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ECONOMETRIC ANALYSIS OF INFORMAL EMPLOYMENT IN THE LABOR MARKET OF THE REPUBLIC OF UZBEKISTAN

Abstract. This article explores approaches to labor market analysis and modeling methods that can be used to regulate and develop the country's labor market. Modern labor market analysis utilizes integrated analytical methods, combining cognitive and program-oriented approaches. In addition to concepts and ideas for forecasting, the article considers the scale and intensity of individual processes and situations, the degree of their interconnectedness and dependence, and the fundamental importance of quantitative assessment, including employment, inflation, unemployment, labor force participation, and demographic indicators. The article concludes with proposals and recommendations for reducing the informal sector in the country in the future.

Keywords: labor resources, inflation, unemployment, correlation, regression, factor analysis.

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ЭКОНОМЕТРИЧЕСКИЙ АНАЛИЗ НЕФОРМАЛЬНОЙ ЗАНЯТОСТИ НА РЫНКЕ ТРУДА РЕСПУБЛИКИ УЗБЕКИСТАН

Аннотация. В статье были изучены подходы к анализу рынка труда и методы моделирования, которые могут быть использованы в регулировании и развитии рынка труда страны. Для современного анализа рынка труда используются комплексные методы анализа, сочетающие когнитивные и программно-ориентированные методы. Помимо концепций и идей в разработке прогнозов, в статье учитывались масштаб и интенсивность отдельных процессов и ситуаций, степень их взаимосвязи и зависимости, а также тот факт, что количественная оценка имеет фундаментальное значение, включая занятость, инфляцию, безработицу, трудовые и демографические показатели. В заключении статьи представлены предложения и рекомендации по сокращению неформального сектора в будущем в стране.

Ключевые слова: трудовые ресурсы, инфляция, безработица, корреляция, регрессия, факторный анализ.

INTRODUCTION

At the current stage of the world economy's development, the role of not only economic indicators that has become a priority in assessing the level of countries' development for a long period, but above all also social indicators that show the standard and quality of population life is increasing. Given the fact that the main part of these indicators is composed of indicators related to the population employment, the emphasis on "human capital" as the main factor of economic growth in developed countries today, the importance of the population employment and related relations is more evident. According to forecasts of the International Labor Organization, by 2023 there will be 3.7 billion of the global working age population, where the number of employed people is expected to be 3.5 billion and number of unemployed one is forecasted to constitute 0.2 billion.

If it is taken into account that by this period, about 55% of the global employed population will have informal jobs, it is necessary to regulate the employment situation in the international labor market on the basis of multi-factor analysis and to optimize the employment level, its modern features should be sufficiently taken into account [1].

These data show that on the basis of the study and analysis of the employment situation in the labor market, it is necessary to adequately take into account the modern features of employment in the processes of its regulation and management.

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As a result of the rapid reforms of subsequent years in Uzbekistan, a new system was formed aimed at ensuring effective employment in terms of quality and quantity.

In the action strategy, "creating new jobs and ensuring the employment of the population, first of all, graduates of secondary special and higher educational institutions, ensuring the balance of the labor market and the development of its infrastructure, reducing the unemployment rate" is defined as one of the important directions [2]. Especially in the context of the global coronavirus pandemic, special attention is paid to supporting the population by increasing the level of employment and income, encouraging new forms of self-employment.

Various world scientific centers, scientists and specialists carried out scientific researches on ensuring population employment, different models, description and changes of factors affecting employment, features and development trends of socio-economic relations in various conditions of the world labor market, improvement of labor market regulation and management mechanisms. Econometric research of population employment in the national labor market of the Republic of Uzbekistan, improvement of models and mechanisms of employment regulation based on the management of multifactorial effects are considered as urgent issues of today.

LITERATURE REVIEW

A number of scientific research works have been carried out in foreign countries on the essence of employment, models of employment, the influence of factors on employment, improving employment indicators and modeling employment on the basis of econometric research.

In this regard, the scientific works of foreign scientists J. Keynes, J. Forrester, M. Porter, R. Dornbush, S. Fisher, G. Menkiw, Hernando de Soto and others are of special importance [4-9].

