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Zarządzanie kryzysowe i bezpieczeństwo

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THE PROCESS OF THE SHADOW ECONOMY IN IT SPHERE

Abstract: In this article, transaction costs are considered in the sphere of IT companies. For the biggest of them in Ukrainian cities transaction costs are calculated. We observe several probability distribution and checked hypothesis about distribution of our data.

Keywords: transaction costs, shadow economy, IT company, probability distribution

1. Introduction

Today, transaction costs are very popular in different spheres. Among them is the shadow economy. Shadow economy – economic activity that develops outside of state control, and therefore not reflected in official statistics. "Shadow" companies do not redistribute their budgets and state funds, they do not pay taxes, increasing their own profits.

2. Main part

2.1. Initial data

The shadow economy has both positive and negative effects on the economy as a whole. It is more flexible and dynamic than legal. For the analysis we selected IT companies, which is currently gaining popularity.

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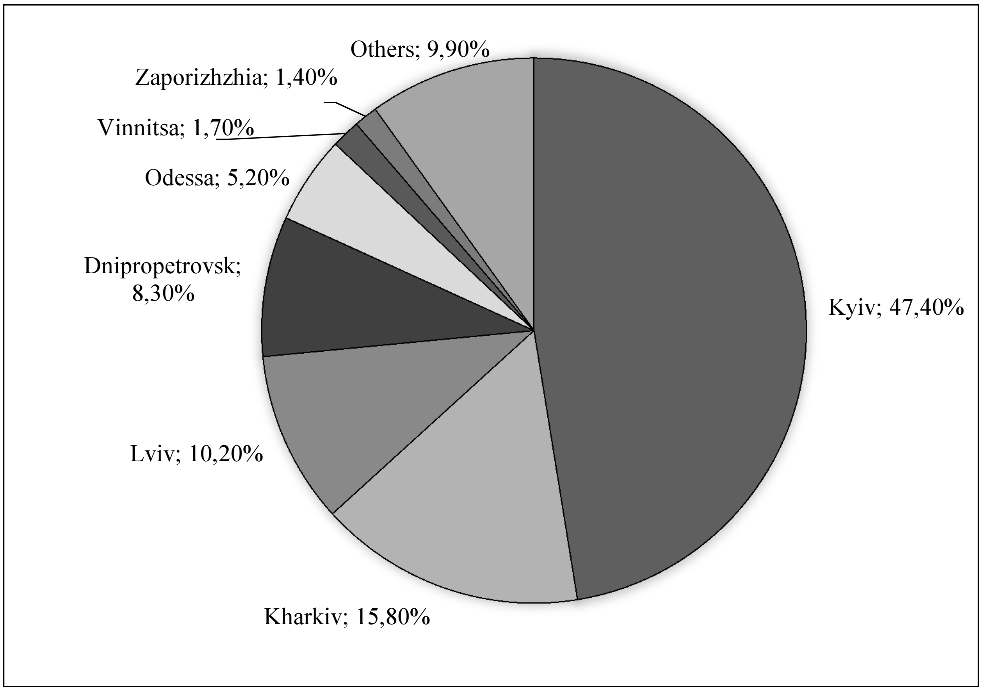
Using data on the number of employees cities of Ukraine involved in IT field we write them in percentage terms.



Graph 1. Number of employees (Data is taken from the site https://jobs.dou.ua/salaries/demography/dec2015/).

Further we will use the most popular cities in IT-sphere, namely: Kyiv, Kharkiv, Lviv. According to the site DOU.ua write down wages according to various levels of knowledge.

Table 1. Number of employees (Own processing)

City	**Lviv**			**Kyiv**			**Kharkiv**		
The level of qualification	1	2	3	1	2	3	1	2	3
Java	33	33	23	129	181	109	36	68	13
JavaScript	25	26	17	64	119	70	25	32	18
C++		14		24	58	36		13	12
Objectiv-C		6		18	38	31		21	8
PHP	8	16	10	63	141	75	8	73	24
Python	6	18	8	21	33	25	29	10	
Ruby/Roils	6	13		8	32	12	8	12	
QA	43	61	19	134	271	113	56	124	28
Sum	121	187	77	461	873	471	162	353	103

In the following tables we provide information about the level of their income.

