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sustainable development of the Crimea and significantly replenish the budget of the Crimea. The coordinated interaction of enterprises, scientific organizations, educational institutions, business and government agencies to solve this problem will ensure the effectiveness of managing the sustainable development of the region's economy for future generations.

It is important to understand that the implementation of the proposed cluster is essentially aimed at solving those problems that are currently central to the economy of the Crimea and require immediate solutions.

1. The implementation of the cluster approach in the processes of managing the regional economy makes it possible to increase the competitiveness of individual companies, industries and the economy of the region as a whole.

2. The cluster approach is characterized by an increasing attention to the peculiarities of local markets and to the level of separately operating companies, which makes it possible to use local resources and develop state targeted support programs [1].

3. Clusterization always means innovative development of the region, primarily small and medium-sized businesses.

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3. Clusterization always means innovative development of the region, primarily small and medium-sized businesses.

In addition to the advantages, there are a number of difficulties in applying the cluster approach. Clusters created in the regions will be sufficiently susceptible to global crises. In this regard, it should be remembered that cluster policy is only one of the ways to increase the competitiveness of the region's economy, and the best effect from it can be achieved only in conjunction with other measures. It is important that the cluster organization of the development of the Crimean region can have an undeniable impact on improving the quality of life and the level of well-being of the population [5].

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ECONOMETRIC MODELING OF POPULATION EMPLOYMENT INDICATORS IN UKRAINE

Abstract.

According to the statistical information of the advancement indicators of Ukraine, a multiple regression model was developed for such a general indicator of employment as the number of employed people of Ukraine (dependent variable). Factors (independent variables) that affect the value of this indicator have been identified. A preliminary econometric analysis of the model was performed: correlation fields were developed and statistical characteristics of the samples were determined, on the basis of which the data of statistical samples were checked whether they keep in with the standard distribution law; paired correlation coefficients are calculated and the closeness (density) of the bond between all model variables is estimated; independent variables that have the greatest impact on the number of employed people in Ukraine have been identified. A multifactor regression model was constructed, the significance of which was verified by Fisher's F-statistics, and the parameters of the models were verified by Student's t-statistics with a confidence probability of p = 0.95. The model was verified for multicollinearity and autocorrelation. The model developed can be used to improve the planning and adjustment of the employed population of Ukraine. The proposed methodology can also be used to develop appropriate models for any region of Ukraine.

***Keywords**: employed population, value of gross output, consumer price index, fixed capital investment, econometric analysis, multifactor econometric model, autocorrelation, multicollinearity.*

Provision of the sustainable socio-economic development of Ukraine is possible on the basis of developing a modern socially oriented economy. One of the most important priorities is to achieve balanced development of the labor market, ensuring productive employment, which needs to be taken into account. Therefore, for the development and implementation of strategies for socio-economic development of the country in general and its regions in particular, it is extremely important to determine the factors of the main and indirect impact on employment.

After all, today the assessment of the results of economic entities, including the number of employed people, is based on the calculation and analysis of standard ratios. Accordingly, in the conditions of innovative economy this method of analysis is not enough.

The issue of introducing innovation into the methodology of analysis of employment factors of the population of Ukraine is becoming relevant. Thus, along with traditional methods of analysis, it is advisable to use methods of econometric modeling.

In general, the model, as a philosophical category, is the replacement of a real system with another system that to some extent reflects the real one. The modeling is based on the intentional replacement of the processes and phenomena under study with their analogous models, which reflect the features of the original analogous models [2].

The application of mathematical methods in economics makes it possible to identify and formally describe the most important, essential relationships of economic variables and objects, as well as inductively gain new knowledge about the object [6].

One of the directions of economic-mathematical methods of analysis, which consists in statistical measurement (estimation) of parameters that characterize some economic concept of the relationship and development of objects is econometrics [8].

The main task of econometrics in a market economy is to carefully study the quantitative relationships between indicators for a better understanding of economic phenomena and processes, which, in turn, allows more informed formulations of management decisions and forecasts for the future.

Domestic and foreign literature has expressed different views concerning what problems econometrics actually solves and what methods it uses. However, today the range of tasks and methods related to econometrics has been almost completely formed. Compared with the approach inherent in mathematical statistics, the actual econometric approach to the problems studied is not that examples and terminology are taken from the economic field but primarily in the attention given to the question of compliance of the model chosen to the economic object. In particular, the point at issue is about formulating hypotheses among which it is necessary to make a choice to further apply these or those methods of model parameters estimation.

