |
| R^2 | 0.1 | 0.35 | 0.23 | 0.05 | 0.03 | 0.05 |

```
t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001
```

Model: Price=Numb/1000+Comp+SComp+DZ

|  | Борошно<br>Price | Буряк<br>Price | Капуста<br>Price | Картопля<br>Price | Макарони<br>Price | Масло<br>Price |
|---|---|---|---|---|---|---|
| Numbth | -0.0910*<br>(-2.23) | -0.584*<br>(-2.43) | -0.0433*<br>(-2.50) | -0.0109<br>(-1.39) | 0.0298<br>(1.04) | -0.683*<br>(-2.38) |
| Comp | 0.0508<br>(0.17) | -1.835**<br>(-2.93) | 0.133<br>(0.44) | -0.0726<br>(-0.60) | 0.0989<br>(1.25) | 0.121<br>(0.11) |
| SComp | 4.024**<br>(2.62) | -2.105<br>(-0.82) | 1.250<br>(1.51) | 0.0949<br>(0.25) | -0.390<br>(-1.33) | 0.184<br>(0.06) |
| DZ | -5.000*<br>(-2.33) | -16.83**<br>(-2.80) | -2.999***<br>(-3.63) | -0.926*<br>(-2.20) | -0.0359<br>(-0.04) | -24.07***<br>(-5.56) |
| _cons | 14.37***<br>(5.88) | 36.46***<br>(5.76) | 8.716***<br>(7.21) | 6.561***<br>(12.49) | 13.13***<br>(15.28) | 128.3***<br>(30.72) |
| N | 261 | 211 | 283 | 276 | 691 | 2093 |
| R^2 | 0.07 | 0.14 | 0.03 | 0.02 | 0.02 | 0.04 |
|  | Свинина<br>lPrice | Цибуля<br>lPrice | Яблука<br>lPrice | Яловичина<br>lPrice | Яйця<br>lPrice | Цукор<br>lPrice |
| Numbth | -5.790*<br>(-2.11) | -3.292***<br>(-7.07) | -0.759<br>(-1.91) | -0.886<br>(-1.45) | 0.000136<br>(0.87) | 0.0320*<br>(2.43) |
| Comp | -5.475<br>(-0.74) | -0.995<br>(-1.05) | -1.013<br>(-0.45) | -3.189*<br>(-2.31) | 0.0441*<br>(2.35) | 0.246**<br>(3.17) |
| SComp | 4.984<br>(0.12) | -0.938<br>(-0.29) | 14.92<br>(1.65) | -10.63*<br>(-2.33) | 0.0141<br>(0.33) | -0.0750<br>(-0.36) |
| DZ | -23.80<br>(-1.19) | -21.58**<br>(-2.65) | -46.11**<br>(-2.70) | -7.102<br>(-1.22) | -0.241**<br>(-2.86) | 0.302<br>(0.85) |
| _cons | 164.1***<br>(5.49) | 51.99***<br>(6.13) | 68.85***<br>(3.70) | 112.6***<br>(13.74) | 2.223***<br>(22.87) | 15.38***<br>(33.52) |
| N | 410 | 251 | 265 | 256 | 1041 | 739 |
| R^2 | 0.003 | 0.205 | 0.06 | 0.04 | 0.025 | 0.057 |

t statistics in parentheses
* p<0.05, ** p<0.01, *** p<0.001