In particular, the neoclassical model of employment was developed by J. Keynes [3], models of world economic growth were developed by J. Forrester [5], M. Porter, R. Dornbush, S. Fisher and G. Mankyu founded economic growth models that include population employment [6-9], whereas informal employment was introduced as a socio-economic category and the factors causing it were justified by Hernando de Soto.

Factor analysis of employment processes in the labor market in the countries of the Commonwealth of Independent States and theoretical aspects of their regulation have been studied it in detail by V.V. Adamchuk, A.I. Rofe, Yu.D. Odegov, S.A. Aronova, A.M. Moiseev, S.G. Rezinkina, E.V. Semerikova and other scientists [10-16].

In the studies that are mentioned above, scientists theoretically studied employment and its characteristics, forms and types, conditions of occurrence (V.V. Adamchuk, A.I. Rofe, Yu.D. Odegov), the influence of factors on employment (S.A. Aronova, E. V.Semerikova), modeling of the em

ployment process based on factor analysis (S.G. Rezinkina), development of the labor market and improvement of regulatory mechanisms (A.M.Moiseev) focused on practical evaluation [10-16].

Development of the labor market in Uzbekistan, ensuring effective employment of the population, the nature and characteristics of employment, forms and types, the influence of factors on employment indicators, modeling of employment processes are reflected in the scientific researches of scientists such as U.A.Otajanov, Q.X.Abdurakhmanov, B.A.Begalov, T.Sh.Shodiev, R.Kholmominov, Yu.K.Mukhamedov, and H.T. Mukhitdinov [17-24].

DATA AND METHODOLOGY

Economic, comparative and logical analyzes were used within the scope of this study by the researchers. In order to perform an econometric analysis on the selected factors, first of all, the direction of the correlation of x and y and the linear coefficient of the pair correlation are as follows:

$$r_{xy}=b\frac{\sigma_x}{\sigma_y} \quad (1)$$

It is calculated using a formula and through it is determined whether the factors are selected correctly and how and to what extent they are linked. Then, the coefficient of determination of how the factors affect the resulting factor:

$$R^2=r_{xy}^2 \quad (2)$$

It is determined by performing calculations using formula (2). Following that, the parameters of the regression equation (model reflecting the process) of the selected factors (arbitrary variables) and the resulting factors are as follows:

$$b=\frac{\overline{y\cdot x}-\overline{y}\cdot\overline{x}}{\sigma_x^2};a=\overline{y}-b\cdot\overline{x} \quad (3)$$

determined by formulas. It should be noted that the selected factors can be linear or non-linear depending on the measurement units. The model in this study is non-linear, all the factors are logarithm to form the regression equation and the resulting

$$lny=lna+b\cdot lnx \quad (4)$$

the potentiation process is carried out by logarithm of both sides of the equality of this level model:

$$Y=C+b\cdot x \quad (5)$$

here, $Y=lny$, $X=lnx$, $C=lna$.

Using the actual values of x_i, the resulting value of the regression equation - $\hat{y}_i$ is determined. Average approximation error – the value of Ā is found t and the equation is checked with the first quality criterion.

$$\overline{A}=\frac{1}{n}\sum_{i=1}^{n}A_i=\frac{1}{n}\sum_{i=1}^{n}\left|\frac{y_i-\hat{y}_i}{y_i}\right|\cdot 100\,\% \quad (6)$$

The mean error of approximation of the regression equation determined by this method was checked, and in our study this error was reliably up to 8.0%. After that, the significance of the equation's parameters is compared by t-Student's test for each parameter in the case of df=n-k-1 when ∝=0.01 or ∝=0.05 according to the temp>ttabl condition. It can also be determined on a computer using STYuDRASPOBR(0.05;df). Empirical value of t-Student's test with the following formulas:

$$t_{emp}=\left|X-Y\cdot Sd\right|, here\ Sd=\sqrt{S_x^2+S_y^2} \quad (7)$$

can be calculated. In addition, the significance of the determined equation is checked by the following formula using Fisher's F-criterion R^2 coefficient of determination:

$$F_{emp}=\frac{R^2}{1-r^2}(n-2) \quad (7)$$

The true value of this Fisher's F-criterion is checked with the critical values given in the table under the condition $F_{emp}>F_{tabl}$, and the obtained value, the random

character of the determined relationship and the statistical insignificance of the equation's parameters indicate the need to accept the hypothesis H0 about the relationship's density.