The Article Is Devoted to the development of an econometric model of dependencies and the influence of factors on the number of employed people of Ukraine. The object of the study is the systemic stochastic connections that are formed during the formation of employment. When writing the article, statistical data on the activities of enterprises of Ukraine of the State Statistics Service of Ukraine, regulations, scientific works of domestic and foreign scientists, theoretical textbooks and manuals were used.

The object of the study is the number of employed people of Ukraine. The main factors that affect the performance trait are identified. This is the gross profit of Ukraine, capital investment, consumer price index. The results of the assessment of the changes of these indicators for 2008 – 2019 period are presented in Table 1.

Table 1

Assessment of the Indicator Changes for 2008 – 2019

No.	Evaluation class	Number of employed people, thousand people	Gross profit of Ukrainian enterprises, UAH billion	Investments in fixed assets of Ukraine, UAH billion	Consumer price index
1	amount	222401.40	23864.20	3978.30	1356.80
2	average	18533.45	1988.68	331.53	113.07
3	average absolute incremental value	-399.45	271.25	31.99	-1.65
4	average growth ratio	0.98	1.13	1.08	0.99
5	variance	3798859.42	954611.61	19228.27	137.77
6	mean square deviation	1949.07	977.04	138.67	11.74
7	coefficient of variation	10.52%	49.13%	41.83%	10.38%

According to [15] and the author's own calculations

According to these calculations (Table 1) in 2008 – 2019 period, the average expected value of the employed population of Ukraine was 18533.45 thousand people. The average absolute increase [12] of this indicator showed that during this period the average annual decrease was -399.45 thousand people and amounted to 98.0% growth. The average deviation from the average expected value was 1949.07 thousand people, which is equal to 10.5%. The coefficient of variation is 10.52%,

so the statistical data series is homogeneous and keepi in with the normal distribution law.

The average expected value of the gross profit of Ukrainian enterprises was UAH 1988.68 billion. The average absolute increase of this indicator showed that during this period the gross profit of Ukrainian enterprises increased by UAH 271.25 billion on average every year or 1.13 as much and achieved 113% growth. The average deviation of the indicator from the average expected value is UAH 977.04 billion, which is equal to 49%.

The results of the analysis of capital investment changes in Ukraine are shown in Table 1. According to these calculations in 2008 – 2019 period, the average expected value of capital investment in Ukraine was UAH 311.53 billion. The average absolute increase of this indicator showed that for this period the average annual increase is UAH 31.99 billion, which amounted to 108% growth. The average deviation of the indicator from the average expected value amounted to UAH 138.67 billion, which is equal to 44%.

The average expected value of the consumer price index in Ukraine [13] was 113.07. The average absolute increase of this indicator showed that for this period the average annual decrease was -1.65 points and amounted to 99% growth. The average deviation of the indicator from the average expected value amounted to UAH 11.74 billion, which is equal to 10.4%.

It should be noted that the coefficient of variation characterizes the level of risk of deviations within the critical norm of financial risks. In general, the growth of the consumer price index is proportional to the growth of the employed population and the gross profit of Ukraine, which is characterized by a close relationship between these factors.

Thus, according to the analysis, it should be noted that not all factors influencing the number of employees in Ukraine had a general tendency to decrease in dynamics, the gross profit of Ukrainian enterprises and fixed capital investment were increasing slightly every year.

Research Purpose Formation

According to the Law of Ukraine "On Employment", employment is the activities of persons not prohibited by law and related to the satisfaction of their personal and social needs in order to receive income (wages) in cash or other form, as well as the activities of family members who carry out economic activity or work for business entities based on their property including free of charge one [1]. To increase the level of employment and taking into account the political and economic situation in Ukraine, the main purpose should be to preserve the potential of working people and professionals who are the drivers of the state's economy.

Successful implementation of state employment policy requires the development and adoption of a long-term program aimed at developing a new socially oriented model of labor market regulation based on a balanced combination of tools of state and market regulation. Such a program should be aimed at gradually reducing tensions in the labor market by creating a legal, economic and institutional framework to improve the efficiency of employment. Decisions in the areas of structural policy, formation and implementation of investment programs, income policy, development of the education system should be formed taking into account their expected impact on employment.