Table 2. The level income (Own processing)

City	**Lviv**			**Kyiv**			**Kharkiv**		
The level of qualification	1	2	3	1	2	3	1	2	3
Java	400	2000	3300	600	2000	3500	600	1600	3150
JavaScript	500	2000	3050	500	1900	3500	600	1900	3000
C++		2000		800	1750	3200		2000	3000
Objectiv-C		1650		530	2000	3500	600	1700	3000
PHP	300	1400	2300	500	1500	2976	350	1400	2500
Python	300	2000	3300	500	2000	3000		1600	
Ruby/Roils	900	1700		1000	2000	3100	800	1700	
QA	550	1250	1950	500	1390	2500	400	1100	2300
Sum	2950	14000	13900	4930	14540	25276	3350	13000	16950

2.2. Formulation of the problem

After calculations, we obtained the following data: the experiment was attended by 2,808 people, the average salary is \$ 1730 in one department the average working 41,29 person. Generalize:

X_0– number of workers (90 000-100 000)

b_0 – salaru (according to the magazine «FORBES Ukraine» the average salary for ukrainians is \$1 000)

c_0 – salary in «shadow» (the average salary is \$1 730, but in «shadow» is \$730)

Suppose salaries have normal distribution $\mathcal{N}(a,\sigma)$.

$f(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{\frac{(x-a)^2}{2a^2}}$ – distribution function;

$M[X] = a$ – expectation;

$D[X] = \sigma^2$ – variance.

Wage distribution schedule has the following view (see Fig. 1):

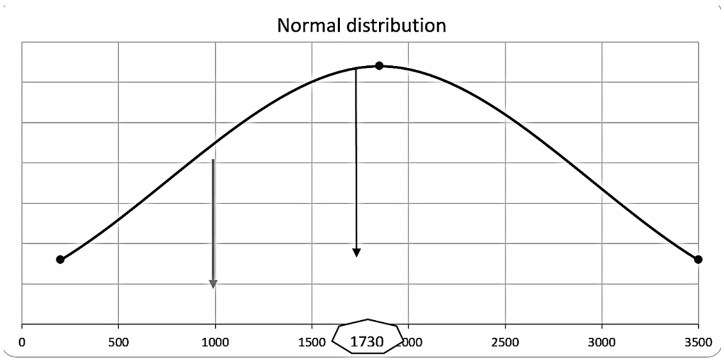


Figure 1. Wage distribution schedule (Own processing)

Now consider the log-normal distribution

$$f_X(x) = \frac{1}{x\sigma\sqrt{2\pi}} e^{-\frac{(lnx-a)^2}{2a^2}} \quad (x > 0, a > 0)$$

$$M[X] = e^{a+\frac{\sigma^2}{2}}; D[X] = (e^{a^2} - 1)e^{2a-\sigma^2}.$$

Similarly, as for normal distribution, we will construct a payroll distribution schedule (see Fig. 2):

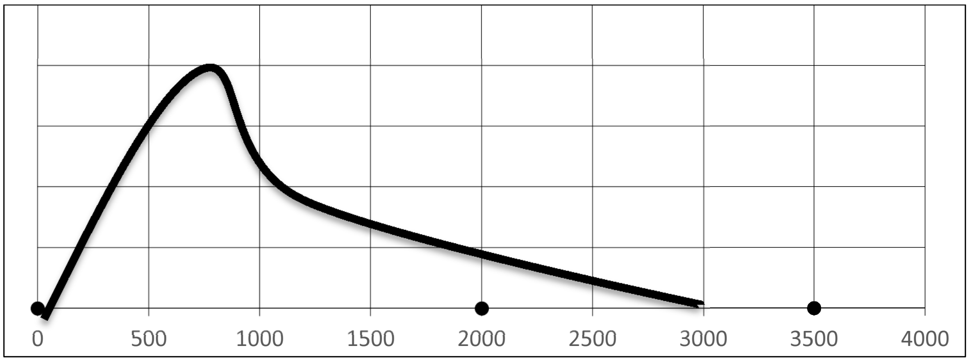


Figure 2. Wage distribution schedule (Own processing)