In order to carry out the research, the number of initial informal items determined as a result of the selective analysis carried out in the Republic of Uzbekistan in 2011-2021 – (Y as the resulting factor and the real total income per capita affecting it - X1, the inflation rate - X2, small enterprises per 100 thousand people –X3, unemployment rate –X4, average per capita GDP volume-X5 and average per capita investment –X6 factors) using Open statistics of the State Statistics Committee of the Republic of Uzbekistan for 2011-2021.

RESULTS AND DISCUSSION

In the field of studying socio-economic processes, the problem of informal employment and its application in the labor market began to be studied in relatively recent years. In different countries, it was recognized that informal employment does not exist in the labor market, but the territorial study of this phenomenon shows that informal labor relations exist in one degree or another in all forms of management with the gradual expansion of the studied problem. Today, the informal economy includes about 90% of the world's micro-enterprises and small enterprises, and more than 50% of the world's labor resources are employed in it. According to the study's results, employment in the informal sector is characterized by four main characteristics that are common for all market economy countries [3]. The presence of these circumstances makes this problem one of the urgent issues in the labor market today: namely, a need to legalize activities of informal economy workers, use of available opportunities along with official economy workers, as well as bringing them to a status of being able to fulfill their obligations.

Based on this, separate models are defined based on regression analysis using the above selected factors that influence exogenous factors based on the relationship in the form of an ergodic time series, linking the level of informal employment to exogenous factors. First of all, due to the non-homogeneous nature of endogenous and exogenous factors, it is appropriate to transfer the obtained time series indicators to the logarithm form based on e, which in turn allows for the reliability and scientific justification of the obtained results (Table 1).

Table # 1

Logarithmic values of the level of informal employment and socio-economic indicators affecting it

Years	Number of informal workers	Real total per capita income	Inflation rate	Number of small enterprises per 100 thousand people, unit	Unemployment rate	Average GDP per capita	Average investment per capita
t	ln Y	lnX1	lnX2	lnX3	lnX4	lnX5	lnX6
2011	8,341196	7,912032	2,028148	6,54276	1,609438	8,165818	6,499185
2012	8,406128	8,09187	1,94591	6,534951	1,589235	8,362923	6,71101
2013	8,455254	8,269419	1,916923	6,551937	1,589235	8,530958	6,915922

2014	8,295848	8,405592	1,808289	6,569201	1,629241	8,711806	7,109879
2015	8,344695	8,542376	1,722767	6,573261	1,648659	8,863927	7,266618
2016	8,353544	8,680657	1,740466	6,554218	1,648659	8,989706	7,38312
2017	8,339381	8,807078	2,667228	6,609619	1,757858	9,190352	7,70877
2018	8,590406	8,957643	2,66026	6,722148	2,230014	9,464029	8,234724
2019	8,588248	9,160057	2,721295	6,950719	2,197225	9,665541	8,671561
2020	8,633873	9,281477	2,406945	7,142432	2,351375	9,775762	8,722629
2021	8,677508	9,497458	2,332144	7,303237	2,261763	9,954145	8,833608

The correlation analysis is performed to evaluate a density of connections between an endogenous factor and influencing (exogenous) factors using the data from the table above. According to the analysis results, it was determined from value of the pair correlation coefficients; namely, the average to strong connection density was determined between the resulting factor and the selected factors. However, among the private correlation of factors, LnX3 and LnX6 factors meet the condition of multicollinearity with other factors (r_(X_3,X_4)=0.99127, ..., r_(X_3,X_5)=0.8389; r_(X_3,X_6)=0 ,8804; r_(X_1,X_6)=0.9715; r_(X_2,X_6)=0.7465; r_(X_4,X_6)=0.9356; and r_(X_5,X_6)=0.9913) , r_(x1,x2)<0.8, these exogenous factors are excluded from the model according to the condition. The work to determine the regression equation will be continued taking into account values of the correlation density between the remaining influencing factors and the resulting factor. It should be noted that the non-linear relationship model was used to create an econometric model reflecting the effect of factor indicators above mentioned on the number of informally employed population.