The economic factors that affect the employment include the following: the level of economic development of the state (GDP per capita); degree of investment activity; tax-budgetary and monetary policy of the state; inflation rate; proximity to state borders, which allows people, who cannot find employment on the terms favorable to them, migrate to other countries; the level of average monthly wages in the region, the level of income that determine the price of labor in the region. Also, the economic factors in the formation of employment are the productive activities of people aimed at creating gross domestic product of society. An increase in the number of employees leads to an increase in the production of goods, provision of services, creates the preconditions for meeting a wider range of needs and increasing the welfare of the population. Economic factors should include the sectoral structure of the economy, which ultimately determines the demand for specialists in various professions.

In line with these trends, there is a transfer of production with a high level of material and energy costs, as well as environmental risks to the underdeveloped countries. At the same time, the highly developed countries encourage the import of intellectual capital. In view of the foregoing, to organize jobs and increase employment, the main thing is the development of industry, which should be based on new technologies, taking into account the requirements of the time, and this needs capital investment. One such form of capital placement is investment. Investment activity covers all spheres of the national economy: both the sphere of material production and social one. The role of the state in solving this problem is of fundamental importance.

Model Specification

Econometric models belong to functional models. They quantify the relationship between the initial indicators X of the economic system and the performance indicator Y. In general, the econometric model can be written as follows:

$$Y = f(X, u), \quad (1)$$

where

X is the initial economic indicators;

u is the random, or stochastic, component.

Indicators X may be deterministic and stochastic. The additive component u is a random variable, and therefore, given that the dependent variable Y depends on u, it is also a stochastic one. This leads to the conclusion that the econometric model is stochastic.

Development and research of econometric models have certain features. These features are due to the fact that econometric models are stochastic. They describe the correlation-regression relationship between economic indicators. This connection quantifies the existing patterns of economic processes and phenomena. Therefore, to develop an econometric model, it is necessary:

1) have a sufficiently large set of observation data;

2) ensure the homogeneity of the set of observations;

3) ensure the accuracy of the original data.

The econometric model contains a set of regression equations that describe the stochastic relationships between the studied economic indicators, as well as certain identities that characterize the relationship between economic indicators.

The most common mathematical type of relationships studied is a linear one (relative to parameters) and additive in form. At the same time, situations are possible when the same indicators in some equations play the role of the variables that should be explained, and the others are the explanatory variables (such models are called simultaneous equation systems).

The main problems of econometric modeling include:

- identification of variables and hypothesis of model specification;
- specification of the econometric model;
- methods for estimating model parameters;
- model verification;
- forecast of the variables that should be explained on the basis of the model.

The solution to these problems is largely based on mathematical and statistical tools. Much attention is paid to the methods of multidimensional analysis and, above all, to the methods of recognition of socio-economic characters, their typology.

We will develop an econometric model of the dependence of the number of employed people of Ukraine on gross profit, capital investment and consumer price index.

We specify variables: y is the number of the employed population of Ukraine, thousand people (independent variable); x_1 is gross profit, UAH billion, x_2 is capital investment, UAH billion, x_3 is consumer price index in Ukraine, %.

In such a manner:

$$y = f(x_1, x_2, x_3) \quad (2)$$

As shown in Table 1, the resulting feature is the number of employed people of Ukraine in thousands. The data sample is equal to 12 years, i.e. 2008 – 2019, i.e., the estimated current period is equal to 1 year [14]. The main data array was obtained from public information of the State Statistics Service of Ukraine on macroeconomic indicators and the consolidated budget of Ukraine.

The Model Parameters Estimation

The model is estimated on the basis of calculations of partial correlation coefficients and regression parameters calculated by the least square method (LSM) [9].

Partial correlation coefficients of the econometric model were obtained from the developed correlation matrix (Table 2):

Table 2.

Correlation matrix

	Number of employed people, thousand people	Gross profit of Ukrainian enterprises, UAH billion	Investments in fixed assets of Ukraine, UAH billion	Consumer price index
Number of employed people, thousand people	1			
Gross profit of Ukrainian enterprises, UAH billion	-0.83	1		
Investments in fixed assets of Ukraine, UAH billion	-0.68	0.96	1	
Consumer price index	-0.34	-0.10	-0.23	1

According to [15] and the author's own calculations

$r(yx_1) = -0.83$, the relationship between the factors is close, inverse direction.