Draw for the estimation of distribution the maximum like lihood method.

$$L(x|\mu, \sigma^2) = -\frac{n}{2}\ln(2\pi\sigma^2) - \frac{1}{2\sigma^2}\sum_{i=1}^{n}(X_i - \mu)^2$$

To maximize the likelihood function equate the partial derivatives to zero:

$$\begin{cases} \frac{\partial}{\partial\mu} L(x|\mu, \sigma^2) = 0 \\ \frac{\partial}{\partial\sigma^2} L(x|\mu, \sigma^2) = 0 \end{cases}$$

$$\begin{cases} \frac{\sum_{i=1}^{n} x_i - n\mu}{\sigma^2} = 0 \\ -\frac{n}{2\sigma^2} + \frac{\sum_{i=1}^{n}(x_i - \mu)^2}{2(\sigma^2)^2} = 0 \end{cases}$$

Taking data from Table 2 and calculating these values we obtain $\hat{\mu} = 41{,}429, \widehat{\sigma^2} = 0{,}4459$.

Regarding the number of workers who receive so-called "white" salary, we assume that they are distributed by the Poisson distribution.

Y_t – number of workers.

$Y_t = \frac{\lambda^t e^{-\lambda}}{t!}$ – distribution;
$M(x) = \lambda$ - expectation;
$D(x) = \lambda$ – variance.
Also write our statistics using gamma distribution.

$$f_X(x) = \begin{cases} x^{\alpha-1}\dfrac{e^{-\frac{x}{\beta}}}{\beta^{\alpha}\Gamma(\alpha)}, x \geq 0 \\ 0, x < 0 \end{cases}, \text{ where}$$

$$\Gamma(\alpha) = \int_0^{\infty} x^{\alpha-1}e^{-x}dx.$$

Schedule distribution salaries for the gamma distribution is the next (see Fig. 3):

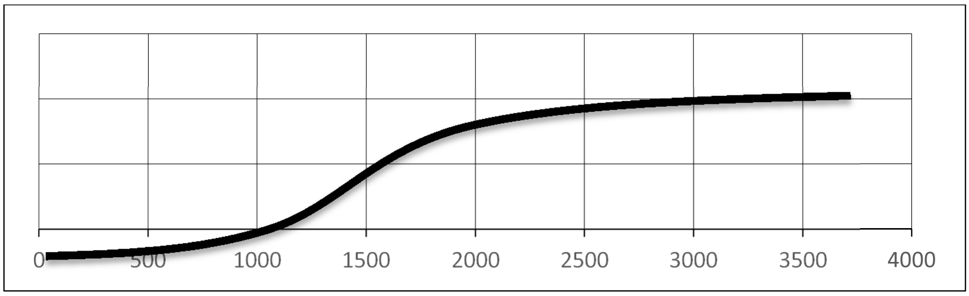


Figure 3. Wage distribution schedule (Own processing).

Evaluate data by method of moments.

$$X_1, \ldots, X_n \sim \Gamma(\alpha, \beta)$$

$$\begin{cases} \bar{X} = \hat{\alpha}\hat{\beta} \\ \overline{X^2} = \hat{\alpha}(\hat{\alpha}+1)(\hat{\beta})^2 \end{cases}$$

Now we obtain

$$\hat{\alpha} = \frac{\bar{X}^2}{\overline{X^2} - \bar{X}^2}$$

$$\hat{\beta} = \frac{\overline{X^2} - \bar{X}^2}{\bar{X}}$$

It should be noted that the estimates found by the method of moments are usually capable, but often ineffective. Therefore, they can only be used as the first approximation, based on which we can find the following approximations with a smaller dispersion.