The coefficients of the multivariate regression equation and the significance of the regression equation and the coefficients in the non-linear association view using the Eviews software show that this association is within the limits based on the established criteria (Table # 2).

Table # 2

Results of determining the coefficients of the regression equation and checking the equation based on the criteria

Dependent Variable: LnY

Method: Least Squares
Date: 29/11/22 Time: 9:26
Sample: 2011 2021
Included observations: 11

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LnX_1	-0.026902	0.673010	-0.039972	0.0497
LnX_2	-0.019638	0.098277	-0.199818	0.0395
LnX_4	0.534942	0.282921	1.890783	0.0072
LnX_5	-0.059085	0.786559	-0.083636	0.0366
C	8.318126	0.999694	8.320671	0.0004
R-squared	0.836839	Mean dependent var		8.434000
Adjusted R-squared	0.706310	S.D. dependent var		0.125892
S.E. of regression	0.068225	Akaike info criterion		-2.225155
Sum squared resid	0.023273	Schwarz criterion		-2.073863
Log likelihood	16.12578	Hannan-Quinn criter.		-2.391123

F-statistic	6.411130	Durbin-Watson stat	2.181217
Prob(F-statistic)	0.033250		

Source: developed by the authors using the Eviews 10 software package.

Based on the coefficients in the table, the multifactor regression equation has the following appearance:

$$LnY=-0,0227LnX_1-0,02LnX_2+0,535LnX_4-0,0591LnX5+8,318 \quad (1)$$

Focusing on the parameters' significance of the determined 1st regression equation parameters by t-statistical criteria, all selected factors for the study from the equality of $t_{jad}=2,4469$ with $\alpha=0,05$ and df=6 are insignificant, however, Prob. According to the indicator, the importance comes from.

In this sense, it is necessary to check the parameters' significance with retrospective forecast quality criteria MAPE (Mean Absolute Percentage Error) and TIC (Tayl Inequality Coefficient) - an alternative measure of the Tayl forecast's accuracy (Fig. 3).

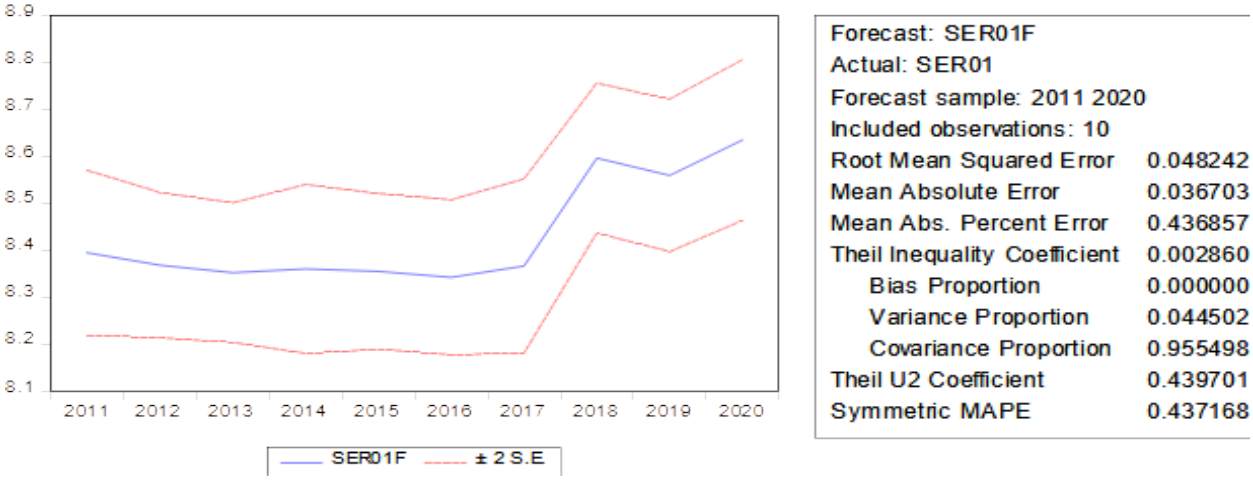

Figure 3. Results of the regression equation's evaluation by MAPE and TIC criteria