$r(yx_2) = -0.68$, the relationship between the factors is medium, inverse direction.

$r(yx_3) = -0.34$, the relationship between the factors is medium, inverse direction.

$r(x_1x_2) = 0.96$, the relationship between the factors is close, straight direction.

$r(x_1x_3) = -0.10$, the relationship between the factors is weak, inverse direction.

$r(x_2x_3) = -0.23$, the relationship between the factors is weak, inverse direction.

According to estimates of partial correlation coefficients, it can be seen that the model is dominated by external connections, i.e. between the factors $y \leftarrow x\ (i)$. The internal relations between $x\ (i + 1) \leftarrow x\ (i)$ have a small correlation effect, except for the variables x_1 and x_2, so the presence of multicollinearity can be predicted between these variables.

Of course, multicollinearity is not a problem if the sole purpose of regression analysis is prediction, because the higher the value of R^2 (coefficient of determination), the more likely the prediction. If the purpose of the study is not only prediction, but also analysis of the model, which uses the values of parameters (parameter estimates), then multicollinearity becomes a problem, because its presence leads to large standard errors in parameter estimation.

The external signs of multicollinearity are the presence of a contradiction that arises from a combination of two factors, namely, the high value of the coefficient of determination R^2 (which is evidence, according to Fisher's test, of the absence of zero values of parameters) and insignificance of t-statistics (according to Student's criterion this means that one or more estimated parameters are statistically little different from zero).

There is no single way to determine multicollinearity. The model was tested for multicollinearity by

Farrar-Glauber method [9,12]. This method most fully investigates multicollinearity and uses three types of statistical criteria and allows to detect multicollinearity:

- of the whole array of independent variables (criterion χ^2);
- of each independent variable with all others (*F*-criterion);
- of each pair of independent variables (*t*-test).

To develop an econometric model, it is necessary to be sure that there is no multicollinearity between the selected factors. The task is to investigate the presence of multicollinearity between these factors and, if its existence is confirmed, to draw conclusions about the options for its elimination and the possibility of using LSM (least squares method) to estimate the parameters of the model.

Using Farrar-Glauber algorithm, we find out whether there is a close correlation between the factor variables.

In the first step of this algorithm, we normalize the factor variables X_1, X_2, X_3 of this econometric model by the formulas:

$$x^*_{ik} = \frac{x_{ik} - \bar{x}_k}{\sqrt{\delta^2_{ik} n}} \text{ or } x^*_{ik} = \frac{x_{ik} - \bar{x}_k}{\delta_{ik}} \quad (3)$$

where

n is the number of observations of the corresponding factor variables;

m is the number of factor variables;

$\bar{x}_k$ is the arithmetic mean of the values of the factor X_k;

δ^2_{xk} is the variance (standard deviation) of the ***k***-th explanatory variable X_k.

Normalization and standardization of data is carried out in order to obtain the values of the statistical sample, which would have the same ranges of change. The difference between normalization and standardization is that normalization transforms data that vary in the range 0 to 1, and standardization makes it possible to obtain data whose distribution has an average value of 0 and a standard deviation of 1.

Table 3 presents a matrix of standardized variables obtained in the electronic processor Excel NORMALIZATION function.

Table 3

Standardized Variables Matrix

Period number	Number of employed people, thousand people	Gross profit of Ukrainian enterprises, UAH billion	Investments in fixed assets of Ukraine, UAH billion	Consumer price index
1	1.251291455	-1.021330764	-0.428547596	0.786662033
2	0.850689381	-1.06615994	-0.999704005	-0.065318508
3	0.888912812	-0.888480832	-1.027107974	-0.337952282
4	0.918773263	-0.654509379	-0.51652876	-0.721343525
5	0.934216555	-0.542027041	-0.272777666	-1.130294185
6	0.959767251	-0.476932621	-0.460278508	-1.070655547
7	-0.236087403	-0.411224103	-0.808597378	1.008176974
8	-1.072436585	-0.000187641	-0.421336025	2.575821171
9	-1.15775949	0.40378669	0.199580223	-0.056798703
10	-1.219583965	1.017577941	0.843573497	0.053958768
11	-1.114661931	1.606907609	1.782520018	-0.278313644
12	-1.003121343	2.03258008	2.109204176	-0.763942552