2.3. Practical approach

After computing the data taken from Table 2 we have:

$$\begin{cases} \bar{X} = 41{,}429 \\ \overline{X^2} = 2539{,}6 \end{cases}$$

$$\widehat{So, \alpha} = 2{,}0849, \hat{\beta} = 19{,}871$$

Write empirical distribution function for the specialists of Senior Software Engineer (1).

(Salary→the number of workers which receive no less wage specified). 300→14; 350→43; 400→132; 500→439; 530→457; 550→ 500; 600→ 698; 800→ 730; 900→ 744.

$$F_{e_1}(x) = \begin{cases} \frac{14}{744}, & x \le 300; \\ \frac{43}{744}, & 300 < x \le 350; \\ \frac{132}{744}, & 350 < x \le 400; \\ \frac{439}{744}, & 400 < x \le 500; \\ \frac{457}{744}, & 500 < x \le 530; \\ \frac{500}{744}, & 530 < x \le 550; \\ \frac{698}{744}, & 550 < x \le 600; \\ \frac{730}{744}, & 600 < x \le 800; \\ \frac{736}{744}, & 800 < x \le 900; \\ 1, & 900 < x \le 1000. \end{cases}$$

Verify the hypothesis of the empirical distribution function for gamma distribution with a significance level of 0.05. Our hypothesis would be to the fact that wages gamma distribution.

2.732637 <1.860 – reject the hypothesis.

Due to the gamma distribution is used inappropriately, then check the hypothesis that wages are normally distributed. To calculate this asymmetry and kurtosis.

$$As = \frac{\bar{x} - Mo}{\sigma}$$

Using the data of Table 1 and Table 2 for a Junior Software Engineer (1) we obtain the following values: $\bar{x}$ =555,4167; Mo= 500; $\sigma^2 = 0{,}4459$.

$$As = \frac{\bar{x} - Mo}{\sigma}; As = 82{,}98927105$$

After analyzing the data we conclude that if Jonior Software Engineer (1) we are dealing with right-sided asymmetry.

Similarly, using the data of Table 1 and Table 2 to calculate the asymmetry of specialist Software Engineer (2). Obtain the following values: $\bar{x}$ =1730,833; Mo= 2000; $\sigma^2 = 0{,}4459$.

$As = \frac{\bar{x}-Mo}{\sigma}$;$As$ =-403,0907451

In this case we are dealing with left-sided asymmetry.

$$Ex = m_4 - 3 = \frac{\mu_4}{\sigma^4} - 3$$

$m_4 = \frac{\mu_4}{\sigma^4}$ - standardized moment,

$\mu_4 = \frac{\sum_{i=1}^{n}(x_i-\bar{x})^4 f_i}{\sum_{i=1}^{n} f_i}$- central moment.

For Junior Software Engineer (1) after scoring get thatEx =56 189 683,93and for Software Engineer(2) Ex =8 807 952 714 897,52. In both cases we have the distribution that satisfies the condition of our original hypothesis.

Also, calculate the percentage of economic resources located in the "shadow". It is 42,2 %

3. Final comments

So, transaction costs are important, yet complex and multifaceted categories, so ignore information about them means not to consider the effect of economic laws of market economy and not be able to make informed management decisions.

This category of economic relations plays an important role in the economic system, as much able to improve the situation in a particular company, because having information about the initial situation in the investment System Company, which invest or future results of situations can make important conclusions. In order not to suffer, but rather to gain.

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Abstrakt

Szara strefa w ekonomicznych strukturach firm IT

W tym artykule, koszty transakcyjne są rozpatrywane w sferze firm informatycznych. Koszty transakcyjne są obliczane dla największych ukraińskich miast. Obserwowano kilka rozkładów prawdopodobieństwa i sprawdzano hipotezę o dystrybucji rozpatrywanych danych.

Słowa kluczowe: koszty transakcyjne, szara strefa, firma informatyczna, rozkład prawdopodobieństwa.