Source: developed by the authors

Based on the data presented in Figure 3, it can be noted that MAPE=0.44, which in turn means that MAPE=0.44<10% has a high forecast accuracy and TIC=0.003<1 coefficient tends to zero so that all the parameters of 1st regression equation are significant.

In order to simplify the mathematical rules and calculation processes and to achieve the results' accuracy, the 1st regression equation created above is potentiated and the following equation is created according to it:

$$Y=\frac{X4^{0,535}*e^{8,318}}{X1^{0,0227}*X2^{0,02}*X5^{0,0591}} \quad (1^*)$$

The created 1*-regression equation is statistically significant at a=0.05 and k1=6; Taking into account that $F_{Jad}=0.22057$ when k2=4, the Fisher value calculated from $F_{his}=452.6$, the significance of the 1*-regression equation under the condition $F_{Jad}<F_{his}$ and DW=2.18, due to the absence of autocorrelation, the equation is reliable and adequacy arises.

It can be seen from the results that the level of reliability of the model determined by the multifactorial change of exogenous factors affecting the number

of informally employed population in the economy of the Republic of Uzbekistan is high.

The socio-economic nature of this determined equation 1* can be explained as follows. If the country's real total income per capita, inflation rate and average GDP per capita increase by 1%, the number of informal jobs in the economy was determined to additionally decrease by 1.4 thousand units, 11.2 thousand people and 3.6 thousand people respectively. Consequently, it can be said from this that the low wages paid to formal jobs in the economy forces the population to work informally.

It was determined that if measures to reduce unemployment among the population in the country are carried out without deviation, a decrease in unemployment by 1.0% will lead to a decrease in the number of informal workers among the population by an additional 32,000.

Using the models of changes of exogenous factors under the influence of the time factor and the above 1*-model of the endogenous factor, the resulting factor (the number of informal workers) and the forecast indicators of the influencing factors in the medium term (2021-2025) are determined:

Real total income per capita-$X1=233.6+1190.2 * t;$

inflation rate-$X2=2,6+0,7 * t;$

unemployment rate-$X4=1.9+0.7 * t;$

the average volume of GDP per capita – $X5=-1192.8+2021.1*t$ using the system of equations (when t=13) multifactor forecast results of the number of informally employed population in the economy in the near future (Table 4).

Table # 4

Forecasts of the number of informally employed population and factors influencing it in the Republic of Uzbekistan in 2023-2028

Years	Number of informal workers, thousand people	Real total income per capita, thousand soums	Inflation rate, %	Unemployment rate, %	Average volume of GDP per capita, thousand people
2023	6208,6	15706,2	11,7	11	25081,5
2024	6369,6	16896,4	12,4	11,7	27102,6
2025	6525,6	18086,6	13,1	12,4	29123,7
2026	6676,9	19276,8	13,8	13,1	31144,8
2027	6823,9	20467	14,5	13,8	33165,9
2028	6967,0	21657,2	15,2	14,5	35187

Source: developed by the authors

It can be seen from the table that by 2028 compared to 2023, the number of informally employed population in the Republic of Uzbekistan is expected to increase by 10.9% to 6,967,000 people. This, in turn, is expected to increase the inflation rate by 15.2 percent and the unemployment rate by 14.5 percent. To conclude from the results, it is appropriate to control the fulfillment of the tasks defined in the normative documents issued to ensure the stability of the inflation level in the country and, most importantly, to reduce unemployment.