The author's own calculations

We calculate the correlation matrix by the following formula:

$$R = (X_1^*)^T X_1 \quad (4)$$

$$R = \begin{vmatrix} 1 & 0.962050114 & -0.10176895 \\ 0.962050114 & 1 & -0.227059977 \\ -0.10176895 & -0.227059977 & 1 \end{vmatrix}$$

Hence, the determinant of the correlation matrix *det R* = 0,057007872 and the value of χ^2 -criterion will be equal to:

$$\chi^2 = -(n\text{-}1\text{-}1/6 * (2*m+5) \ln |R| \quad (5)$$

where *n* is the number of observations (*n* = 12), *m* is the number of factor variables (*m* = 3).

χ^2 =26.259.

Comparing the obtained value of χ^2 with the table χ^2_{tabl} = 7.814728 at (1/2**m** (*m*-1) = 3 – degrees of freedom and a given level of significance α (α = 0.05), we draw the following conclusion:

since $\chi^2 > \chi^2_{tabl}$, then in this array of factor variables there is a phenomenon of multicollinearity.

The next step of the study will be the calculation of the *F*-criterion by the following formula:

$$F_k = \frac{(c_{kk} - 1)(n - m)}{m - 1}, \quad (6)$$

where c_{kk} are the diagonal elements of matrix *C*, which is inverse to the correlation matrix *R*.

$$C = \begin{vmatrix} 16.63706674 & -16.47040013 & -2.046631868 \\ -16.47040013 & 17.35976192 & 2.265531822 \\ -2.046631868 & 2.265531822 & 1.306128028 \end{vmatrix}$$

We find F_1 = 70.37; F_2 = 81.80; F_3 = 1.53.

We compare the corresponding values with F_{tabl} = 19.35322 at 10 and 2 degrees of freedom and a given level of significance α = 0.05.

We obtained that $F_1 > F_{tabl}$ and $F_2 > F_{tabl}$. Thus,

there is a dependence of factor variables X_1 and X_2 on a set of other variables.

We find the partial correlation coefficients that characterize the relationship density between two variables provided that the other variables do not affect this relationship:

$$r_{kj} = \frac{-c_{kj}}{\sqrt{c_{kk} \cdot c_{jj}}}, \quad (7)$$

where

c_{kj} is the element of C matrix, located at the intersection of the k-th row and the j-th column, c_{kk} and c_{jj} are the diagonal elements of C matrix.

$$r = \begin{vmatrix} -1 & 0.969156445 & 0.439044 \\ 0.969156445 & -1 & -0.47578 \\ 0.439044437 & -0.486002958 & -1 \end{vmatrix}$$

We calculate the t-test by the formula:

$$t_{kj} = |r_{kj}| \cdot \sqrt{\frac{n-m}{1-r_{kj}^2}}, \quad (8)$$

$$t_{hj} = \begin{vmatrix} & 2.917263253 & 1.374934 \\ 2.917263253 & & 1.487419 \\ 1.374934089 & 1.518617413 & \end{vmatrix}$$

Comparing the obtained values of t_{kj} with the tabular t_{tabl} = 1,812 at 10 degrees of freedom and a given level of significance α = 0,05, we draw the following conclusion: since $t_{12} > t_{tabl}$, there is multicollinearity in the pair of variables X_1 and X_2.

A multicollinearity study found that there was a strong relationship between factor variables x_1 and x_2, which could potentially be included in the econometric model, both throughout the array of variables (χ^2-criterion test result) and in pairs. This dependence can significantly affect the quality of estimates obtained using least square method (LSM). Models, in which multicollinearity is observed become extremely sensitive to a specific data set, and the estimates obtained by LSM are biased.

Let's leave the variable x_1 in the model, and exclude the variable x_2.

The model was tested for the presence of autocorrelation of residues based on the Durbin-Watson test.

The statistics are calculated by the formula:

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} \quad (9)$$

where e_t is the residues of the econometric model.

Calculation of Durbin-Watson statistics (Table 5)

Table 5.

Calculation of Durbin-Watson statistics (Table 5)

Residues	*(e(i)-e(i-1))^2*	*e(i)-e(i-1)*	*e^2*
1349.76	1821842.78		
-214.71	46100.40	-1564.47	2447555.75
-63.45	4025.73	151.26	22880.01
75.59	5714.44	139.04	19332.84
-41.90	1755.83	-117.50	13805.44
168.43	28369.53	210.34	44240.90
-324.72	105440.80	-493.15	243196.00
47.54	2259.74	372.25	138572.45
-1614.96	2608098.30	-1662.50	2763897.93
-596.59	355914.00	1018.38	1037088.65
337.32	113785.68	933.91	872181.56
877.68	770326.99	540.36	291990.45
Amount	4041791.44		7894741.97

The author's own calculations

d = 1.95

According to the Durbin-Watson distribution tables, we determine the lower and upper limits of Durbin-Watson statistics: d_l = 0.81, d_u = 1.58 [12] (table 6).

Table 6.

Critical values of Durbin-Watson statistics

from	*to*	*Finding*
0	0.81	autocorrelation is available
0.81	1.58	ambiguity area
1.58	2.42	autocorrelation is non-available
2.42	3.42	ambiguity area
3.42	4	autocorrelation is available

Therefore, the calculated value d of the statistics fell into the zone that determines the absence of autocorrelation of residues.

The general type of the regression equation is described by the equation:

$$y = \hat{y} + e \quad (10)$$

where

y is the actual value of the employed population of Ukraine,

$\hat{y}$ is the theoretical (regression) value of the employed population of Ukraine,

e is the error of results.

The linear form of multifactor regression on the set of 2 factors in general is as follows:

$$\hat{y} = b0 + b1 \cdot x1 + b3 \cdot x3 \quad (11)$$

where

$\hat{y}$ is the theoretical (regression) value of the employed population of Ukraine,

*x*1 is the gross profit, billion UAH

*x*3 is the consumer price index in Ukraine, %.

*b*i is the parameter of the regression equation calculated by the least square method (LSM).

The calculation of the equation of the multifactor econometric model is performed using the Data Analysis application, which is shown in Fig. 1.

RESULT OUTPUT

Regression statistics	
Multiple R	0,933474
R-square	0,871373
Sized R-square	0,842789
Standard error	807,1647
Obseravations	12

Variance analysis

	df	SS	MS	F	F meaningfulness
Regression	2	39722678,83	19861339,42	30,48485769	9,81738E-05
Residue	9	5863634,219	651514,9133		
Total	11	45586313,05			

Coefficient		Standard error	t-statistics	P-value	Lower 95 %	Upper 95 %	Lower 95 %	Upper 95 %
Y-transverse	30001,33	2364,614113	12,68762285	4,78363E-07	24652,20328	35350,46	24652,20328	35350,46079
Gross profit of Ukrainian enterprises	-1,745772	0,239728079	-7,28229942	4,65203E-05	-2,288074244	-1,203469	-2,288074244	-1,203469061
Consumer price index	-70,72018	19,95546892	-3,543899697	0,006275613	-115,8625872	-25,57777	-115,8625872	-25,57777331

Fig.1. The results of the Data Analysis add-on – Regression.

The author's own calculations

The multifactor model of changes in the number of employed people of Ukraine has the form:

$$\hat{y} = 30001.33 - 1.745x1 - 70.720x3 \quad (12)$$

According to the model obtained we have the characteristics of changes in the factor of the number of employed population *y*:

- with an increase in gross profit of Ukraine (*x*1) by UAH 1 million, the value of the employed population of Ukraine will decrease by 1,745 thousand people;

- with an increase in the consumer price index in Ukraine (*x*3) by 1%, the value of the employed population of Ukraine will decrease by 70,720 thousand people.

Checking the quality of the model developed.

The model obtained is significant, which is confirmed by the value of the multiple coefficient of determination $R^2 = 0.8713$. Factors *x* (i) have 87.13% of the influence on the resulting *y*, and the other 12.87% of the influence belongs to factors not taken into account in the model.

The multiple correlation coefficient *r* (*y*, *x*1, *x*3) is 0.9335, which indicates a high level of closeness between the factors. The model is adequate, which is confirmed by the calculations of Fisher's *F*-statistics [10]. $F_{calc} > = F_{theor}$ ($\alpha = 0.05$, df1 = 3, df2 = 10), i.e. 30.48> = 4.76, and the significance of Fisher's F-statistics is close to zero.