Forecast indicators based on trend models show that the level of informal employment and indicators of factors affecting it will have a tendency to increase in the near future.

These changes are caused by the quality changes observed in the main regional and macro-level socio-economic indicators considered in the analyses that are performed above (Figure 5).

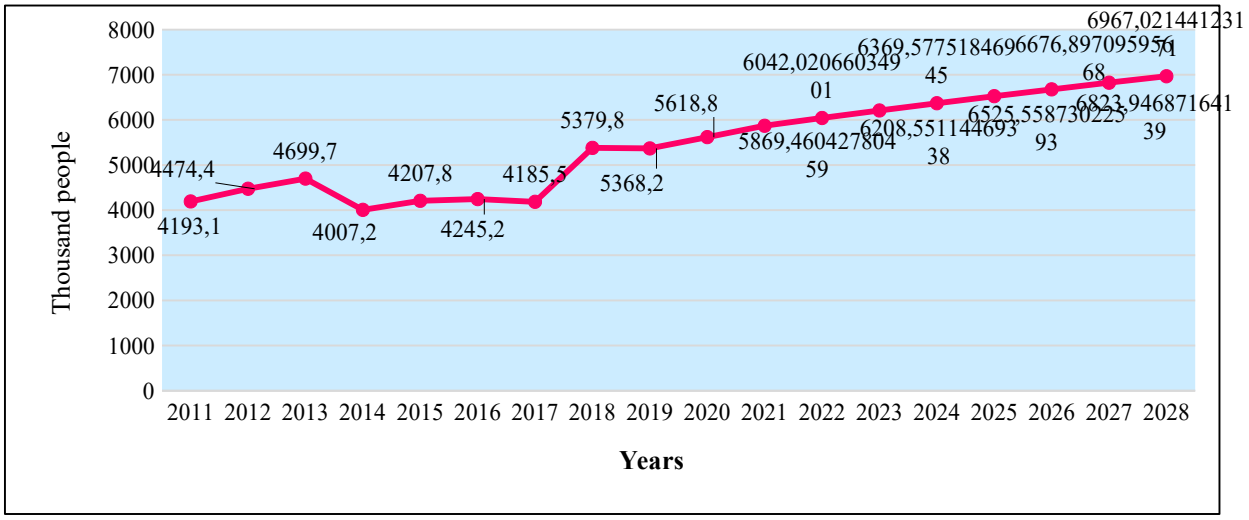

Figure # 5. Changes in the number of informal jobs in the Republic of Uzbekistan

As can be seen from the figure # 5, the number of informal jobs in the Republic of Uzbekistan is forecasted to increase in the future. In order to legalize the situation of informal employment existing in the labor market of our country, the following activities are required:

1. Legalization of informal employment status by improving the current legal and regulatory documents;
2. Encouraging informal workers to move to the formal sector by expanding benefits in the tax and pension system;
3. Strengthening economic and administrative sanctions applied to cases of informal recruitment of labor for enterprises with the status of a legal entity;
4. Application of a stratified and flexible approach to the implementation of state policy in the field of informal employment taking into account the differences between regions;
5. Ensuring the migration of informal workers to the formal labor market by effectively managing the factors directly and indirectly affecting informal employment in the regions. As a result of activities in the specified directions, the legalization of informal employment in our country will be accelerated to a certain extent.

CONCLUSION

In conclusion, the study of collecting process and analyzing existing the social and labor sphere's indicators showed that there are systemic problems; namely, necessary reporting indicators are not fully collected, methodology used in data collection and summarization is not in accordance with generally accepted

international standards of employment measurement, scale of covering enterprises and employees in statistical research is insufficient and there is a limited access to statistical data. In the analysis of the labor market today, it is recommended to use a complex method of analysis that combine cognitive, programmatic and theoretical game methods. With the help of the model defined as a result of this research, the situation and changing trends in the labor market are studied on the basis of correlation-regression analysis and various scenarios can be developed by identifying trends. With respect to the developed scenarios based on the available opportunities, potential and optimal option, the complex model's second component for labor market development – the program-target model – will be formed and implemented.

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