The significance of the regression parameters is confirmed by the evaluation of Student's t-statistics at degrees of freedom (n-2, $\alpha = 0.05$) $t_{theor} = 1.812$. The significance of the model parameters showed that they are all significant:

- *b*0: t_{calc}=12,69; *b*1: t_{calc} =-7,28; *b*3: t_{calc} =-3,54.

Thus, all parameters are significant.

Predictive assessment of factor influences.

Estimation of forecast fluctuations of theoretical and actual values of the model of changes in the number of the employed people is given in table 7.

Table 7

Estimation of factor influences in econometric model

Period number	Period	Number of people employed, thousand people	Regression value of the number of people employed, thousand people	Deviation of the actual regression value from the actual one	Lower data range	Upper data range
1	2008	20972.3	19622.54	1349.76	8215.18	31029.90
2	2009	20191.5	20406.21	-214.71	9474.03	31338.39
3	2010	20266	20329.45	-63.45	9447.58	31211.32
4	2011	20324.2	20248.61	75.59	9445.91	31051.31
5	2012	20354.3	20396.20	-41.90	9750.59	31041.82
6	2013	20404.1	20235.67	168.43	9523.96	30947.37
7	2014	18073.3	18398.02	-324.72	6550.02	30246.01
8	2015	16443.2	16395.66	47.54	3499.26	29292.07
9	2016	16276.9	17891.86	-1614.96	6176.31	29607.41
10	2017	16156.4	16752.99	-596.59	4653.53	28852.44
11	2018	16360.9	16023.58	337.32	3787.92	28259.24
12	2019	16578.3	15700.62	877.68	3496.73	27904.51

	amount sum					

The author's own calculations

As shown by the evaluation results, the range of changes in parameter values is within the following [19]:

$$B_{lower} < b_i < b_{upper}$$

$$24652.20 < b_0 < 35350.46$$

$$-2.29 < b_1 < -1.20$$

$$-115.86 < b_3 < -25.57$$

The graph of the range of changes of regression values of the econometric model of changes in the number of the people employed is shown in Fig. 2.

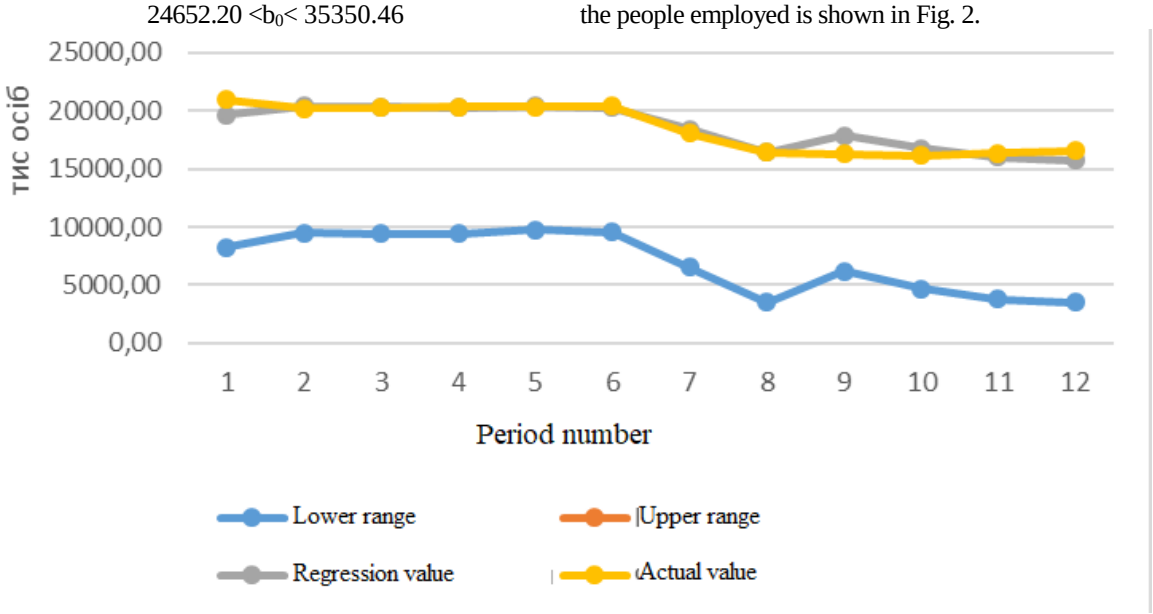

Fig. 2. Graph of the range of changes in the regression values of the econometric model of changes in the number of people employed in Ukraine

The author's own calculations

In general, for the period 2008 – 2019, the number of people employed in Ukraine is characterized by a gradual decrease with slight fluctuations.

CONCLUSIONS

Econometric analysis allows us to investigate the economic system on the basis of stochastic equations, the formal appearance of which is renewed on the basis of the form and type of relationship between dependent and independent factors.

Employment is one of the important indicators of the macroeconomic characteristics of the state, on the basis of which wages, gross income, etc are hereafter studied. According to the previous hypothesis, it was concluded that there is a relationship between employment, gross income, investment in fixed assets of Ukraine and the consumer price index.

Employment was estimated on the basis of a multiple econometric model on a set of two independent factors using the least squares method.

A multicollinearity study found that there was a strong correlation between the factor variables x_1 and x_2, which could potentially be part of the econometric model, both throughout the array of variables (χ^2 criterion test result) and in pairs. This dependence can significantly affect the quality of estimates obtained using LSM. Models in which multicollinearity is observed become extremely sensitive to a specific data set, and the estimates obtained by LSM are biased. Let's leave the variable $x1$ in the model, and exclude the variable x_2. Checking the model for autocorrelation of residues it was determined that the model residues are not autocorrelated.

The developed econometric model of changes in the number of employed people in Ukraine has a high level of multiple correlation and determination (about 87.1%), which indicates a sufficient quality of the model. The estimation of the parameters is confirmed by statistical significance based on Student's *t*-statistics.

The adequacy of the model was assessed using Fisher's *F*-test at 0.05 significance levels, degrees of freedom 3 and 8, respectively, according to the level of variances. The model is adequate, which is confirmed by comparing the actual and table values of the Fisher test.

In general, for the period 2008 – 2019, the number of people employed in Ukraine is characterized by a gradual decrease with slight fluctuations.

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SOCIO-ECONOMIC DEVELOPMENT ASSESMENT OF UKRAINE IN A PANDEMIC

Abstract.

Socio-economic development has many factors of influence, but in 2020 the main factor on which it depended was the COVID-19 pandemic and the introduction of quarantine measures. Most foreign and international scientific publications and forums emphasize that the spread of the virus has a significant impact on the functioning of states. Of course, the negative impact of COVID-19 did not escape the economy of Ukraine. That is why, the main purpose of this article was to assess the economic situation in Ukraine during the pandemic.

Keywords: *socio-economic development, COVID-19 pandemic, nominal GDP, unemployment rate*

Socio-economic development of countries can be described as a complex process of movement and interaction of economic phenomena or units and population. It is an important component of the successful functioning of the state, as its main indicators indicate the current state of the national economy at the international level.

Socio-economic development has many factors of influence, but in 2020 the main factor on which it depended was the COVID-19 pandemic and the introduction of quarantine measures. Most foreign and international scientific publications and forums emphasize that the spread of the virus has a significant impact on the functioning of states. They claim that they are taking measures to curb pandemics, have been effective and slightly aimed at spreading it, but they have a negative impact on the economy [2]. Of course, the negative impact of COVID-19 did not escape the economy of Ukraine. That is why, the main purpose of this article was to assess the economic situation in Ukraine during the pandemic.

The special purposeful cooperation with Ukraine due to the virus was caused by all production processes and any other activity for several months during the all-Ukrainian quarantine that took place in 2020. This has significantly affected the economy and socio-economic development in general.

To better understand the impact of pandemics on the state of countries, we will consider and analyze the main socio-economic indicators using a data from State Statistics Service of Ukraine.

One of the most important indicators is the country's nominal GDP, which in 2020 amounted to UAH 4,194.1 billion. Compared to 2019, it decreased (at constant 2016 prices) by 4.0%. Per capita, the nominal GDP of Ukraine in 2020 amounted to UAH 100.47 thousand. As Ukraine's GDP decreased by 4%, this indicates a decrease in production and sales of goods. The level of unemployment and the level of average wages (nominal and real) have a direct impact on Ukraine's GDP.

According to the State Statistics Service, the unemployment rate was 8.2% at the beginning of the year and 9.3% at the end. Regarding the level of average wages, the data are given in Table 1.

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